

DIGITAL DELIVERY NETWORK

Breaking New Ground in Digital Media

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Abstract

The Digital Delivery Network is a new model for digital exchange of audio and other media resources across Australia. It has received funding and support from the Commonwealth Government and Microsoft Australia, and is being piloted with the Australian community broadcasting sector, perhaps Australia's most dynamic site of community participation in learning and communication. In this pilot the Digital Delivery Network has harnessed satellite and datacasting technology.

To date, exploration of the potential of datacasting for one to many delivery has stalled by lack of applications with commercial advantage or apparent utility. By contrast the Digital Delivery Network is showing that a clever combination of real time data and non-real time datacast delivery can unlock new utility, with the added advantage of low cost structures.

The DDN has involved the development of technology tools to enable selective capture of high quality digital media on a real time basis, coupled with user on-demand replay. The technology has been harnessed to enable:

- Automatic program and content delivery;
- Cost free and / or cost neutral operation for even the smallest non-profit community stations;
- Maximisation of user control over content choice;
- Automatic updating of content;
- Ongoing sector compatible library resourcing; and
- Access and local storage of a vast range of content and services.

The appeal and simplicity of the user interface (appropriately titled 'Plaything') has made the system suitable for both first time users and veterans.

Although there is no intrinsic technology constraint to full public access, the DDN project is providing services to a closed user base. It is therefore a microcosm for the development and trial of a range of services. A motivated user base is providing on-going feedback that is directly informing system management and enhancements.

It is, in effect, an action research project which will yield many valuable insights to help shape the delivery of digital media in the future. Some early lessons will be discussed:

- Provision of an automatically updating archive of high quality content directly to end users raises copyright and rights management issues that are necessarily addressed by the DDN project on an on-going basis.
- The variety and emphasis of new services that digital technology makes possible, and that add value to traditional broadcast service models.
- The means by which to assess the utility of new services for end-users.
- The effect of changed end-user behaviour on the viability of existing services and / or service models, and how this may impel or impede the provision of new services.
- The means by which to manage the playout / delivery of new services in a cost effective manner.
- The extent to which the choice of delivery technology can be neutralised.

It takes little imagination to see the applicability of the DDN to more conventional educational services. For example, leveraging the DDN functionality with the ubiquity of satellite coverage might enable:

- Specialist curriculum service delivery and exchange between centres of learning;
 - Teacher / class / student access to shared material on demand;
 - Real time lecture casting, in addition to
 - Automatic storage for later replay on-demand.
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Introduction

My sphere is broadcasting and technology, yours is education and technology. Our worlds often coincide as broadcasting, and community broadcasting in particular, is about ideas and information. The Digital Delivery Network adds new dimensions to the broadcast model and I ask you to consider what I have to say from my broadcast perspective in terms of the opportunity it presents for you to expand the learning community.

It may seem self evident that the form of what we see, hear and read in the media is highly influenced by the technology of its delivery. However, in the early 1990's, with the promise of new technologies on the horizon, Australia's Broadcasting Services Act was drafted with the idea of breaking the linear relationship between the service content outcomes and the technical means of delivery. That idea has foundered in many respects as technology imperatives continue to set out the form in which content is both generated and the extent to which it is available to end users.

The digital environment makes new modes of delivery and content forms possible and economical. Assuming the right mix of features and functionality is found this will mean new media experiences await end-users. Within this environment there are opportunities to expand the learning community. It is at this 'bleeding edge' of piloting new technology and end-user functionality where the Digital Delivery Network sits.

Digital Delivery Network

The Digital Delivery Network is an idea ahead of the mass market curve. The kernel of the idea is to carefully utilise various communications technologies in a way that best suits the topology of each technology, thereby achieving high delivery efficiency and low cost structures. It is an ecumenical merger of the usually disparate churches of broadcast, IT and telecommunications in a way specifically driven by anticipating what is the optimal end user functional requirement.

The DDN uses the broadcast model for mass delivery of material to end-users, thereby achieving great efficiency. The broadcast platform used in the pilot with the community broadcasting sector is satellite based, using the DVB-S transmission format with the baseband encoded in MPEG. Trials with other broadcast platforms are currently being negotiated, including terrestrial digital television and radio platforms. It might also be feasible to add DDN functionality to existing analog systems.

Dedicated point to point links are used for real-time contribution to the system. Typically these make use of ISDN or other dedicated symmetric DSL style network infrastructure. A separate new initiative may see a large number of ADSL circuits and an internet based VPN for non-real time contribution and interchange.

