

Section 4 – New Projects

This section covers projects that either significantly extend core offerings currently provided by CATS or introduce entirely new services. The projects in this section are contingent on the successful implementation of the main recommendations offered further above in section 1 of this report.

Most of the projects introduced below represent suggestions as to how CATS could engage new audiences by growing beyond the traditional cable television model.

CATS has very successfully provided high quality PEG content on Comcast Cable since the mid 1970s and ultimately owes its existence and funding (through a share of local cable franchise revenue) to the cable industry. This report does not suggest that CATS abandon this core area of its operation. However, with the increasingly Internet centric nature of modern society CATS is in the unique position to reach a broader audience effectively and thus create additional value for the local community.

The City of Bloomington has been a strong supporter of its principal PEG operator for decades and has created an exemplary track record in terms of transparency in government. Few communities can boast a television services that offers for local government (both at the City and County level) what C-SPAN provides at the Federal level.

As high-speed Internet access becomes increasingly common in the Bloomington area and Monroe County the mandate for repurposing this existing government content for online distribution becomes ever stronger. Some CATS produced government content is available today in an incomplete (there is a back log in digitizing recorded meetings) and basic fashion (the existing catstv.net website lacks usability).

After the successful implementation and launch of the new CATS web portal proposed in section 1 of this report the basic building blocks for expanding online services will be in place.

Where appropriate or feasible suggestions regarding the likely cost of the various measures are included. However, in many circumstances the variability of cost makes predictions all but impossible without actually testing demand. The long-range nature of most suggestion further diminishes the value of detailed breakdowns at this stage as bandwidth and data volume cost continue to decline.

Given the mandate for effective use of public funds, speculative investment in potentially costly content delivery infrastructure may be impractical and irresponsible without proven demand. At the same time, low bandwidth or slow response times, may actually moderate the demand for a specific service. Thus transparency, proactive exploration and the management of user expectations will be essential for long-term success in a space where “build it and they will come” is no longer economically viable.

Background – Internet Video Delivery

Baseline Online Service – What Section 1 Would Deliver

After successful implementation of section 1 of this report CATS should provide access to an expanding portion of its historic library of publicly produced content through a functional, well designed website.

Government content encompassing recordings of all meetings currently telecast/recorded by CATS, as well as important documents being discussed during such meetings, should be available through the same aforementioned website.

Users should be able to search for programs, browse and play video and download associated documents through an intuitive and capable web interface.

The CoB should be able to include videos and documents hosted by CATS directly in pages published through the “City CMS” content management system. To the user these videos may appear as part of the City’s web pages. Monroe County and MCPL may elect to use the CATS repository in a similar way to embed video content on their

respective websites. To drive traffic to the CATS website in general and encourage exploration of the online content repository offered by this PEG operator, video material hosted by CATS and included on the City's, County's and MCPL's sites should be credited as "powered by CATS" or similar with a clickable link back to the CATS site.

On the government content side the backlog of un-digitized meetings not available online should decrease steadily as CATS meets agreed performance targets. Simultaneously, more and more material from the public video production archive should become available online.

The two existing streaming services for City and County channels would be retained and prominently displayed along with an explanation why other channels are currently not available through streaming (i.e. due to rights issues and infrastructure cost). Rather than treating this matter as a regrettable shortcoming, CATS should use it as an opportunity to further drive traffic to the online archive. One way to do so would be by pointing out that many programs on the CATS schedule are available from its archive for on demand viewing.

The schedules for all PEG channels should be presented intuitively and accurately on the website. This should also enable the grouping of content presentation by channel, so that each channel has dedicated branded pages on the site. Upcoming schedules for channels as well as other text-based content on the CATS site should be fully searchable through an appropriate web-search facility. Subject to reaching agreement with Comcast on this matter the web schedule should "mirror in content" the information presented through the subscribers' cable guide provided by the cable set-top box.

The Effects of Section 1

Overall, a range of measures should increase the interest and consequently use by the public of the CATS online repository and general catstv.net website. To recap, this use would include:

- Consumption of normal WebPages
- Queries of the repository (archive of public and government content)
- Downloading of documents (associated with government content)
- Viewing of on-demand video streams/progressive downloads, either from search results or by request received through video items embedded in other partner sites such as bloomington.in.gov
- Viewing of live video streams for City and County channels

It is likely that peak loads on the infrastructure proposed in section 1 of this report will increase as a result of this envisaged expansion of service. Greater accessibility, larger diversity of material, and more exposure points for this material should increase consumption.

What is impossible to predict reliably at this point is by how much consumption will increase and how access patterns to content will be distributed.

- Will user consumption cluster/peak around certain hours of the day and/or specific items of content, potentially leaving the infrastructure near idle the rest of the time?
- Or will the increase be more uniform, increasing the average base-line load on the systems as more users consume more material throughout the day?

Most likely a mix of both phenomena might be observed. Under peak-loads content searches may become slower, downloads could slow down below real-time performance, resulting in buffering/interruptions of playback. Live streams, depending on the encoding and streaming technology used, would either drop video segments or audio or suffer image degradation. Under extreme loads connections to services may drop completely or time out, giving the user the impression that the service is unavailable.

The severity of peaks and troughs and the resultant strain on the hardware and network bandwidth, while currently beyond reliable prediction, are not entirely beyond the (at least relative) control of CATS. The projects further below will provide some examples as to how this control can be exercised.

The Ideal System

It may be tempting to dismiss the challenges posed by demand peaks and troughs as merely an investment issue that is best solved by buying a few more servers and a faster “internet link”. Taking a speculative approach to spending public funds in the hope that service quality will either be sufficient to meet demand, or, if over provisioned, that once “you build it they (the user) will eventually come and use it”, seems unsophisticated and frivolous given the economic circumstances.

Assuming that capital will always be a constrained resource an ideal system would scale cheaply, instantly and incrementally (in single user increments) both in terms of content capacity (amount of content stored) and bandwidth (number of users that can concurrently access this content). When scaling characteristics of a specific service are discussed, this model of the ideal system will serve as a reference point for comparison.

The Myth of Free

While most non-technical decision makers can readily appreciate the associated costs of scaling hardware or the speed with which this hardware is connected to the Internet far fewer appreciate the cost of data transferred over this connection.

The availability of “un-metered” broadband connections in the consumer space may have enforced the perception that there is a cost “for the size of the hole in the bucket” but no real cost to the “amount of water that flows through this hole”. Unfortunately this is not the case. While bandwidth and data-volume cost continue to decline for

commercial customers, the Internet is far from free when used as a mass distribution medium for bandwidth and data volume hungry content such as online video.

The problem is further exacerbated by the nature of much of CATS’s content. Unlike YouTube’s clips, which is usually only a few minutes in length, CATS carries long-form programs such as government meetings often lasting two hours or more. So CATS and by extension much of the CoB content delivery is much more comparable to the feature film delivery of “Netflix Streaming” than to the short clip delivery of popular video sharing sites.

While a speculative assumption, it is likely that a viewer dedicated enough to follow a specific committee meeting online is also likely to consume significant portions of this item, resulting in comparatively large data volumes transferred by each user. This in turn will generate a steeper rise in data volume / traffic from the site, compared to short form centric sites, as popularity increases.

Service Expansions and Their Implications

The following paragraphs consider the direct and indirect impact of introducing various new services to the CATS and CoB portfolios of Internet video services.

The direct impact of a service on the infrastructure of CATS and the CoB describes a change in demand for resources associated with the provision of the service and associated features.

The indirect impact of a service explores likely changes in user behavior as a result of the introduction/use of the service and their effect on the resources deployed by CATS and the CoB. It also describes methods to steer user behavior.

Twitter

twitter.com

“Twitter lets you write and read messages of up to 140 characters, or the very length of this sentence, including all punctuation and spaces. The messages are public and you decide what sort of messages you want to receive—Twitter being a recipient driven information network. In addition, you can send and receive Twitter messages, or tweets, equally well from your desktop or your mobile phone.”

(Source: <http://business.twitter.com/twitter101/>)

Description of Service and Features

The micro blogging site (for those unfamiliar with its nature please follow the URL provided above) could be used to publicize specific content items once they become available for online consumption.

Due to the inherent encoding delays and occasional logistics conflicts, such as two meetings occurring at the same time and being covered by different CATS crews, government content is not necessarily instantly available online. It may be subject to delays of up to a few days before appearing on the new CATS content portal and subsequently (through links) on the relevant committee webpage hosted by the CoB.

A range of notification mechanisms such as RSS feeds and Twitter will enable subscription based self-service notification for interested parties. Furthermore, Twitter could prove a useful tool for providing notification when frequently requested material is due to appear on a specific PEG television channel.

In turn the “@username” feature would also allow followers to respond/react to content tweeted by CATS. This essentially turns Twitter into a text based broadcast medium with “back-channel” capability.

Lastly it may serve as a tool to engage audience segments by providing updates on projects and general day-to-day activities at the

PEG providers or by disseminating promotional clips for upcoming programs.

Summary of applications suggested:

- Notification of online availability of specific content items
- Notification of impending telecast of high value programs
- Share stories, thoughts and images concerning day-to-day operation or specific projects at CATS
- Share preview video clips of upcoming programs (applicable to both online and cable TV based delivery)
- Generate feedback on all of the above from followers

For further inspiration on possible applications of Twitter in a business context please refer to the site’s case study section. (e.g.: http://business.twitter.com/twitter101/case_bestbuy)

All these services should be delivered **through a company account specifically set up for CATS or the CoB** respectively and NOT through an individual employee’s account. This is both a matter of identity / brand development as well as service continuity against the backdrop of staff turnover.

Direct Impact

The need for bandwidth to deliver Twitter feeds is minimal as each message is limited to 140 characters in length. While it is possible to use 3rd party providers to share images through Twitter (for an overview see: <http://mashable.com/2009/05/19/twitter-share-images/>) the bandwidth demands would still be relatively low compared to online video distribution.

Twitter, again through the help of 3rd party providers, could also be used to distribute video clips (as mentioned above) (for an overview see: <http://mashable.com/2009/05/23/video-for-twitter/>) to followers of CATS or the CoB. Bandwidth needs, even in this scenario, are relatively low as the 3rd party services place both length and/or file size

restrictions on the video tweets. Thus a tweet containing for example a promotional preview of an upcoming program would constitute one single upload with all the heavy lifting for the onward distribution to interested users done by the service providers' infrastructure.

Indirect Impact

Online content promoted through Twitter may generate artificial demand peaks shortly after a tweet has been sent out. With suitable bandwidth monitoring and demand modeling CATS could also use tweets to selectively generate demand during periods of otherwise low activity, thus utilizing its infrastructure more effectively.

Similarly by delaying the availability or announcement of such for a predictably popular item, until system demand generated from other popular items has tailed off, CATS could use Twitter as a tool to manage user engagement.

Cost and Requirements

The Twitter account is free.

However, an organization using Twitter should establish clear internal policies on who may use the account and how it is to be used. What type of content is suitable / permissible and how user interactions should be managed. Without such policies a plethora of risks to the organization covering the gamut from breach of confidentiality to libel may arise from undirected use of the company account.

If CATS is aiming to use Twitter to boost demand for selective items or delay announcements to avoid clashes of demand peaks for competing popular items, then real-time information, preferably enhanced by predictive modeling (based on historical data), about system utilization (of online services) should be available to those intending to use Twitter for this purpose.

Finally, if the "corporate" Twitter account for CATS evolves into a popular feedback tool, additional software to manage the incoming information flow and evaluate the impact/effectiveness of outbound communication should be considered. Various free applications are available. (Consider these lists starting points:

<http://www.toprankblog.com/2010/02/twitter-management-tools/> and <http://hyder.me/social-media/14-tools-of-highly-effective-twitter-users/> and <http://www.bookmarket.com/twitter-trends.htm>)

Facebook

www.facebook.com

"Facebook's mission is to give people the power to share and make the world more open and connected.

Millions of people use Facebook everyday to keep up with friends, upload an unlimited number of photos, share links and videos, and learn more about the people they meet."