It was a deliberate design choice to use the broadcast model for mass delivery of real-time and non-real time data. Alternatives such as terrestrial internet based networks are often suggested but have serious drawbacks for the end user service model required.

Firstly, they incur inevitable download costs to each end user which, when multiplied out by a sizeable user base, quickly become very significant. Broadcast models are cost free to the end user.

Secondly, real time delivery using terrestrial internet is all but impossible as the network infrastructure is typically a shared resource and delivery timing is contingent on network loading. Near to real time can be achieved using dedicated high speed capacity to each user but such an approach is expensive and counter to typical internet usage trends. Broadcast models are real time and are not affected by network loading.

Thirdly, whilst point to multi-point internet delivery is common, it is really a case of establishing multiple point to point connections. Accordingly, the dimensions of the send-end equipment and bandwidth connectivity must be scaled proportionately to suit the anticipated user base, and expanded as required. The costs of scaling to suit the total user base is exorbitant and so systems are always designed to expect simultaneous use by only a small proportion of the user base at any given moment. Simultaneous delivery of large files / streams to a large user base on a regular basis will therefore cause delivery failure. An increase or decrease in the size of the instantaneous user base does not affect the scale and efficacy of broadcast models.

Finally, it has been suggested that some of the issues with mass delivery using terrestrial internet can be resolved using multicast protocols and edge servers. Multicast protocols require co-operation across all ISPs in a network. Moreover, they undermine the cost / profit ratio of each ISP, except perhaps the one relevant to each end user. That may explain their very limited implementation even after many years. Edge servers simply means caching content closer to the point of end use so as to reduce stress on the network backbone infrastructure. This does not solve the delivery challenge presented by real time feeds. In any case the ultimate edge server is one operated by the end-user, such as is the case with the DDN.

It is clear then that internet based terrestrial networks are useful for interchange and contribution of content but have limited utility for mass delivery. Broadcast is clearly the best delivery technology for the optimal end-user model.

What is the anticipated optimal end-user model?

The community broadcasting sector is perhaps Australia's most dynamic site of community participation and learning. This is reflected in the diversity and depth of programming broadcast by the sector, and by the variety of skills and experience of its participants.

The need to expose the best of that programming to the widest possible audience saw the establishment of the digital satellite delivery system, upon which the Digital Delivery Network leverages.

Interestingly, the satellite network and most community stations in their own right face a delivery dilemma. They have a brief to pursue innovative and stimulating content whilst at the same time maintaining an audience. Traditional thinking by commercial radio and, sadly, in recent times emulated in some areas by ABC radio, has been to reduce opportunities for learning and simply repeat familiar music and ideas. The strategy is to create a consistent experience for the end-user, and the evidence is that this leads to increased audience size.

No one denies that the block programming format necessarily adopted by many broadcasters (including most community broadcasters) can be alienating. The Macedonian program, followed by Science, followed by Jazz followed by a discussion on the ethics of transgender breast-feeding in public are all interesting in isolation but might be a stretch as continuous listening.

Block programming requires, or at least presumes, the radio listener will behave in much the same way as most tend to use television. That is, that the user will pick and choose preferred content, and then make arrangements to be available when that content is broadcast. Therein lies the tyranny of the broadcast model - it necessarily operates to a delivery schedule.

Whilst recognising that our routines mesh with consistent delivery schedules, and are an important part of the broadcast user experience to be maintained, one of the key presumptions underpinning the DDN is that users might also prefer to break the nexus between content and the delivery schedule. That is, to hear content they prefer at a time of their own choosing.

Logically that presumption follows for block program formats on television as well as radio. The DDN is an idea ahead of the curve in that respect as well. Discussion of similar but less capable systems for television (known as digital or personal video recorders) is only now beginning to gain steam. The DDN was first conceived in the mid 1990's and has already faced and overcome many implementation difficulties. It offers tighter timing and more dynamic end-user utility than current proposals for digital video recorders. Having said that, the ideas clearly resonate with each other to show the future for digital media delivery.

The DDN pilot presumes, inter alia, that the end-user optimally prefers:

1. **Pre-filtered content.** That is, content that has been packaged, sorted and peer-approved. Very few of us have enough time and/or self-assurance to individually trawl the world for gems.
 2. **Live delivery according to a time schedule.** Essential to our daily routines and a sense of shared experience.
 3. **The option of content on demand.** Content we want, when we want it.
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At first blush, points 2 and 3 may seem mutually exclusive. You get content on demand by pressing the PLAY button on the CD or DVD, whereas shared experience according to a time schedule is the stuff of traditional broadcasting.

But it is possible to have your cake and eat it as well. The DDN is already showing that selective live content capture coupled with replay on demand is a key service model for adding value to broadcasting.

This conviction is not purely based on speculation but on the experience of developing the concept and function of the Digital Delivery Network and its on-screen replay interface/s, appropriately dubbed 'Plaything'. The DDN and Plaything is a service based evolution. Its development and implementation is, in effect, an action research project. Being a real and practical project there are powerful user expectations. The system is delivering.

Being a real and working system, the evolution of the service is continually being informed by user feedback. Much of this feedback provides a bellwether to the shape of future value added services for digital delivery to the public at large.

What technology is required?

The Digital Delivery Network leverages the traditional broadcast delivery model by combining concepts of real time digital data delivery, digital datacasting and real time digital audio delivery into one easy to use package.

The system requires a delivery technology platform capable of delivering well protected data streams alongside the real-time delivery of media content. In addition, reception equipment must have the ability to be 'always on' and have built-in and reliable storage capacity.

Beyond those requirements it matters little which technology is chosen for delivery. The concepts discussed here and systems of the DDN are largely platform agnostic.

For the technocrats, the current pilot of the DDN and Plaything operates over a DVB satellite system, using MPEG bit rate reduction and auxiliary data capacity. Two extra systems have been added to that platform to further protect and encrypt critical control and other content data. The fact that this system can feed a television set means little for, as far as technology delivery is concerned, radio is simply television with your eyes shut. To take that one step further all wireless digital delivery technologies developed for broadcasting are really systems for delivery of data. The fact that some of the data is intended for television screens, radio speakers or a PC screen is really just a service model construct.

The state of the art is not yet at the point where all the ingredients for the DDN and Plaything are in one pre-packaged piece of consumer level equipment. Some specific software and hardware has been developed to glue this together, but the idea has always been to design the interfaces around standard, common and popular technologies due to lower cost and wide availability. Hence, for example, the user interface screens emulate garden variety web browser functionality.

The system is working smoothly and to exacting levels of reliability. Many radio stations now rely on the DDN and Plaything for their hourly news broadcasts and many other programs that leave little tolerance for failure.

Management of access to content

The key to combining real time media delivery with replay on demand is for the send-end playout system to automatically and digitally 'flag' content as it is delivered. All content that the service provider intends to make available for replay on demand must be flagged in that way.

Taking that as a given, there are then options on how to manage users. Which option is appropriate is largely determined by what management / business model is sought by the service provider.

The two main options are:

1. **Allowing each user to grab any or all flagged content.** Meaning that the service provider has no knowledge of usage patterns but can still decide which content to make available for capture by end-users.
2. **Requiring that each user indicate content preferences in advance to the service provider,** thereafter being able to capture and store content according to indicated preferences. The service provider thus gains knowledge of content take-up and can adjust the programming complexion on the basis of accurate user feedback.

At a technology design level the DDN is able to operate in both or either modes, but the management imperative is emphatically on the second. That's because the satellite service this development leverages from is called 'ComRadSat'. Operatives Boris and Natasha and their Big Brother like to know exactly who's using what and when.

Thus, a web linked database has been developed for the DDN pilot into which end-users express their content preferences. The user's equipment then operates according to those preferences until next updated. In this way the system conditionally permits live use of material and end-user capture of a large automatically updating resource of program and other content.

Meta-data is associated with content in several ways. XML is used internally to inform on-screen graphics. Although it could be XML is not sent to end-users. XML has no relevant standard for meta-data and there is a risk of mismatch between meta-data and content. Instead meta-data is appended directly to the content in several info-chunk formats, some of which are progressively reaching international standardisation for broadcast use. Use of multiple info-chunks achieves maximum compatibility with content replay systems already in use.

At the time of writing the system is delivering 125 separate programs per week (250 editions). This equates to 25 programs (40 editions) on a typical weekday. On top of that are special programs, short items, music tracks sorted by genre, plus on screen text, graphics and media clips.

The on-line database works with several other internal databases and systems for management of datacasting and main program / content delivery. Simple in concept and for the end user, but diabolical in system design and execution.

As well as being necessary for system operation, the various databases enable statistical analysis and reporting for program makers, content providers, artists and those providing support for program creation. This research is also being used to guide future schedule and content changes.

Addressable delivery necessarily requires that each user be uniquely identified and the system is thus capable of tracking and reporting on the preferences and patterns of each individual user. To be pedantic, the DDN actually has three separate identification systems: two to enable the broadcast program and its associated control data to be addressed to specific users; and a third to address datacast services to specific users.