(Source:

<http://www.facebook.com/facebook?ref=pf#!/facebook?v=info&ref=pf>)

Description of Service and Features

The actual functional components of a Facebook-based service are much the same as those proposed for Twitter. Facebook provides a staging area for information dissemination and sharing with back channel capability. In fact, Facebook feeds, which provide real-time updates about activities of users to their friends, can also incorporate Twitter posts. The main difference between Twitter and Facebook is the increased level of asynchronous interaction. While Twitter seems to thrive on the immediacy of its exchanges, Facebook as an aggregating contextualizing quality and implicitly encourages user driven content curation. Furthermore, the Facebook application model encourages user and third party interactions that can transcend the boundaries of the social networking site itself.

Translating this abstract characterization of Facebook into concrete services provided by the PEG operators a number of options present themselves:

- Notify of online availability of particular content

- Notify of impending telecast of high value programs, preview upcoming highlights
- Share stories, thoughts and images concerning day-to-day operation or specific projects at CATS
- Share preview video clips of upcoming programs (applicable to both online and cable TV based delivery)
- Generate feedback on all of the above from followers/friends and evaluate user engagement
- Affiliate with other organizations on Facebook by becoming “friends” with their pages. CATS and MCPL could link up in such a way to demonstrate their mutual support.
- Develop Facebook applications that provide added value or interactivity to users (e.g. voting, program requesting, educational gaming, etc.)

Connecting with users through Facebook is not an alternative but a complementary vector of engagement to Twitter and a service expansion into this space should be considered as an integrated rather than compartmentalized strategy.

Direct Impact

The direct impact is very similar to Twitter as the volume of data generated by updates to the social networking site is comparatively small. The heavy lifting for end-user distribution is provided by the infrastructure of the social network operator and thus offloads bandwidth consumption from the local PEG operator’s infrastructure.

Facebook nominally does not place any overt restrictions on the length of video clips posted to and thus served by its platform. However, it is likely that a fair use policy would prevent CATS from off-loading the majority of its video delivery onto Facebook. Using the site for previews of specific programs seems more advisable and better aligned with the combined objective of a Facebook and Twitter online presence to promote, engage and inform PEG audiences.

Indirect Impact

Compared to Twitter demand spikes are less likely to occur in very close proximity to an announcement made on a Facebook page. Facebook offers a broader range of interaction types all competing for the user’s attention. This is likely to demote the prominence of updates and posts on the CATS Facebook page as it competes with “Framville” (and other games), status updates by friends, pokes, event invites etc for the user’s attention. Twitter by comparisons seems almost focused with its devotion to the expression and relay of opinions.

Currently interactions may still be dispersed throughout the day and be non-continuous, but the increasing integration of Facebook with mobile devices is likely raise the level of immediacy over time.

With stronger competition for the user’s attention on the platform, the effectiveness and thus strength of demand amplification will be largely based on the consistency with which updates are made and on how engaging the over all content offered through the page turns out to be. Thus exact predictions about the long-term significance of the impact of such a page cannot be reliably made.

Yet, CATS must not neglect other methods of engagement at the expense of an overly zealous focus on Facebook. While quite pervasive Facebook is by no means universally used. If too much content is posted exclusively through Facebook, then would create an implicit requirement for PEG users to join this social network. The policy implications of this may be undesirable at best, or outright contravene open access principles at worst. Facebook should thus present merely one out of many potential ways to engage with PEG online, but must never be the dominant option.

Cost and Requirements

The Facebook account is free, as is setting up a group page. For further information on how to create a page for a business please refer to the following information:

<http://www.facebook.com/advertising/?pages> and
<http://www.facebook.com/help/?page=175>

Facebook groups tend to function as gathering places for people with common causes whereas business pages serve a stronger brand building function. They essentially provide an online identity to the business/organization in the same way a personal Facebook profile provides an online identity to an individual.

Furthermore, Facebook pages for businesses include a suite of free analytical tools to provide feedback about user engagement with the page; a feature that is lacking from groups. With these considerations in mind CATS might be best served by a page rather than a group, owing to the greater flexibility (and ability to create a richer more engaging experience for users) afforded by this choice.

As with Twitter, an organization using Facebook should establish clear internal policies on who may use the account and how it is to be used. What type of content is suitable / permissible and how user interactions should be managed. Without such policies a plethora of risks to the organization covering the gamut from breach of confidentiality to libel may arise from undirected use of the company's Facebook account.

Atom or RSS Feeds and Podcasts

The Atom and RSS standards provide a mechanism to automatically propagate frequently updated/published content such as news pages or audio and video podcasts. The latter terms describes content feeds that include or are based on audio or video material. A user or another website may then subscribe to these feeds using software to aggregate a number of these feeds into a personalized content portfolio. The aggregator software will poll the publisher of the content on a regular basis for updates and download them when they become available.

Please consult the relevant Wikipedia articles as a starting point for further information on the technologies involved.

<http://en.wikipedia.org/wiki/RSS>

[http://en.wikipedia.org/wiki/Atom_\(standard\)](http://en.wikipedia.org/wiki/Atom_(standard))

“Podcast” has become somewhat of a generic term for downloaded media rich content feeds using RSS or Atom technology. The term derives its name from Apple’s iTunes/iPod software and hardware combination that helped accelerate the adoption of syndicated audio/video content for download from a publisher to the users local device. Podcasts thus implicitly support offline consumption as opposed to webcasts, which require online access to consume streamed material.

The iTunes platform (consisting of the store hosted by Apple and the iTunes client application installed on the user’s machine) still provides a convenient way to publish podcasts to a large user based by allowing content publishers free access to the iTunes ecosystem. Once published this way (subject to review by iTunes staff) a podcast becomes discoverable by searches on iTunes clients. However, it is important to understand that Apple does not host the actual media files. The iTunes platform merely serves as a directory of available/submitted content feeds. The podcast is still downloaded from the publisher’s servers once a user has subscribed to it via the iTunes client software.

While a convenient way to reach a large user population, the iTunes platform is not a prerequisite for distributing “podcast-style” content.

Podcasts and RSS / Atom feeds in general are often perceived as push technologies from a user’s perspective, since new content automatically appears on their devices. Technically this view is not correct since the client software polls and then downloads (automatically) any new content. This has some positive and negative implications for network infrastructure demand as will be discussed further below.

Description of Service and Features

Different content feeds or episodic podcasts could be created based on topic or genre. For example all episodes of the CATS produced series “Pets without Partners” (which is a program already available as video podcast by CATS today) or all meetings of a specific City

Government committee could be grouped in such a feed. Subscribers would then automatically find the most recent edition / episode of this program in their “reader” application.

Such feeds present a valuable alternative to users that do not wish to rely on/or join Facebook or Twitter to stay up-to-date with PEG content.

While “iTunes delivered” podcasts would be commonly based on audio or video content, more elaborate feeds based on RSS or Atom technology could also include accompanying material such as notes discussed at the meeting, thus essentially replicating a dedicated news web page for the specific program. The provision of such feeds would be significantly simplified by the successful implementation of the web content management system (WCMS) proposed for CATS.

The WCMS could automatically generate the RSS/Atom feed and also host podcast files as necessary. These feeds in turn could be presented both for consumption or subscription through other sites such as the CoB website. In doing so a wider range of potential touch-points with interested consumers can be created, hopefully resulting in significant subscriber numbers and thus increased content consumption.

As digitization backlogs on the government and public content side decrease CATS should be vocal about this achievement to its audiences.

CATS should publicize both facts through an “about CATS” or “CATS news” type RSS feeds. On the government side users should be alerted once missing programs from a specific meeting category for a particular year become available (or the old real-media versions are re-released in the new site’s streaming format).

For public content a promotional service might include a regularly updated RSS feed of curated collections based on themes (e.g. shows involving pets) or programs (for example the 1984 season of a specific local show) as they become available through the archive digitization process, creating incentives for continued engagement with audiences.

By leveraging its vast archive along newly produced content CATS has a range of options available to update its site with fresh material and provide incentives for frequent return visits by its audiences.

Direct Impact

Compared to conventional live web-casts, which require real-time delivery, the benefit of this type of syndicated content lies in its “for download” nature. Podcasts are downloaded to the playback device or application and thus cope well with slower connections. Alternatively RSS/Atom feeds with embedded media content may present this material either as progressive download or as a conventional link for down.

Either method allows media delivery over bandwidth constraint connections that would not support real-time streamed video at acceptable quality levels. Podcast inherently keep the download process a background task, which allows for even slower media delivery compared to progressive download type applications from a user experience perspective.

Based on the number of subscriptions any new feed published would generate a more spread out demand peak (as not all feed reader applications are likely to be active and polling for content at the same time). For podcasts these peaks can be bandwidth managed, as real-time delivery is not critical in this case.

This may potentially allow a provider to serve a greater number of users with a specific item of content over time as would otherwise be possible in bandwidth constraint situations. The availability of server-logs indicating the number of past requests for a specific item of content within a feed will also allow estimates of feed subscriber numbers and provide aggregate data useful for capacity planning of the over-all system.

The most significant drawback of the automated delivery compared to user initiated content pulls (based on visits to the website) lies in the quantity of data consumed, particularly where podcasts are concerned; Each subscriber to a specific podcast will have her “podcast catcher” application automatically download for example the

entire 2½ hours of video for a specific meeting, even if she is only interested in a 10-minute segment.

Progressive downloads, if configured appropriately, or conventional “on-demand”, streamed content allows for user interaction with the content while it is still stored on the server of the provider. The aforementioned user for example could skip through the video file to the 10-minute segment she is interested in and then close the connection. This behavior results in a significantly lower quantity of outbound data delivered from the provider’s servers and may be economically more viable.

A compromise that allows for a “best of both worlds” approach might be to embed progressive downloads or links to streamed content in conventional RSS or Atom content feeds (subject to adequate bandwidth at the provider’s end).

Indirect Impact

If subscriber numbers for each feed are modeled on an ongoing basis the release schedules of various feeds can be used to smooth demand peaks and provide higher over all resource utilization. For example one popular feed is released and once demand tails off (as most subscribers have downloaded the feed), two less popular feeds can be released simultaneously generating an aggregate demand on the infrastructure similar to the one popular feed.

Thus with diligent resource monitoring, content syndication can provide a valuable tool to steer user demand and deliver media over bandwidth constraint connections without sacrificing resource utilization.

Cost and Requirements

WCMS implementations generally include the capability to generate syndication feeds based on either RSS or Atom technology. The iTunes platform does employ a review mechanisms for podcasts published through it. This service is free to content providers but may impose delays in launching new feeds or prove unreliable when some politically sensitive issues are covered.

Archive Streaming and Progressive Downloads vs. “Conventional” Downloads

If the recommendations outlines in section 1 of this document are implemented by CATS, the main PEG provider in the Bloomington market, a vast archive of publicly produced content will become available for online consumption over the coming years.

As indicated elsewhere in this report, this archive reaches back to the late 1970s and at this point comprise significantly more content than the rapidly expanding collection of government meetings.

Unlike government meetings, which tend to decay in relevance as time progresses, and thus are less likely to generate late access requests, this public (access) archive represents a much wider spread of material with largely unpredictable access patterns.

When implementing a method for presenting the material for online consumption, CATS will be required to make trade-offs between speed of service and the number of serviceable requests. These trade-offs will largely be based on the delivery method chosen.

Description of Service and Features

The following options present themselves as suitable solutions for serving content to users from the archive of publicly produced content based on user browsing or searching activity. These considerations are independent of any other tools, such as for example Facebook or Twitter, which CATS may consider using to promote specific items of content.

- **On-Demand Streaming:** Subject to a suitable streaming server being available this provides instant access to content including skip and pause functionality. Service quality is highly dependent on the available system bandwidth to serve users. Bandwidth degradation directly and immediately degrades the user experience. As user graze through segments of material only one video stream per user is generally active at any given time resulting in moderate amounts of data being consumed by the user.