Addressable delivery is clearly a powerful and appropriate tool for a closed user group but may seem over the top for free-to-air broadcasting. In the context of free-to-air it might be easier to avoid debates about privacy and forgo that goldmine of information about who's using what and when. Maybe that's true for the main program and its associated control data, but it is clearly helpful to provide for addressable delivery of datacast services. The DDN is uncovering all sorts of delivery opportunities in this category, including for example: music tracks, video clips, topical and archival grabs.

As the system beds in further there will no doubt be more experience to be gained about what types of services will be valued by its users. It takes little imagination to see the applicability of the DDN to more conventional educational services. For example, leveraging the DDN functionality with the ubiquity of satellite coverage might enable:

- Specialist curriculum service delivery and exchange between centres of learning;
 - Teacher / class / student access to shared material on demand;
 - Real time lecture casting, in addition to
 - Automatic storage for later replay on-demand as often as is required.
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User control and choice

It is interesting to consider how DDN functionality might affect the user relationship with traditional broadcast service models if it were implemented more widely.

Replay on demand by pressing the PLAY button on the CD machine is something one can indulge in regularly. Fun for sure, but it lacks the feeling and excitement of doing it with others.

There is definitely a positive psychology to the sense of shared experience created by a broadcast program schedule. The coming together of content capture with replay on demand maintains that positive feeling. You know when you press the button that you're not alone - lots of people are doing it.

And by doing it when it suits them the user's experience is enriched in many ways. The ability to focus easily and repeatedly on specific programs provides a compelling environment for educators, programmers and broadcasters to invest in well researched and high quality programs. More people will hear them, and overall diversity in programming can co-exist alongside a consistent user experience.

I know I'm already hearing gems that I would have never heard before the introduction of the DDN. The ephemeral nature of broadcasting is no more.

Commercial perspectives

Traditionally, presuming a program is highly regarded in every other respect, its ratings, as one measure of program impact, can only ever relate to the number of people in a position to listen at the time of broadcast. What about all the rest? On-demand replay clearly has benefits in a commercial context.

The ability for selective content capture coupled with replay on demand means that the user experience of a particular broadcast service is potentially highly selective.

For instance, I'm finding that each time I pass by my own Plaything I now instinctively hit the NEWS button, listen for a few seconds to the head stories and then continue on my way to the kettle. In this way my Plaything was first to tell me that the Queen Mum had died, and that some friends in the Middle East were in mortal danger.

Apart from the incredible convenience of this, my point is that what I'm not doing is waiting around just before the top of each hour to hear the NEWS and therefore being a target for sponsorship, advertisements, or spivs spruiking new miracle cures for baldness. I sincerely trust I haven't missed anything important.

Of course it would be possible for the broadcaster to include those vital messages within the confines of a program or segment, rather than scheduling them as adjacent and, of course always, distinct from program or editorial content.

On the other hand, users may react badly to being effectively forced to capture and experience advertisements. Ultimately the equation to weigh up would be the potential for adverse user reaction versus the amount of cash a broadcaster received for inclusion of the comment.

Finally, I should note that where user profiles are known by the service provider, that information could be used to target specific messages and / or advertising. One can replace generic broadcast messages with specifically targetted messages held locally. Broadcasters know that technique as 'localisation'; a feature also built into the DDN. An advertising person's mind might race about how that technique can be applied directly in end user equipment.

Copyright

Broadcasters are used to paying fees for the right to use protected material in their programs. Usually these fees are paid through an agency representing the interests of the copyright owner/s on a collective basis, and the fees are based on a percentage of broadcaster gross revenue.

The agreements intend to cover the majority of broadcast situations, but there are common exceptions. Specific (grand) rights need to be negotiated to broadcast entire musical works. Permission is needed to broadcast individual pieces, including poetry or other literary works in entirety.

Moreover, none of these rights allow for the permanent copying or storage of material. Broadcasters do have a special right under the Copyright Act 1968 to copy and store material on an ephemeral basis; otherwise production and dissemination of programs would be unworkable.

The ephemeral right means that capture and storage of ComRadSat material by the DDN is permitted, as it is simply a means of disseminating material ultimately intended for broadcast. Fees are due by the broadcaster, as normal, upon actual broadcast of the material to the public.

The same applies to music tracks distributed to stations using this system. It's been found that new and emerging artists are often not (yet) in the repertoire of the collection agency, and so a greater proportion of specific individual permissions must be sought.

Of course, it's a very different story when capture and storage of material is occurring in equipment owned and operated directly by individual members of the general public. The ephemeral right no longer applies.

New agreements will need to be negotiated to reflect this new service model. One might expect those negotiations to be protracted. The copyright implications of expanding delivery of media and other content for education and learning purposes may well provide a new job stream for the legal department for some time.