- **HTTP Segmented Streaming:** This solution allows for bandwidth adaptive video delivery over networks with variable bandwidth characteristics such as cellular data connections (The technology naturally also works with desktop clients). The client requests short snippets of content based on the connection quality and assembles them during playback. The technology works with conventional web servers without the need for specialist streaming servers/protocols. It traverses firewalls and network address translation without problems, unlike some streaming protocols. The segmented HTTP streaming approach allows for dynamic switching between different quality levels during playback based on network quality. However, media needs to be encoded (in multiple version), segmented and packaged correctly for this technology to work. Furthermore, the playback client needs to support the technology. There are currently three competing and mutually incompatible implementations available:
 - Adobe HTTP Dynamic Streaming (requires Flashplayer 10.1, thus excludes iOS devices but likely to work with Android and Symbian mobile devices as announced player ports become available):
<http://www.adobe.com/products/httpdynamicstreaming/>
 - Apple Live Streaming (currently limited to iOS devices and OSX with QuicktimeX):
<http://developer.apple.com/iphone/library/documentation/networkinginternet/conceptual/streamingmediaguide/introduction/introduction.html>
 - Microsoft Smooth Streaming (requires Silverlight plugin on client machine and Microsoft IIS web servers to host, can emulate Apple Live Stream server sided for iOS clients):
<http://www.iis.net/download/SmoothStreaming>
- **Progressive Downloads (HTTP based):** Search results are displayed through an embedded player application similar

to for example “YouTube.com”. This allows for a reasonable user experience over variable bandwidth connections, with paused playback and consumption delays as the most significant impact. User expectation may be more accustomed to this behavior based on the variable service quality available from larger video (sharing) sites like “Youtube.com”. The tendency by users to pre-cache content by opening multiple windows in their browser does exist but is likely to be more prevalent for multiple short content items (further research would be required to verify this). Skip and pause functionality is generally available and leads to a renewed download from the new playback point in a file (if the destination point had not yet been downloaded), thus reducing the overall quantity of data transferred. Can be delivered through standard web server.

- **“Conventional” Downloads:** Search or browse results may contain a brief preview clip served through either method above, but the actual main program would be downloaded as a whole by the user. This allows for delayed but high quality servicing of user needs even over severely congested connections, as delivery speed can be significantly slower than real-time (user tolerance provided). As anecdotal evidence from download and file sharing services seem to suggest this may encourage a hoarding behavior on part of the user where large quantities of content are downloaded “just in case” without actually ever being consumed. This method of delivery is likely to result in the greatest quantity of data being consumed per user. Skipping and pausing on the local machine has no impact on the quantity of data required for serving the user as the whole program is always downloaded regardless of how much of it is actually consumed.

Advanced Service Options

With HTTP streaming services in particular CATS could deploy new service concepts such as content adaptive or personalized streaming channels with skip forward functionality. These concepts have been pioneered in the music domain by services like “Pandora” and “SlackerRadio”. The user is presented with a dynamic playlist of clips based on genre or her own preferences and thus gets the impression

of a continuous, streamed channel. If the user does not like a particular program she can skip forward to the next program. The server can then take into account user preferences as the playlist is extended.

There are a number of variations on this concept and CATS could use such services to exploit the depth of its archive and create prolonged engagement with its users by facilitating such “assisted” content discovery. The latter would require good metadata to classify archive content suitably well to allow for preference-based suggestions. Additional data to improve playlist customization could be drawn from recommendation systems based on analysis of related searches and consumption patterns by other users. Due to the underlying analytical complexity to drive such a service it has been placed in this section (section 4) rather than section 1.

Direct Impact

If analytical tools are in place, streaming and progressive downloads offer a rich source of data about user behavior and content preferences. For an organization like CATS, which does not depend on selling online advertising linked to popular content, such data may be less relevant than for a commercial provider.

Each method described above has the potential to generate demand peaks based on unexpected popularity of a specific item. On-demand streaming is most susceptible to the self-limiting implications of instant user experience degradation (dropped streams, frames or poor image/audio quality) caused by an overloaded delivery platform. Progressive downloads will degrade less perceptibly, especially shorter clips, as a brief wait before playback may be less noticeable to users. Conventional downloads would suffer the least as consumption is delayed to a later time regardless. Popular downloaded files are also more likely to be passed on among a community of followers through other channels (such as file sharing), which may not necessarily impact CATS’s infrastructure.

As over-all popularity of the archive increases progressive downloads are more likely to accommodate “grazing” users exploring a diverse selection of content while still maintaining an acceptable quality of service (user experience) as the technology smoothes over temporary

congestion. In terms of limiting the quantity of data consumed by the user population this service is also likely to significantly outperform conventional downloads and perform almost as well as the most efficient option of on-demand streaming.

Indirect Impact

Each of the four solutions presented offers different potential for actively influencing user behavior to maintain overall service levels and mitigate some of the inherent shortcomings of each technology. A non-exhaustive list of suggestions follows.

On-demand streaming, subject to appropriate management, could be configured to serve a lower resolution version of popular material during peak times, thus allowing a greater number of users to be served this way. For very long items resetting a user’s connection after a certain time interval may be effective during times of high demand. This process forces the user to reconnect and skip to the last position (prior to the reset/disconnection) in the clip. It thereby eliminates streams that have lost the user’s attention.

Progressive downloads and segmented streaming generally don’t offer active server sided image quality management, however the number (and speed) of connections allowed to a specific client can be limited to reduce the amount of pre-caching through multiple open browser windows. In the case of segmented streaming this also provides an indirect means for controlling/limiting the maximum image quality of a stream.

Conventional downloads allow for similar interventions as available for progressive downloads. Namely, the number and speed of connections/downloads available to each user can be managed/limited quite easily to curb excessive consumption by a minority in favor of providing service to a greater number of users.

Quality of service for all types of delivery may also be prioritized based on past consumption patterns associated with a specific IP address or IP location. Connections from within Bloomington or by frequent or infrequent users may be prioritized. The latter requires tracking of individual machines by means of IP address or cookies. Each

approach has drawbacks and inaccuracies and thus such measures may be considered controversial and should probably be avoided in favor of an infrastructure upgrade.

Cost and Requirements

The actual cost of implementing the service would be captured as part of the WCMS deployment. Streaming server licenses may add some extra cost (up to several thousand dollars depending on the platform) compared the HTTP/FTP based solutions (i.e. progressive downloads, segmented streaming, conventional downloads). Segmented streaming currently is still the most complex to implement and operate (due to specific content packaging requirements).

Depending on how the billing for connectivity is structured. On-demand streaming and progressive downloads would be more influenced by the cost of connection speed whereas conventional downloads would impact data volume (quantity) charges more severely.

From the scalability perspective, if the archive service were to become surprisingly popular, conventional downloads place the lowest burden on the hardware infrastructure (servers) and provide the highest degree of influence over managing user bandwidth and indirectly also the quantity of data consumed (if downloads were actively slowed down). However, in an environment where instant availability of media is increasingly expected the very limitations of a download service could hamper widespread user adoption.

Live Streaming of Channels

CATS currently offers live streaming of its output for Comcast channels 12 and 14 (City and County Government respectively) through its website. The service is based on Apple's QuickTime streaming and was available under the following URL at the time of writing this report: <http://stream.catstv.net/cats/>

Description of Service and Features

After transferring CATS's web presence to the web content management system (WCMS) proposed in section 1 of this document the live web-streaming of channels 12 and 14 should continue.

The streaming technology may eventually change or bandwidth and encoding settings may be altered compared to the existing setup to accommodate more users or better picture quality within the infrastructure constraints.

The user survey conducted for section 2, although statistically not representative, surfaced a desire by participants to increase the number of CATS channels available through live streaming. While technologically possible, rights issues may prevent this from happening in the near term.

Comcast channels 3 and 7 may eventually offer some or all of their content for streaming. However, this would require an adjustment to the rights negotiated for events covered, particularly for local musical performances. In the likely event that rights clearance cannot be achieved universally, live streaming of these channels would have to be temporarily disabled during programs not licensed for online distribution. A suitable noticed should be displayed during such breaks.

For as long as Comcast channel 96 remains allocated to re-broadcasting SCOLA International, any webcasts of its content seem unlikely to happen due to rights issues. SCOLA maintains its own subscription based online strategy and offers selected items for free online.

The type of intermittent live streaming, as applicable to Comcast channels 3 and 7, would require more sophisticated rights management than currently supported by CATS's processes and systems. Furthermore, a reliable mechanism for rights based linking of broadcast and webcast operations would be required, which may prove expensive to implement.

The proposition of online access frequently substitutes as a “catch up” service for those with access to a cable subscription but may occasionally provide value in live coverage to those without. However, given the limited extra benefit compared to an on-demand streaming solution (with accelerated turn-around / availability of relevant programs), the cost and complexity involved in implementing live streaming for channels 3 and 7 seem hard to justify.

Public expectation on this matter needs to be managed with a clear explanation available online as to why channels, other than those for City and County, are not available for streaming.

Direct Impact

Assuming that for the reasons outlined above live streaming will remain limited to the two existing channels, only moderate infrastructure upgrades may be required. The existing service seems to be relatively lightly used although this may be in part due to lack of promotion of CATS’s online activities. Since an increasing number of City meetings are available for on-demand streaming, the value proposition of the live service is reduced within the use context of online delivery as a “catch-up” service.

However, it is possible that increasing traffic to a searchable archive of all content, covering political and public access material alike, may negatively impact the live streams in the future. Further monitoring of user behavior will be required to establish reliable metrics for capacity planning.

Depending on the hosting options chosen by CATS, streams may still originate from the local infrastructure. Alternatively relaying via a third party provider may be an option to either increase service capacity temporarily, during very popular events, or permanently. In either scenario CATS would just provide one single (protected) live stream to the relay provider, which would then service streaming requests by users from this 3rd party infrastructure.

Another cheaper option might be providing an additional lower bandwidth audio only stream as a fall back option during times of high demand.

Multicast delivery is often cited as another bandwidth efficient delivery method for live streams. In this approach only one stream is passed between Internet routers until the stream reaches a branch point to which multiple users requesting to view the stream are connected. While elegant and resource efficient in theory this technology never gained widespread adoption outside closed private networks, as all routers between the client and streaming source need to support the protocol.

Occasionally there are attempts to resurrect the concepts behind this type of delivery but at this point such projects are largely experimental, much like peer to peer streaming, and thus seem not (yet) suitable for CATS’s needs.

Indirect Impact

Live services may lead to less engaged / passive consumption compared to the more focused mode of interaction common with on-demand clip browsing. A live stream might be “left on” to run in the background, long after the user has lost interest. This results in hours of bandwidth and data consumption by a software client and does not necessarily equate to actual content consumption by a human (user).

To manage the cost implications of this behavior it may be advisable to periodically reset the connection of a user to force a disconnect and reconnect. This procedure would help to automatically eliminate such background / disengaged content streams from the streaming server’s connection list. One or two hour intervals may be suitable to strike a balance between user experience and resource conservation.

Peak use is likely to mirror the cable TV channels for popular PEG content and network monitoring should help establish online “prime-time” periods. Such knowledge may in turn influence demand management on other services, depending on what level of priority live streaming is given in CATS’s online strategy.

Cost and Requirements

Streaming server licensing fees are frequently based on the number of clients supported. However, this number may not correlate to the actual number of connections supported by the infrastructure. CATS

should perform diligent capacity planning prior to any new license acquisitions and aim to re-use existing licenses for QuickTime (and possibly Real) streaming.

Due to the moderate user pool permanent relaying may not be cost effective at this point.

Linking Schedule to Archive

The weekly or daily schedule displayed on the website may include direct links to programs stored in the archive for on-demand consumption. This option provides an effective substitute for live webcasting of channels with mixed content usage rights and can be managed through manual processes if necessary.

Description of Service and Features

Based on the workflow changes suggested in section 1 of this report all content being telecast on cable TV should have already passed through an archive digitization process prior to playout. Thus all material that has been “aired” (cablecast) would automatically be available for online consumption. This excludes live content or content relayed from other external feeds.

CATS could chose to make this material available to users in a convenient way by providing direct links to these programs (stored in the on-demand archive) from the schedule pages on its website.

CATS may then chose to control availability based on when the program is aired or when the schedule has been finalized. The latter would essentially provide prioritized content availability for online consumption over telecast viewing.

Suitable live material, such as government meetings, could link to the live streaming services. Public access material that is produced live using the studio at CATS could either be offered as live webcast for the specific event or be ingested in into the archive and made available shortly after airing.

Direct Impact

The service may increase traffic to / use of the online archive service and live streaming service by providing an additional and convenient means of interaction. Demand peaks are likely to occur within hours or days of airing a specific item. Depending on what online release policy is chosen, control over those peaks is limited and driven by the playout schedule of the actual cable channels.

Indirect Impact

By serving as an entry point to the online content archive this service may have promotional qualities that may increase over all use of the archive.

Users that in the past would have simply looked up a channel's schedule online may be enticed to explore the archive further for other recently telecast programs.

Cost and Requirements

Providing this service should not incur any significant additional cost beyond the infrastructure upgrades already discussed in section 1 of this document. Some minor programming work may be required to automate the schedule publishing and linking process as well as define the rules for availability / online release of content. Other than that this service fully utilizes existing resources from the recommendations above and merely represents a usability improvement for content access.

Seeding “Peer to Peer” Networks

Per to Peer networks (P2P) provide an effective way for content delivery to large groups of users without the need of an extensive hosting infrastructure by the content provider. This fact has been heavily exploited by various file-sharing services, which in turn has given P2P a reputation for enabling large-scale music and video piracy. This negative image of P2P somewhat detracts from its legitimate use as a low cost distribution platform for organizations without the financial means to support the large and well connected download platform.

But also large players in the media industry like the British Broadcasting Corporation (BBC) have used P2P technology in the past to deliver content. The first version of the BBC iPlayer service used P2P technology. iPlayer is billed as a “catch up service”, which makes all of the BBC’s content broadcast on its seven radio and five television networks available online in the UK for 7 days after the date of broadcast.

P2P allows a client to download parts of a file from a number of sources simultaneously and then make this file available again as a source to other clients on the P2P network. The more widely a file is downloaded by clients the more widely it becomes available as a source on the P2P network. This adds to over-all system capacity and accelerates downloads of this file. The entire infrastructure of the P2P network is distributed across all clients, i.e. the users’ computers connected to broadband connections. No central data-center or server infrastructure is required. In certain implementations search functionality may be centralized.

No significant data volume related charges are incurred by content providers as all data is transferred between users and thus is only “applicable” to their broadband connections.

Please refer to <http://www.bittorrent.com/dna?csrc=splash> for additional information on the concept. BitTorrent is one of the more popular P2P solutions remaining in this space.

The features outlined above would make P2P, theoretically, the perfect distribution platform for CATS’s content.

However, there are a number of issues with this approach. For the purposes of this report it is assumed that any content that CATS would inject into a P2P network would be rights cleared for online use and that CATS would not have any interest in actively controlling, monitoring or restricting the re-distribution of such content.

But even with rights issues cleared, P2P networks tend to only be effective at delivering performance improvements for content that is repeatedly requested, ideally within a clearly defined window of

popularity, by a large number of users. Orphan or rare content may only be available on potentially one single machine and another user requesting this clip for download would be limited by the slow uplink provided by the other (hosting) user’s broadband connection. The resultant download speed might be so slow that it would take weeks to receive the clip. (Furthermore most users will restrict the upload speed of their P2P connection even further through bandwidth management). If the hosting user decides to stop sharing the clip or deletes it from her machine this download request would then never be completed.

These issues can be circumvented if the content provider (CATS in this case) maintains a permanent injection point for seeding the P2P network. Effectively CATS would appear as another client to the P2P network, one that never disconnects or deletes its content and is connected to the network at reasonable speeds. In the previous example, the download of this rare clip would then be only limited by the bandwidth available at the CATS injection point. The experience to the user might be similar to that of downloading directly from the CATS site.

Given the large archive and the comparatively small user population this scenario is likely to occur frequently. P2P would only accelerate the downloads of the most popular items in the CATS archive during their demand peaks.

However, this raises another issue. In order to enable P2P delivery users would have to download a specific application (the P2P client) to access CATS. The installation of a specific application to access CATS content might effectively erect a new barrier to access. Some user may not be willing or able to install the application or simply not have permission to do so (due to restrictions placed on company or college computers). Non standard or mobile platforms would also be excluded from this delivery method if no suitable P2P client is available.

Lastly, since P2P networks tend to saturate ISP’s last mile infrastructure (the most precious commodity in terms of bandwidth), many have taken to restricting or even blocking P2P traffic on their networks, although this practice may not be readily acknowledged and both severity and services targeted do vary. Comcast in particular

fought for and for now has won the right to use this practice (see appeals court ruling: <http://pacercad.uscourts.gov/common/opinions/201004/08-1291-1238302.pdf>). While primarily geared at targeting consumer file sharing activities associated with copyright infringement, legitimate content delivery traffic could still be negatively affected by such practices.

Description of Service and Features

CATS would act as a seeding client offering its archive content for download through a selected P2P network/technology, such as for example “BitTorrent”. Users would download a suitable client application and would then be able to download CATS content through the P2P network.

BitTorrent offers technology (BitTorrent DNA) that opportunistically uses its distribution technology, if installed/present on the user’s machine, but will transparently allow access to content through conventional methods in case it is not.

Direct Impact

Reduced bandwidth needs and data volume consumption at CATS for popular content items during demand peaks. Depending on the type of P2P network used, CATS content may reach a wider audience beyond the Bloomington market as CATS clips appear in user’s searches on the network. BitTorrent in particular would allow CATS to maintain a closed/private user community if so desired.

Under certain circumstances P2P networks may also encounter problems traversing local firewalls or gateway devices in the user’s home or place of work. This may result in support questions being directed at CATS, which may not possess the technical expertise or resources to handle them effectively

Indirect Impact

Variable user experience (download speeds) and the potential need to install a P2P client on the user’s machine may act as barriers to access and slow down local adoption of online consumption for CATS content.

Cost and Requirements

Depending on the P2P platform used actual licensing costs may be nil. BitTorrent for example provides its “BitTorrent DNA” technology free of charge to commercial customers and offers some analytics features through its free basic commercial accounts. (See official demonstration of the service: <http://www.bittorrent.com/dna?csrc=splash>)

System integration work to automate/adapt the content distribution at CATS to work with the P2P technology will be required.

Content Delivery to Mobile Devices

While various means exist to deliver content to specific mobile platforms in a rather tightly integrated way such custom development seems un-economical for CATS. Please refer to the “Note on Software Development and Niche Services” further below. Such tight integration can deliver a seamless user experience on the consumer device but is often contingent on participating in a closed platform or “walled garden” owned by the device manufacture or cellular network operator.

Apple’s AppStore for it’s iOS devices and Verizon’s VCast service both represent example of this approach. With the ever-growing market share of smartphones equipped with reasonably competent on-board web browsers the need for such custom development is fading away. A standards compliant webpage has the potential to reach most smart phone users without the need for any custom development. Although some limitations, such as the lack of flash video support by iOS devices, remain.

Description of Service and Features

The CATS web content management system (WCMS) could be configured to automatically detect browser requesting its pages from mobile devices. The WCMS could then reformat the web page requested accordingly to make it more user friendly in this “small screen” environment. Both textual and schedule information could be delivered this way as well as video content (subject to the limitations mentioned above).

CATS could also provide SMS (commonly referred to as text messaging) notification services that would alert users when relevant content has been updated on the site or a program of interest is scheduled to be aired on one of the PEG channels.

Direct Impact

Internet access through mobile devices is set for explosive growth and is likely to overtake desktop based Internet access by 2014, according to the latest prediction by Marry Meeker, managing director of Morgan Stanley's global technology research team (Please refer to slide 8 of the company's most recent "Internet Trends 2010" report available here:

http://www.morganstanley.com/institutional/techresearch/pdfs/Internet_Trends_041210.pdf, the more comprehensive "Mobile Internet Report" the aforementioned presentation is based on can be found here:

http://www.morganstanley.com/institutional/techresearch/mobile_internet_report122009.html)

Regardless of how accurate the forecast by Meeker's team will turn out to be, mobile Internet access will eventually become the dominant mode of access in the future. CATS and the CoB should be able to service mobile devices with only minor adaptations to their web content management systems by providing small screen friendly formatting templates for their textual content. The support for video content may remain slightly more challenging in the short term, as the support for various video codecs and playback solutions tends to be platform specific. For now, HTML5 and H.264 or VP8 seem set to be the dominant technologies in the medium term.

The CoB could use live audio streams (and video streams at a later date, as the infrastructure for cellular data networks in the US catches up to international standards) of government meetings to allow interested parties to keep in touch with proceedings while "on the go". Such a service naturally has some potential to generate demand peaks during important meetings of public interest. Yet these comparatively low bandwidth audio streams, ideal for mobile delivery under current circumstances, would also be more serviceable by CATS's early infrastructure.

Indirect Impact

Mobile devices may actually soften general demand peaks as the window of access to suitable hardware for content consumption is significantly expanded (beyond the time spent with a laptop or desktop computer).

By giving the opportunity to easily fill gaps of idle time with media rich content, mobile devices invite consumption of shorter clips. Content recommendations for mobile devices should reflect this fact. This also provides room for more metadata-based innovation for long-form government content, such as tagging of sections base on agenda items or speakers in clips covering longer proceedings.

The field is still emerging and lessons learned in other cultures (such as Japan or Korea) may only partially apply to the US. Predictions with regards to the CATS audience thus remain speculative. (For an interesting perspective on the related domain of mobile television see: The Economist, Special Report on Television, "*The Emergency Screen, mobile television is unlikely to take off*", London, April 29th 2010, http://www.economist.com/node/15980809?story_id=15980809).

Once core online services are stable and well understood by CATS, delivery to mobile devices represents a potential area for experimentation and rapid innovation. Based on the preconditions in terms of expertise and infrastructure that CATS will have to meet before being able to competently engage in any kind of more customized mobile projects, it is most likely that such work will become relevant only towards the end of the timeframe covered by this report.

Cost and Requirements

Other than some additional configuration and template design work, if reformatting for smaller screens is desired, this service could be implemented as a cost free extension to the WCMS.

Summary

The table below compares the various service options across a range of dimensions. Please note the comparison reflects subjective aggregate measures and is neither quantitative nor absolute in nature. (Key: \$ = inexpensive to \$\$\$ = very expensive, ++ = best, o = average, -- = worst)

| Service Type | Direct Impact on Bandwidth to Run Service | Direct Impact on Data Volume to Run Service | Demand Peak Generation (stronger peaks are negative) | Ability to Steer/Influence User Behavior (poor ability to steer behavior is negative) | Cost to Create Service | Cost to Operate Service | Scalability: Small / Large Scale |
|------------------------------------|---|---|---|--|------------------------|-------------------------|----------------------------------|
| Twitter | very small | very small | -- | ++ | free | free | ++/++ |
| Facebook | very small | small | - | + | free | free | ++/+ |
| Atom or RSS Feeds | medium | medium | o | ++ | free | \$ | ++/++ |
| Podcasts | medium | high | + | + | free | \$\$ | ++/+ |
| Archive Streaming | high | high | + | o | \$ | \$ | +/- |
| Segmented Streaming | high | high | + | o | free/\$ | \$\$ | o/+ |
| Progressive Download | high | high | + | o | free | \$ | ++/++ |
| “Conventional” Download | medium | very high | ++ | -- | free | \$\$ | +/o |
| Live Streaming of Channels | very high | very high | o | - | \$\$ | \$\$\$ | o/-- |
| Linking Schedule to Archive | very small | medium | + | + | free/\$ | \$ | ++/++ |
| “Peer to Peer” Networks | medium | medium | ++ | -- | free/\$ | \$ | --/++ |
| Content Delivery to Mobile Devices | high | medium | ++ | o | free | \$ | +/o |

Table 15 Comparison of Online Services in Terms of Resource Consumption, User Behavior, Cost and Scalability

NOTE:

- The cost to create the service tries to reflect any potential extraordinary development effort required as well as software licensing cost
- The cost to operate the service tries to reflect ongoing licensing cost and associated bandwidth and data volume/quantity charges
- Scalability reflects both effectiveness and administrative efforts associated with scaling the service

Technology Solutions – Scenarios

As the following paragraphs will demonstrate, some of the characteristics of the “ideal system” described in the introduction of this section can be achieved. Low cost, incremental scaling of bandwidth (for both system and network) and incremental scaling of storage capacity are each available through various technical solutions.