Conclusion

This paper has concentrated on the idea and implications of providing broadcast service users with the ability for selective content capture coupled with replay on demand. I believe this is to be a major opportunity for content delivery in the future.

The pilot of the Digital Delivery Network and Plaything with the community broadcasting sector is a pioneering development and one that, as an action research project, will yield more valuable insights to help shape the future delivery of digital media.

It presents some exciting challenges and opportunities for the education sector to expand the learning community.

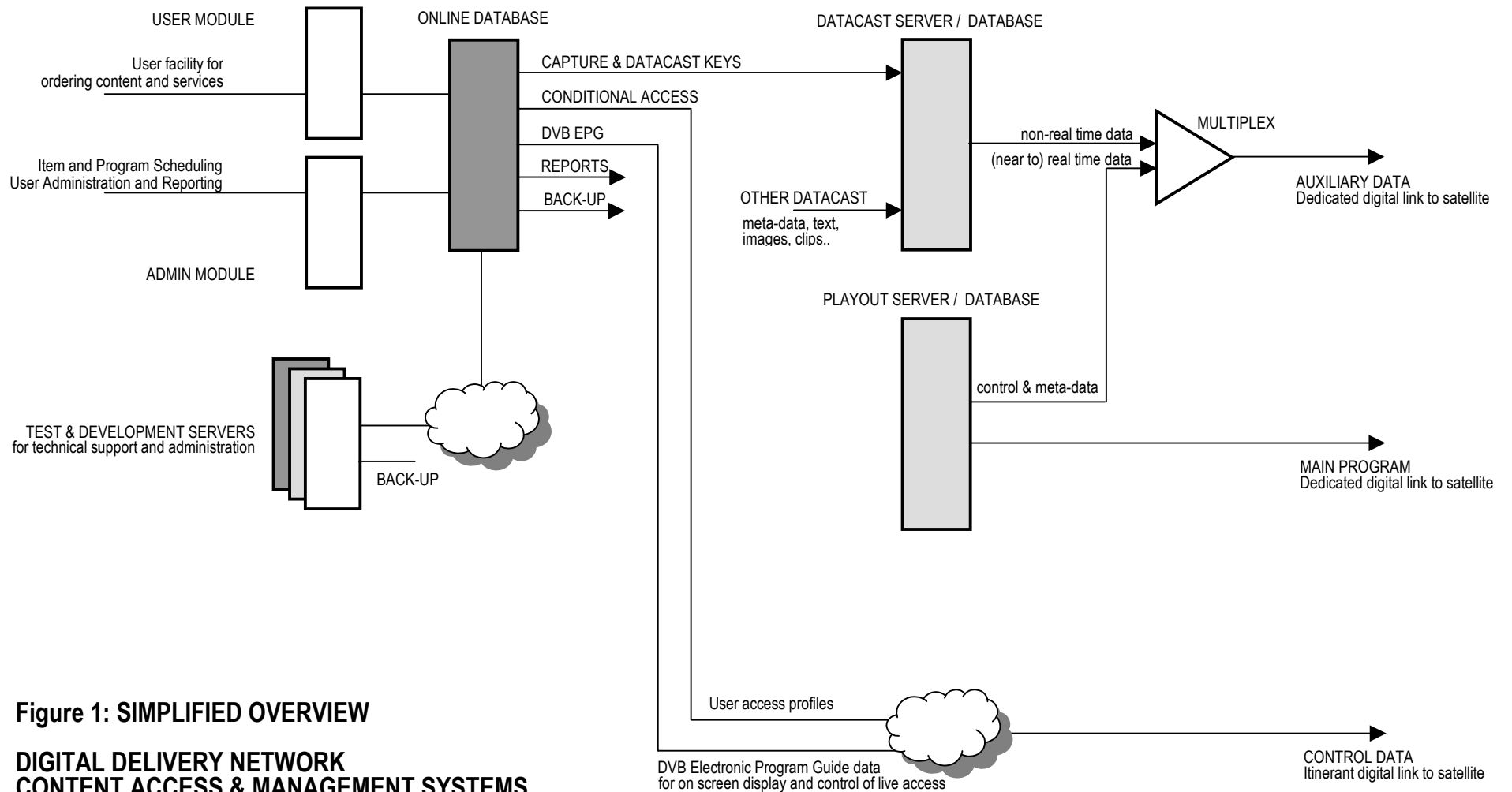


Figure 1: SIMPLIFIED OVERVIEW

**DIGITAL DELIVERY NETWORK
CONTENT ACCESS & MANAGEMENT SYSTEMS**
Some details have been omitted for clarity