However, one or sometimes two of these three characteristics usually have to be traded off against each other. Which types of trade-offs may be acceptable will depend on the environment and even the phase of growth the customer finds itself in. The following paragraphs will present various scenarios, consider their trade-offs and analyze their appropriateness for confronting the likely challenges faced by CATS and the CoB in the online video space over the coming years.

No Additional Investment

This option assumes that no additional investments in bandwidth or hardware are made. The existing infrastructure would be repurposed for the new site.

Based on the limitations of the existing arrangements the availability of services may suffer during peak demand resulting in reduced user satisfaction. Initial enthusiasm for new services may give way to apathy and discontent and ultimately defection. In the long run this may result in a self-regulating system and “right size” the user population to one the limited infrastructure can support.

Assuming that there is a latent need for some services such as the CoB meeting archive, the user population could stabilize at either current levels or slightly above (within the constraints imposed by the infrastructure). The current user population does not seem to place any notable strain on the existing infrastructure, leaving some room for growth.

The benefit of such an approach lies in the minimal impact on the operational budget. Connectivity is shared with MCPL and there is

always the possibility that any surge in traffic might result in network upgrades being paid for by the Library.

CATS and the CoB would both be able to claim the public relations benefit of an expansion of their online service portfolio without major additional investments. As services gain popularity the actual user satisfaction would be reduced below existing levels as users frequently experience service outages and delays during demand peaks. This may result in a loss of good will towards CATS and potentially also the CoB by a section of the community.

Overall, sustained inaction on investment related to service provision would seriously undermine any attempts to increase the reach and accessibility of PEG content and sit contrary to the spirit of this report.

However, selective short-term resource starvation may allow for more targeted and effective investment and avoid over provisioning. This method can be effectively employed in conjunction with a soft launch (no active promotion or closed user groups) of a new service, followed by detailed monitoring and analysis of user behavior, concluded with swift adaptation of the infrastructure. This methodology, if used competently can help improve capacity decisions and lead to more efficient investment.

The creation of infrastructure adaptation plans should form part of the service development process so that once needed swift action can be taken. Swift action, even if it employs temporary solutions, within this context would be measures in days rather than weeks or even months. Agility and transparency about addressing demand constraints is vital to maintain the good will of the user base.

Onsite Hosting

This solution entails the largest degree of control over the actual architecture of the infrastructure deployed by CATS but also requires a certain degree of expertise to maintain it securely and reliably.

Under this proposal CATS would purchase, operate and own its entire server infrastructure and procure bandwidth to connect it to the Internet from local providers. The relatively modest size of CATS's operation makes it less able to capitalize on the economies of scale offered by some of the larger managed infrastructure solutions. Furthermore it would allow more room for experimentation and customization of potential new services.

Particular with regards to CATS's digital archive, which is expansive and deep, managed/hosted services are comparatively poor value at present. Most managed hosting is generally geared towards a limited but highly popular content portfolio whereas CATS's archive may be considered a classic "long-tail" application catering to highly fragmented niche audiences with a huge content portfolio. Since storage volume/size is often a key factor in pricing outside offerings this would penalize CATS significantly and thus push up expenditure on a "per user" basis, given the potentially modest size of its target audience.

Keeping the archive system in house would allow CATS to take full advantage of plummeting local storage prices well before this trend/price point manifests in external offerings. However, as time progresses and external cost structures change the balance may tip and moving the user facing part of the infrastructure onto a hosted platform could become more cost effective.

The major drawback of an in-house/on-site arrangement is the access to bandwidth and expert knowledge to maintain the infrastructure. Smithville Digital could be a good local partner to address the connectivity issues in a cost-effective way. The expertise shortfall within CATS however is of some concern. Keeping an infrastructure exposed to the Internet secure and available requires expertise that is not part of the current skill set available through internal staff. CATS may at times be able to rely on help by the CoB or the MCPL IT department but either party may be unable to service more extensive needs associated with an increasingly popular online service.

Contracting for an outside maintenance service or restructuring the internal staff pool to include a higher level of server and network

technology expertise are not just options, but essential conditions for making an on-site hosting scenario work.

Local Peering / Local Presence

While listed here under a separate category, this essentially represents an extension to the on-site hosting model. It thus entails the same requirements in expertise for successful implementation and operation. The difference in this model lies in how bandwidth is procured and network traffic is routed. Unfortunately the structure of the American telecommunications market makes such an arrangement highly unlikely to occur since infrastructure unbundling and thus access to telephone exchanges at reasonable rates has not been realized.

This approach would provide excellent quality of service to local Bloomington users and actually limit the burden on the backhaul network infrastructure of the local last-mile providers.

In peering arrangements a number of providers will exchange network traffic between their networks free of charge and share the operational cost of the peering point. The Bloomington telecom hotel could potentially one day evolve into such a location for CATS originated traffic if suitable interest manifests from local operators.

The local presence scenario is similar but would involve at cost pricing to allow a content provider to directly inject their traffic into the local infrastructure of a last mile provider. Thus if a number of AT&T DSL subscribers were requesting CATS content, a suitable arrangement would allow CATS to directly inject its traffic into the local Digital Subscriber Line Access Multiplexer (DSLAM) serving the copper lines of these subscribers at the AT&T exchange. This would occur without putting any burden on the backhaul network serving the exchange. Ultimately the ease of implementation depends on the architecture choices made by the last mile provider and the associated management structures. For now the high degree of centralization pursued by most last-mile providers makes receptiveness on this matter unlikely.

The value of such a solution directly depends on the level of local network traffic generated by CATS and at current levels would not justify the investment by either party. However, despite the likely challenges, exploratory talks might yield different insights and should not be dismissed a priori.

Smithville

This is the only provider that may be willing and able to accommodate such a solution. If CATS were to engage Smithville as its primary local connectivity provider (building on the existing MCPL/Smithville agreement) the company would effectively be implementing the above proposition in some form for its own broadband subscribers anyway. This holds the potential for the highest service levels to be experienced by Smithville broadband subscribers with regards to CATS online content.

AT&T

Free of charge peering with AT&T is only available to large national network operators (see: <http://www.corp.att.com/peering/>). Exchange level traffic injection to provide better service to DSL customers is not a common feature in this market. For U-verse customer's local central offices (exchanges) would still represent a suitable injection point into the fiber network underpinning parts of this service.

Security and physical connectivity concerns may further impede adoption. CATS would need to generate traffic levels that would place a significant strain on the backhaul infrastructure connecting the local exchanges. For this to happen CATS would need to operate a sizable server infrastructure and generate matching user demand.

Local traffic injection would deliver enhanced quality of service to AT&T broadband customers but seems difficult to realize based on the likely scale of demand required to prompt responsiveness by the operator.

Comcast

For as long as the former "Insight" cable head-end is still operational in the Bloomington market this would provide a perfect opportunity for local traffic injection. Without knowledge of the long-term infrastructure

plans by Comcast it remains difficult predict whether this physical location for traffic handover would remain accessible in the long-term.

In principal all the same opportunities and limitations apply to Comcast as do for AT&T. However, as the following quote by the vice present for IT and CIO of Indiana University demonstrates, Comcast has refused to cooperate on peering with local organizations orders of magnitude larger than CATS.

"Indiana University remains gravely disappointed that Comcast adamantly refuses -- as recently as June 2010 -- to provide the simplest of network peering connections for the Bloomington community. We have tried for seven years to achieve with Comcast and its predecessors the same arrangement that Smithville and other major Internet providers agreed to 5+ years ago. This literally no-cost intransigence undermines the quality of Internet services for the thousands of IU faculty, staff, and students who call Bloomington home."

Dr. Brad Wheeler, IU Vice President for IT & CIO, Dean, and Professor, Indiana University <http://ovpit.iu.edu>

Virtual Private Server

This would give CATS its own server (or servers) hosted by a provider in a (distant) datacenter. While these machines would appear to CATS as if they were physical entities they would be only "simulated". These virtual machines share the physical resources of an actual machine with other virtual servers but provide the benefit of having full operating system level control over the virtual machine. Thus applications can be run or tested without the restrictions of a shared hosting environment (where different websites share and are limited to the capabilities of one web server).

This approach allows the service provider to more fully utilize the underlying hardware by sharing the processing capacity between a number of server entities. This arrangement may be cost effective and

viable for a general web presence by CATS but would be inadequate and uneconomical for the vast storage needs of its digital archive.

Managed and unmanaged options are usually available, with the latter placing the responsibility for system security and integrity firmly upon the customer.

Furthermore under certain circumstances spikes in resource demand by other entities hosted on the same hardware may negatively impact the performance of a virtual server. Thus a certain degree of variability in terms of performance can exist for certain implementations. Virtual servers tend to be more appropriate for non-media rich hosting applications at this point.

Datacenter Collocation

This approach would see CATS place hardware owned by it in an actual server rack located inside the datacenter of a service provider. This would give CATS's hardware the environmental protection such a location affords (redundant and protected power and cooling as well as diverse high bandwidth network connectivity). The drawback is that management, and thus responsibility for the hardware's integrity would remain with CATS.

Physical access to hardware collocated inside a secure and potentially remote data center can be difficult and costly. The major benefit would be savings on storage cost compared to most other managed/hosted services described in this section. This statement is only applicable to the very large CATS archive.

Cloud Computing Services

These services represent the next step in the evolution of virtual private servers by scaling processing capacity for specific tasks or services on demand. For example, if a website were to increase abruptly in popularity additional web servers could be added automatically to the "virtual" machine pool and share the load of requests. This process

would be almost instantaneous and would require no administrative action by the site owner (subject to service type).

Cloud storage may present itself as one infinite "bucket" that grows with the data written to it and provides high performance throughput even as the number of read and write request to the storage increases. The customer does not need to worry about partitioning storage arrays, managing disk or replicating data.

Infrastructure cloud services, like Amazon's "Elastic Compute Cloud (EC2)", provide entire virtual server images on demand, whereas cloud application providers, like Google's "App Engine" allow the scaling of specific applications only.

The cloud service provider dynamically and transparently spreads the workload across its vast infrastructure and generally guarantees certain levels of performance throughout.

The permutations and charging models for cloud computing solutions are vast and continue to grow, but most pricing models generally incorporate a "pay as you use" component allowing for the scaling of resources (and thus operating cost) with demand. This virtually eliminates idle computing resources from the client's cost structure.

The major drawback at this stage is the cost of cloud storage. At the time of writing this report 500GB of Amazon's S3 cloud storage cost approximately \$900 per year excluding any in or outbound (data) traffic (see: <http://calculator.s3.amazonaws.com/calc5.html>). The exact size of the CATS archive is not known but estimated to be at least several terabytes (1000s of GB) even in its compressed form. Under certain circumstances (namely assuming high levels of traffic to the repository) cloud storage can potentially already be cost competitive with local storage, as the very simplified assumptions of Table 16 below seem to suggest.

| | | | | | | |
|---------------------------|-------------------|---------------------------------|--|-------------------------|---------|---------|
| Discount Rate | 5% | | | | | |
| Drop in Hard Drive Cost | | 33% pa | | | | |
| Local Storage: | | | | | | |
| Enclosure | \$4,500 | | power requirement | 500W | | |
| Cost per kW/h | \$0.10 | | | | | |
| Drive Initial cost | \$150 | for 1 TB drive | Number of drives required reflects bandwidth | and storage space reqs. | | |
| | | | Service becomes more popular | 2nd enclosure needed | | |
| Year | 0 | 1 | 2 | 3 | 4 | 5 |
| Enclosure | \$4,500 | | | \$4,500 | | |
| Number of drives | 5 | 7 | 9 | 18 | 22 | 24 |
| Cost of Additional Drives | \$750 | \$201 | \$135 | \$406 | \$121 | \$41 |
| Operating Cost / Power | | \$438 | \$438 | \$876 | \$876 | \$876 |
| Sub | \$5,250 | \$639 | \$573 | \$5,782 | \$997 | \$917 |
| NPV | | \$7,661 | | | | |
| Total | \$12,911 | | | | | |
| Amazon: | | | | | | |
| 50GB | \$90 | increment | 50 | | | |
| Assumes Upfront Payment | | Price Decline for Cloud Storage | 15% | | | |
| Storage Need in GB | 400 | 1000 | 1500 | 2000 | 2500 | 3000 |
| Storage Cost | \$720 | \$1,530 | \$1,951 | \$2,211 | \$2,349 | \$2,396 |
| Bandwidth Charges | \$150 | \$250 | \$300 | \$350 | \$400 | \$450 |
| Sub | \$870 | \$1,780 | \$2,251 | \$2,561 | \$2,749 | \$2,846 |
| NPV | | \$10,440 | | | | |
| Total | \$11,310.4 | | | | | |

Table 16 Cloud Storage vs. Local Storage, Simplified Case

What Table 16 does not take into account is that CATS would require storage for the TV resolution (high quality) versions of all video files regardless. Initially the same storage could be used to host the comparatively small online (highly compressed) versions of the clips. This fact tips the case back in favor of local infrastructure.

Traffic charges are generally more affordable, for example if only 250GB of material (the equivalent of approximately 3 1/2 government meetings per day at 200MB per file) is requested throughout the year, this would add a total of approximately \$36 to the annual cost.

Specialized video storage / streaming providers such as Brightcove are also not cost competitive for deep archives due to storage cost. The aforementioned company offered a \$99/pcm starter package at the time of writing this report, which allowed users to store 50 videos on their system and offered 40GB of bandwidth per month (see: <http://www.brightcove.com/en/video-platform/editions-and-pricing>)

Leightronix, the vendor used by CATS for part of its current playout infrastructure offers a managed content streaming service, paired with automated encoding and upload from its playout servers, starting at

\$249/pcm for 500hrs of storage (see: http://www.leightronix.com/pdf/PressReleases/LEIGHTRONIX_Press_Release_PEGcentral.pdf). While the service offers useful functionality such as template driven branded publishing and index points within a video, the volume of content produced by CATS makes this service uneconomical compared to locally hosted alternatives. The very strong vendor lock in of this service exposes financial risks and may also inhibit the development future innovative online service by CATS.

Given the substantial storage space requirements even for the online portion (clips encoded at web-resolutions) of a well-developed CATS archive, cloud storage is a rather expensive, although high performance and elegant alternative to local on-site infrastructure.

CDN – Content Delivery Networks

Since the early days of the “dotcom” bubble, about 10 to 15 years ago, specialized content delivery networks have been developed. These networks represent a part of the Internet infrastructure that is geared towards accelerating the delivery of (media rich) web content to the end-user. This is often achieved by moving the content, or multiple copies of it, dynamically and intelligently closer to the user(s) requesting it. This process is often described as moving or pushing the content to the edge of the network. Intelligent caching algorithms on the CDN provider’s servers retain popular content elements close to user populations requesting them and delete them once they are no longer needed. For the customer engaging the services of a CDN provider this process is virtually transparent.

CDNs allow customers to effectively outsource the investment in a large bandwidth rich server infrastructure. A CDN would be able to accelerate access to CATS’s most popular archive items or also provide relaying capacity for its live video streams. CDNs are most effective from a pricing perspective for smaller yet highly popular content sets. It would be unrealistic and economically unviable to place the entire CATS archive in the hands of a CDN at this point.

It also remains doubtful whether CATS would, at least in the short term, generate enough demand with strong enough demand peaks for specific content items to warrant an investment in a CDN.

The same access patterns that make P2P based content delivery effective, i.e. a small number of items requested by many users within a specific time window, define the ideal deployment scenario for CDNs. Some free options are available, many of which rely on adapted P2P technology. Should CATS grow to generate suitable access patterns that would warrant a CDN deployment for part of its online services such options should be revisited. At this point however the focus should be on creating the basic systems outlined in section 1 of this document to enable effective access to online material and create a robust platform to experiment with, test and develop new innovative online offerings.

Please refer to the following two links as a starting point to learn more about CDNs and for a list of current providers and technology platforms:

- http://en.wikipedia.org/wiki/Content_delivery_network
- <http://www.mytestbox.com/miscellaneous/content-delivery-networks-cdn-list/>

Outsourced IT vs. Managed Security and Network Services

As an organization CATS currently lacks the level of IT expertise desirable to allow it to effectively leverage modern Internet and communication technologies. It will thus face technical challenges and organizational barriers to launching and operating innovative new online services in a secure and reliable manner. Moreover, the perceived risk and cost of seeking external development expertise to create and support such services may stifle innovation and perpetuate a risk-averse attitude towards an online expansion.

Against this background the required expertise may be created through a mix of skills transfer and employee development or

restructuring. A basic level of competence created this way could be further enhanced by project specific sub-contracting using modern online market places for IT-contractors (see section 1).

Alternatively a complete outsourcing of IT services including desktop operation and maintenance might appear attractive. Given that CATS is primarily a media production and dissemination operation, desktop support could be considered a non-core function of the business and should thus be outsourced. However, outsourcing deals tend to work best for organizations larger in size than CATS and with a relatively generic office IT infrastructure. The very nature of media production necessitates a host of specialized applications and workflows that conventional outsourcing providers are ill equipped to deal with.

Based on the existing operation, with some help and knowledge transfer by the MCPL and CoB IT teams, CATS should be able to transform its internal desktop and production infrastructure into a secure and well-managed environment.

However, the operation of Internet facing servers, the web content management system in particular, as well as the monitoring of the main archive server and database will require more expertise than can be reasonably expected to be developed internally by non-domain experts. CATS should seek a service and support contract to keep these systems operational and secure, either by negotiating a dedicated “for pay” service level agreement with MCPL, CoB ITS or another third party provider specializing in these areas.

Lastly as part of such a support contract network management and monitoring services and responsibility should also be delegated. The goal should be to provide creative staff and managerial staff with easily understandable real-time report functions that detail system and network loads, popularity of content items across time and user groups and other relevant information. The presentation/availability of such information should support decisions about when to release specific content items, give insights on how successful individual services are in reaching audiences and help with timing infrastructure upgrade decisions.

Summary

The table below compares the various technology solutions across a range of dimensions. Please note the comparison reflects subjective aggregate measures and is neither quantitative nor absolute in nature. (Key: \$ = inexpensive to \$\$\$ = very expensive, ++ = best, o = average, -- = worst)

| Technology Solution Type | Expertise Required to Deploy | Expertise Required to Operate | Speed to Deploy | Maturity of Market/Solutions | Cost to Deploy | Cost to Operate | Scalability: Small / Large Scale |
|---------------------------------------|------------------------------|-------------------------------|-----------------|------------------------------|----------------|-----------------|----------------------------------|
| No Investment | n/a | n/a | n/a | n/a | n/a | n/a | x/x |
| Onsite Hosting | high | high | - | ++ | \$\$ | \$\$ | ++/+ |
| Local Peering / Local Presence | very high | high | -- | -- | \$\$ | free | -/++ |
| Virtual Private Server Managed | medium | medium | + | + | \$ | \$ | +/- |
| Virtual Private Server Unmanaged | high | high | o | + | \$ | \$ | +/- |
| Datacenter Collocation | high | high | - | ++ | \$\$\$ | \$\$ | +/+ |
| Cloud Computing Services | low | medium | ++ | +/o | \$ | \$ to \$\$\$ | ++/++ |
| CDN | medium | low | + | + | free to \$\$\$ | \$\$\$ | --/++ |
| Outsourced IT | medium | medium | o | ++ | \$\$ to \$\$\$ | \$\$ tp \$\$\$ | --/++ |
| Managed Security and Network Services | low | low | ++ | + | n/a | \$\$ | o/+ |

Table 17 Technology Comparison based on Expertise Requirements, Deployment Speed, Cost and Scalability

NOTE:

- Cost to operate cloud computing services usually varies with amount of resources (storage, processors) consumed
- Scalability tries to consider appropriateness of technology for small/large scale deployments

Note on Google Fiber

Like many other communities around the country, Bloomington has submitted its bid to become one of the testing grounds for Google's "advanced fiber to the home" infrastructure trials.

For further information on the nature of the project please follow this link: <http://googleblog.blogspot.com/2010/02/think-big-with-gig-our-experimental.html>

At the time of writing this report Google had given no indication which communities might be chosen as test sites. Should Bloomington be chosen as one of them, the implications for PEG operations could be significant but also costly.

All PEG content could be simulcast on cable and the fiber network at normal SD or HD resolutions depending on the resolution of the source content (and subject to rights issues). All archive material could also be made available at full native resolution for video-on-demand delivery. A host of additional interactive applications could be built on top of these services.

However, to deliver these services, which are likely to generate higher demand than under normal circumstance (by virtue of the novelty value of this project and connection speeds on offer), would require significant investment in server infrastructure. Alternatively considerable development effort may be required to port such services onto Google's cloud computing platform if preferential access to this resource were available as part of the trials.

NOTE: Currently "Google Cloud Storage" and "Google App Engine" do not fully address the needs of media rich content delivery of the kind described above. However, these limitations and potential cost barriers may disappear by the time the fiber network is deployed.

Either scenario could generate cost and skills gaps that may not be readily address through the funds available in the ordinary operating budget for CATS. If Bloomington were to be chosen as one of the test sites appropriate provisions to address these matters should be negotiated early by CATS with the CoB.

BDU – Bloomington Digital Underground

The BDU fiber optic network is only covered in this report with regards to its relevance as a piece of "enabling" infrastructure to enhance video service production and delivery in the Bloomington community. It is acknowledged that the BDU network has a range of other potential uses beyond the domain of video services. However, their discussion falls outside the remit of this report.

When viewed from a video services perspective three distinctive uses present themselves for the network:

1. **Improved access to locations for live coverage of events** – By connecting cultural and sports venues to the BDU live telecasts from these locations can be achieved reliably and inexpensively. Conventional live TV transmission from such venues would require mobile microwave based linking equipment and vehicles, which are financially out of reach for many local providers (Cellular technology may provide a viable substitute for certain low bandwidth applications but quickly reaches its limits in the full-resolution video domain). The list of venues and the order of priority with which they are connected to the BDU should be derived through joint discussions with all local public media outlets.
2. **Enable collaboration and exchange of media rich content between different local public media organizations** – By connecting all sites housing public media providers, such as for example CATS, IUSTV, WFHB, WIUX and WTIU, to the BDU at speeds of preferably 10GB/s or more, new forms of collaboration between the providers can be enabled. Subject to appropriate network security arrangements, this allows for the seamless sharing of production and postproduction resources by all parties as if all were collocated in the same building.

For example, WFHB or IUSTV editors could connect into CATS's Final Cut Server infrastructure (see section 1) to jointly edit a project. At the same time CATS staff might review a finished program at full resolution in real-time with their

coproduction partners at WTIU, backed up by a high resolution multi party video conference over Apple iChat. While these activities are in progress, volunteers at IUSTV and WFHB may directly digitize material from their local workstations into the CATS archive as a manager at CATS reviews their work in real-time. Simultaneously WIUX staff may add metadata to archive content and work on updates for the various local public media sites.

The BDU has the potential to single handedly make physical location of assets and people irrelevant, remove duplication of effort and thus enable new levels of technological and human collaboration between local PEG and public media organizations.

3. **Provide tighter integration of content delivery between the CoB and its PEG providers** – Subject to relevant agreements and network planning, CoB and CATS servers hosting content for online delivery could eventually serve as mutual backups or load-balance request for streaming media between their outside connections. Furthermore, the option to enter into a peering agreement with IU could be pursued to provide high-speed access to content for students on campus and in campus housing.

The BDU is a unique asset in the development of tighter cooperation between local PEG providers and public media outlets by providing an advanced platform for state of the art collaboration.

The CoB, as one of the most technically competent partners in this domain, may need to serve as an evangelist about the potential benefits of the BDU. Cooperation agreements, if formalized, may benefit from clauses including a commitment to BDU connectivity as well as concrete commitments on how and when to fund local access equipment to light the fibers provided. Lastly, as a neutral party responsible for the physical assets of the BDU, the CoB may also be the natural choice for the role of actual “network operator”, managing the day-to-day operation for this kind of BDU use.

Note on Software Development and Niche Services

As CATS and the CoB expand further into online video delivery and services the temptation to cater to vocal proponents of niche platforms may rise. Until CATS has achieved all the goals outlined in this document and is operating stable, usable and reliable online services such endeavors may not be an effective use of public funds.

Moreover, most niche platforms can be served through more generic means effectively without tying up scarce internal development resources. A well laid out HTML5 web video implementation would be equally accessible to iPhones as it would be to conventional desktop PCs without the need for custom development (subject to platform specific video codec support).

Ultimately CATS should be as widely available as possible and not prioritize niche platforms at the expense of more universal services. With this in mind, nothing must detract from the core mission of the PEG operator to produce and deliver content.

However, CATS is in a unique position to sidestep some of the issues outlined above by providing open standards based access to its content that allows interested third parties to develop custom applications for niche platforms. The provision of RSS/Atom feeds, persistent links to video content, good metadata and synoptic data should all help enable such activities.

From iPhone applications to content access via Box-e or Google-TV, development should be encouraged and supported by providing the right “hooks” into the CATS system.

The aforementioned examples provide a solid foundation for this purpose but may need to be expanded as technology evolves. If such adaptations or applications for niche platforms flourish thanks to third party developers, CATS always retains the option to promote or endorse this work and thus still benefit without committing vast resources to the task.

TV-PROJECTS

This section has mainly focused on projects for leveraging CATS's online presence to generate new advanced services. Yet opportunities exist to further improve the traditional TV production and delivery infrastructure beyond the recommendations captured in by section 1 of this report. The following paragraphs discuss relevant projects and seek to highlight the potential challenges and benefits associated with them.

Like the proposed online expansion these projects are not strictly necessary for the continued operation of CATS but represent opportunities to further enhance the PEG experience for local audiences.

Mobile Live Production Capability in HD

Section 1 provides a detailed discussion about the issues and limited benefits associated with introducing HD services in the nearer future. The main argument to justify such an investment is building a HD archive for public and events based content, which may be exploited by future HD services on digital cable (most likely after 2012 when the FCC analogue cable delivery mandate expires, subject to future FCC review – see:

http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-276576A1.pdf and

http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-07-170A1.pdf see page 7 of this document) or be used for online distribution through an advanced delivery infrastructure yet to be developed by CATS. Recent marketing communication sent to residential cable customers indicates that Comcast is seeking to become an all-digital provider by the end of 2010.

To make this transition in the most cost effective way possible the first step would online involve the acquisition of HD camcorders for public productions. As section 1 of this report describes in the relevant recommendation on this matter, such a transition is almost inevitable for public content production since any new camcorders are likely to

be HD capable by default. As also mentioned in section 1 the editing software available at CATS is already HD capable.

The next step in such a transition process would be to create a modest HD live production capability, useful for event coverage on location. This capability would be an upgrade to the existing Sony Anycast production system.

Such upgrades should only be pursued as part of the natural end-of-life replacement for the existing Anycast System, unless viable HD delivery conduits become available to CATS before this date.

The following two systems currently represent potential options for such a replacement.

- Sony Anycast HD (AWS-G500HD, retail price varies between \$15,000 and \$19,000 depending on options)
- Newtek Tricaster HD (TCXD300, list price between \$15,000 and \$18,000 depending on options)

While comparable in price. The Newtek product is by far the more capable and versatile solution. The Sony product also suffers from internal resolution constraints for video processing making it not truly HD capable. Either product would require video sources with analogue HD or preferably HD-SDI connectivity.

This may be accomplished inexpensively by converting the HDMI (monitor) output of e.g. the Panasonic AG-HMC40 HD camcorder, recommended in section 1, to HD-SDI with suitable converters (e.g. AJA HA5, retail price from \$490).

Inherently such a solutions has limitations in terms of picture quality and general mechanical robustness compared to a full HD outside broadcast/location setup. But it delivers almost comparable functionality at a fraction of the cost and should be able to readily meet the needs of CATS for political and special events coverage.

HD/SD Upgrades Showers Control Room

The benefits of upgrading the Shower's Control Room to full HD capability are limited given the relatively static nature of the content and lack of HD delivery conduits at this point.

Immediate benefits could be gained by recalibrating the standard definition cameras currently mounted in the council chamber. See sample images in the appendix under "Current examples of CATS content". The color balance of these cameras seems to be mismatched with the florescent lighting in the chamber.

When upgrades are pursued as part of normal end-of-life replacements a potential solutions could deploy the HD capable Newtek Tricaster live production system. This system would be able to interoperate with the existing cameras and allow for a staged replacement of individual camera units by being able to match different input resolutions in the production workflow.

The commonality across the rest of CATS's live production infrastructure would yield further operational and maintenance benefits (see previous item above).

Sample Cost:

- Newtek Tricaster HD (TCXD300, list price between \$15,000 and \$18,000 depending on options)
- Integrated HD capable remote pan and tilt heads between \$4500 and \$6500 per unit. Sony, Panasonic and others provide a range of suitable units with HD-SDI outputs
- Depending on the vendor and system chosen, camera control units (including positioning control) run from \$1500 to \$5000 per unit

Thus the total equipment cost for a HD upgrade has an estimated entry-level price of approximately \$35,000.

General Enhancements to Output Chain

As CATS transitions to fully server-based playout of its cable channels, upgrades to its final output chain become viable. Most upgrades of this nature should be covered under general day-to-day TV infrastructure maintenance and tend to follow established industry practices centered around the use of the SMTE SDI or HD-SDI interfaces.

Thus this simply serves as a reminder to consider the inclusion of signal processing equipment in the final output path that will legalize and adjust any deviations of CATS's signal in real-time to conform with technical and network television standards. CATS may consider audio and video processing and delay such investments until Comcast has transitioned onto a fully digital infrastructure.

In doing so CATS could use one single signal path to offer digital feeds of its channels to Comcast, U-verse, S+TV and other potential future providers at a central location such as the Bloomington Telecom Hotel. This single feed could be specially pre-processed and optimized (by CATS's signal processing equipment) for digital compression rather than traditional composite NTSC coding.

By offering such an optimized feed the image quality experienced by subscribers should improve on all digital services. CATS may also consider soliciting feedback on this issue from the service providers to optimize its investment and use the opportunity to network with contacts on the provider's side.

Low-Power Broadcast TV License

At the time of writing this report the FCC had postponed the opening of a license application filing window for digital low power (LP) television stations until further notice (see FCC public notice: http://hraunfoss.fcc.gov/edocs_public/attachmatch/DA-10-1168A1.pdf). There exists an open filing window for digital LP television services in rural areas created by an earlier public notice (see FCC public notice: http://hraunfoss.fcc.gov/edocs_public/attachmatch/DA-09-1487A1.pdf). CATS will not be able to use this provision, as

Bloomington, due to its location within a 75 mile radius from Indianapolis, is not classed as rural by the FCC.

More detailed analysis of the legal background and procedures governing the licensing of low power or full power broadcast TV stations by the FCC falls outside the remit of report. As do any recommendations with regards to the type of license that might be appropriate to pursue for CATS should a future broadcast service be desired.

Please refer to the following links as a starting point for further inquiry:

<http://www.fcc.gov/mb/video/lptv.html> and
<http://www.fcc.gov/cgb/consumerfacts/lptv.html>

Digital technology allows for the delivery of one HD and two to three SD TV channel or alternatively up to six SD only channels within the channel bandwidth usually occupied by one analogue TV broadcast channel. Such a bundle of channels is referred to as a digital multiplex.

The 5 existing SD channels played out to cable by CATS would thus fit into one digital multiplex requiring the channel bandwidth equivalent of one analogue broadcast TV channel. The technology required for encoding and managing the data stream for such as a multiplex, as well as the subsequent over the air broadcast using the ATSC transmission standard, tends to be still relatively expensive at this point.

The potential cost, even for a basic low power UHF system rated at 1kW output at the transmitter (effective radiated power (ERP) will be a multiple of this depending on antenna gain), is likely to exceed \$170,000 for a 5-channel SD multiplex. (**Note:** This is a very optimistic cost estimate and may vary upwards considerably depending on the vendor and system integration services used. The aforementioned figure was derived by adapting pricing and configuration information provided online at <http://www.fmamtv.com/products/TV/HDRack%20Sys.html>. It reflects a 5-channel SD-TV setup). This number **excludes** the cost of a

transmission tower, which can be substantially greater than the aforementioned amount depending on the tower's height.

WTIU has pursued this delivery option, operating a full power digital transmitter in Bloomington and may be able to provide additional budgetary and technical advice. Furthermore, given the cost of tower construction, tower sharing with WTIU should be considered.

The National Telecommunications and Information Administration provides a "conservative" equipment cost estimate for sample configuration as used by a full power PBS TV station (see: http://www.ntia.doc.gov/ptfp/application/equipcost_tv.html).

Furthermore this Canadian study on digital conversion of existing analogue TV stations provides additional guidance on the range of applicable expenditures for such projects (see: <http://www.crtc.gc.ca/eng/publications/reports/dtv0903.htm#a6.3>)

Based on current regulations, low power TV stations are not eligible for must carry privileges on local cable systems.

Given the cost involved such a project would almost certainly require further cost benefit analysis and be dependent on substantial external grant funding to succeed.

Local Sports

CATS has covered local high school sporting events in the past. According to CATS the licensing conditions imposed by the IHSAA triggered a license payment of approximately \$200 each time an event was played on one of CATS's channels. CATS was also prohibited from providing tape copies of the events, triggering complaints from disappointed parents.

Given the proven ability of sports to build audiences CATS with assistance from MCPL and the CoB should consider renegotiating a suitable deal with IHSAA. Future deals should focus on extending coverage for events not already recorded by the IHSAA and seek to

include online distribution rights and free repeats for TV payout. Video footage can also serve as a valuable training tool for coaches, a benefit that may currently not be fully exploited.

IHSAA's own television strategy seems to be centered around championship coverage rather than deep local coverage (see: <http://www.ihsaa.org/dnn/Media/MediaReleases/IHSAANewsRelease31210/tabid/792/Default.aspx>). A new partnership with CATS could be complementary to this project and generate additional audiences for high school sports in Monroe County. Other local team sporting events including some IU intramurals would add extra opportunities for extended sports coverage on CATS.

For example, ESPN today commands the highest carriage fees out of any cable channel and impressively demonstrates the value sports coverage can bring to an operator (see: http://www.nytimes.com/2008/11/25/sports/ncaafootball/25sandomir.html?_r=1). By focusing on local events that would commonly be ignored by commercial providers CATS may be able to leverage some of this “pulling power” associated with sports while providing extra value to the local community.

For an interesting perspective on the ability of sports coverage to generate audiences please refer to: The Economist, Special Report on Television, “*The killer app. Television needs sport almost as much as sport needs television*”, London, April 29th 2010, <http://www.economist.com/node/15980873>

Growth Strategies – Policies

The following paragraphs re-iterate and collate policy recommendations made elsewhere in this report to conserve and manage financial and infrastructure resources intelligently without compromising service delivery.

Incremental Hard Disk Purchases

Storage enclosures used for any storage subsystem associated with the CATS server infrastructure should only be populated to the extent required to either maintain the minimum systems performance or accommodate storage 3 months into the future. Hard disk prices are continuously dropping and since the proposed RAID enclosures would require the same type of drive for each slot, incremental purchases will reduce the overall cost of storage.

The fact that CATS's archive digitization project will be the main consumer of storage over time, with content being gradually added to the system, further encourages this cost saving strategy.

Incremental Bandwidth Upgrades

The temptation to build out a vastly over-provisioned network infrastructure in the hope that users will eventually come and saturate the service should be sternly resisted. Given the uncertainty over which type of usage patterns may emerge and what types of online content and services might be popular, bandwidth needs are almost impossible to predict reliably at this stage. CATS currently has no accurate baseline data about user behavior and bandwidth needs of its existing online services, which further complicates capacity planning.

Over provisioning would result in a highly ineffective use of public funds and open up CATS to unnecessary external criticism. Instead CATS should, depending on what type of hosting strategy is chosen (see discussion further above), make arrangements for accurate bandwidth and usage monitoring of its new services. This approach should then be backed up with provisions (contractually and technologically) to quickly upgrade bandwidth in small increments with the relevant connectivity provider.

With such a facilities in place CATS should be able to grow and possibly also shrink the bandwidth of its Internet connectivity at short notice while maintaining acceptable service levels.

Managing Resources by Managing Users-Demand

Certain spikes in demand are unavoidable (e.g. people watching live streams of a School Board Meeting during a budget crisis) and sensible compromises between quality of service and level of infrastructure investment will need to be made. Throughout CATS and those who repurpose its content (e.g. bloomington.in.gov) will be able to actively manage the public's expectations in terms of service quality.

So when congestion occurs repeatedly, then proactively communicating the reasons and anticipated remedies will be as helpful as the remedies themselves in maintaining public support. Internet audiences are likely to expect a higher degree of information sharing in return for good will and loyalty.

Beyond simply increasing the bandwidth and server capacity the options below present themselves for managing user behavior and service quality. The mix of measures to be actually used is ultimately a policy decision and may warrant further discussion between CATS and the CoB.

Resource and User Management

The goal of all the measures presented below should be to improve the overall experience of CATS and CoB online content for the majority of users and discourage disruptive or excessive resource use by the few.

- Temporarily degrade live streams during periods of high demand. Reduce image resolution and/or frame rate. Provide audio only feeds (with explanation for reason why this measure was taken) once demand exceeds video streaming capacity. Offer notification to interested parties once high quality video version of the event is available via the archive at a later date
- Periodically reset user connections to live streams to eliminate dormant, orphan streams
- Use IP address geo-location data to prioritize local traffic

- Implement network and resource tracking/dashboard that allows non technical staff to judge system use and time the release of new assets accordingly
- Track popularity of assets and events and coordinate RSS, Twitter and Facebook updates accordingly. For example avoid releasing new material near the time two important government meetings are also expected to be streamed
- Track user's consumption levels, prioritize or degrade service levels for heavy or light users as per policy when resources become temporarily stretched
- Limit the number of connections / downloads allowed per client
- Continuously evaluate cost/benefit of new/alternative delivery technologies for online content to improve service quality within budgetary constraints

It should be noted that measures based on IP address or client connection counts could be circumvented by the very dedicated. Never the less, it is likely that such methods will at least curb unintentional bad habits in the user population. Ideally user testing should be considered before deploying any new control measures to gauge acceptance.

Create New Media Manager / Webmaster Position

To account for the increasing importance of the Internet and advanced online delivery in the service portfolio of CATS, this should be reflected by adding a permanent new media / webmaster position to the staff roster of the organization.

This person would be responsible for managing and monitoring the flow of information and content to the various online services from Twitter to Internet streaming and be technically skilled enough to

handle the day-to-day administration of these services. The responsibilities would include the CATS web content management system and related products. HTML5/CSS, JavaScript and other development skills as well as general web design and usability skills would be essential for this position.

A certain level of creative marketing skills appropriate for the domain would also be highly desirable to help initiate new product development in conjunction with CATS creative and production staff. The role would most likely be placed at management level with mutual reporting lines to both engineering and production.

The timing of a hire for such a new position may be partly driven by budget constraints. But it warrants consideration that the outlays associated with such a position could be offset against projected development costs (for future services) by keeping those projects “in house” rather than paying an external contractor.

Final Thoughts – In Pursuit of Innovation

Put Operation of Individual PEG Channels Periodically Out for Tender

Another way to promote innovation in the local PEG community might be to periodically solicit bids for new operating proposals for one or more of the existing channels.

Considering the human and technical resources required today for operating a channel full-time, it might be difficult to find a new entrant soon. Dropping technology cost may address some of these issues over time; alternatively a time-shared channel model could also be evaluated.

This might be combined with measures that award operation of such a “floating” channel for a limited number of years and would then require periodic re-assessment as to whether the channel asset has been used effectively for the benefit of the local community.

Whether such assessment would be through direct public vote or by appointed commission is a policy decision that lies outside the remit of this report. However, simple popularity-based evaluation would almost certainly be inappropriate and undermine the free speech principals underpinning the PEG mission.

Currently four out of the six PEG channels operating in the Bloomington market serve very distinctive purposes and clients. They either provide a venue for public productions or carry educational and governmental programming linked to the respective funding partners of CATS (CoB, ToE, MCPL and Monroe County).

The fifth channel, TIU-World, could provide a broader outlet for local content originating from the IU campus in addition to its popular PBS content. This leaves the sixth channel, Comcast channel 96, as the carrier for SCOLA programming the least locally grounded outlet at present.

Thus the City should take the aforementioned circumstances into consideration when evaluating whether to pursue a floating PEG channel and which channel asset could be used for this purpose.

Online User Generated Content

The public access component of the PEG operation in Bloomington represents a strong instance of user-generated content. This mode of public expression predates any online activities presently grouped under the label of user-generated content.

However, with a more diverse portfolio of online services, PEG providers could introduce new ways of facilitating user generated content production. A hybrid between fully-fledged public TV production and mere passive consumption would be possible. Any such activity/service must never be a substitute for a public production service but should serve as a complementary path to increase user engagement and possibly even act as a conduit to transition online contributors into the main TV production environment.

For example, such a service could offer selected rights-free clips, such as government meetings, for re-edit and re-dubbing with basic online tools. Any submissions through this process may require moderation by administrators or the user community, but over all such a service could provide another outlet for local creativity. An example for this type of user-generated content can be found on the NFL website (see: <http://redzone-re-cutter.nfl.com/Default.aspx>).

This and other applications, such as “citizen reporting” using cell phone cameras to record videos and ad hoc interviews, are all potential future options to further increase audience interactions with the PEG provider. However, in the near term the priority must lie on implementing the basic digital infrastructure and services recommended in section 1 of this report to create a solid foundation for sustainable online expansion.

Public News Partnership

This proposal would see an expansion of the existing cooperation between WFHB and CATS to provide a local tri-media content pool for daily local news. Such an operation would provide daily and weekly news items for radio, TV and online consumption.

The existing partnership between WFHB (<http://www.wfhb.org/>) and CATS (<http://catstv.net/>) already delivers on some key elements of this idea. WFHB provides daily local radio news and produces a weekly TV news program (“Catsweek”, also available as podcast from <http://catstv.net/podcasts.html>) with the assistance of CATS.

An expansion of this partnership to include IUSTV and WIUX (see: <http://www.iustv.com/> and <http://www.wiux.org> respectively), the student run TV and radio stations at IU, would hold considerable potential to reduce effort duplication and broaden content even further. It is also hoped that the participation of the student stations might encourage WTIU (<http://www.indiana.edu/~radiotv/wtiu/index.shtml>) and the IDS (the IU campus student news paper: <http://www.idsnews.com>) to engage or join such a partnership.

The goal would be to initially provide a communal “wire service” which all parties may draw on and contribute to for their own news production efforts. This service should eventually be augmented by a dedicated online news platform that provides one central point of access to the public for all material originated from this partnership.

To make such a partnership succeed the following groundwork should be considered:

- **Formation of a development group of interested parties irrespective of their organizational affiliation** – This project should be *open to* all local public media outlets and should be *promoted to* all of them. The “PEG Summit” suggested in section 3 of this document could serve as the clearly defined starting point for this process. This suggestion is included as a reminder that individuals rather than abstract organizations ultimately carry ideas. The goal should be to

bring together and empower a group of individuals passionate about the idea of a local public news service.

- **Common clearly defined and documented minimum technical production standards** – Audio, video and eventually web content should adhere to a set of common technical standards and specifications such as program audio levels, video black levels, file formats, metadata and file naming conventions etc. The agreed upon standards should be publicly available in one central point of reference. Local compliance duty should be delegated to a senior producer within each organization. This group should then be able to refer to one network producer for arbitration if necessary.

These standards are technical in nature and completely independent from any potential editorial policies the group may agree upon.

To avoid replication of effort and leverage common resources these standards should be backed up by shared training material developed by the group. These training materials should teach volunteers why these standards matter and how to achieve them in a production.

- **Contribution to the pool should be the default for new material produced in member organizations but exclusivity time windows and appropriate attribution for use must be respected** – Thus a system for signaling potential embargo periods on exclusive items or breaking stories and policies on how/when to invoke those measures need to be agreed upon and documented by the group.
- **Leverage technology for collaboration** – As indicated further above the BDU could evolve into a vital enabling technology to help member organizations collaborate as if collocated in one building. The group should aim to negotiate a definitive implementation timeline with the CoB for BDU connectivity. As a condition for such service support by the CoB member organizations should develop and execute

internal readiness programs to adapt processes and technology to fully leverage the benefits of one common high-speed network.

This work may benefit from regular workshops and a joint steering group set up to encompass representatives from all member organizations.

- **Capture fringe benefits within member organizations** – for example, WFHB generates potentially valuable descriptive metadata for CoB meetings recorded by CATS as part of its review work for “CATS Week”. This data should be captured by CATS and used to enhance the functionality of the government meeting archive.
- **Work towards a cross-trained, common volunteer based where possible** – Some membership organizations are demonstrably better at leveraging their volunteer base than others, either by nature of experience or their operating environment. In the long run the group should develop a system to jointly administer and train volunteers interested in working across platforms and organizations. This pool may prove highly valuable for addressing staffing bottlenecks at short notice and aid smoother overall operation.
- **Seek and jointly pursue relevant grant funding for the project** – The existing funding capacity from within the organizations as well as the CoB or other funding partners may be insufficient to fully implement such a local public news organization. Thus external funding from foundations and relevant government grants should be pursued vigorously.
- **Develop simple common planning tools to help coordinate journalistic and technical resources when covering events** – the goal is to remove duplicate effort as much as feasible from within the system and help organizations better plan their own resource commitment.

Whatever system and process is chosen must be so simple and intuitive that membership organizations use it habitually for all their event coverage planning. Failure to achieve this will inevitably lead to effort duplication as schedules are maintained both in an internal and shared system. This is likely to result in inconsistencies, wasted administrative effort and eventual abandonment and failure of any shared system. Like the common technical standards mentioned above, such a system must be agreed upon and implemented by the group. A joint steering group with full decision authority may be the most viable way to achieve this.

Alternatively a shared newsroom production system could be considered in the long run. However, based on general usability standards most commercial newsroom production systems on the market today may hold challenges for volunteer training in a high turnover environment.

- **Coordinate infrastructure investment to develop individual organizational specialization** – Eventually, if successful, a local public news organization may lead to more coordinated equipment and training investment decisions by its members. It is plausible that over time certain members will develop areas of specialization such as for example sports or government reporting and thus adjust their technical capabilities accordingly.

If executed correctly this should further increase efficiency savings while improving the production values and journalistic quality of the individual stories and thus of the overall output of the partnership.

As in cooperation or merger scenarios in a business context the right balance between common systems and processes vs. enough (federated) autonomy to maintain organizational agility will need to be found. This balancing and coordinating of interests and goals will never reach a stable “end state” but much rather represents an ongoing activity, the success of which first and foremost will depend on effective and open communication between all partners in this venture.

Once successful and stable, such a partnership could even be expanded to include “for profit” entities as affiliates, subject to such organizations’ willingness to embrace the principals behind a content sharing operation. Through attribution and active promotion in return for participation, such commercial organizations may be able to help further increase the “audience reach” of a public media partnership.

If all is executed successfully to create a sustainable, tri-media, daily local news service, this would put Bloomington and its community on the forefront of local media innovation in the United States and create a lasting legacy for all involved.



Appendix