# "Comparison of Near Video on Demand Methods for CATV"

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## Abstract

This paper will describe a simulation model for evaluating trade-offs between Video On Demand, (VOD), schemes and transmission methods. A statistical approach is used and the concept of a "Demand Function" is introduced. The model is then applied to the specific case of a CATV system which assumes new fiber optic architectures which use "Star" configurations from the Headend and standard coaxial "Tree and Branch" networks to the subscriber. This is similar to the architecture used by ATC in their Queens project [1]. The model is also can be used to compare the capacity of different networks, such as Telephone, CATV, and DBS, to provide NVOD services.

## 1.0 Introduction

There is currently a clear demand by consumers for prerecorded video program material, as evidenced by the success of Video Tape Rental stores, (VTR), with revenues estimated at greater than $15 billion.

Several industries are currently developing strategies for getting a portion of these revenues; such as DBS, Telcos, CATV, and even Terrestrial Broadcasters. Recent advances in digital video compression will allow these industries more channels to compete with the Video Tape Rental stores.

But, how can we compare the efficacy of these different industries for providing NVOD services electronically to the home? And how can different methods for supplying video programs electronically to subscribers in their homes, within the same industry, be compared and evaluated?

Video On Demand, (VOD), is a term that has been used by Telcos [2] to mean a video program delivery system that retains the features of a VCR, (such as Play, Rewind, Fast Forward, Pause, etc.), and provides virtually instant access to large video libraries.

The implication is that :

* any Subscriber can view,
  any Library Title, at
  any Time.

This scenario could take infinite, or nearly infinite, resources to be able to satisfy all of the demands of all of the subscribers all of the time.

A less ambitious goal has been called Near Video On Demand, (NVOD), where less resources are required, ie. Sources, Titles, or Switching.

Such that:

* not all Subscribers can view,
  any Library Title they want , at
  any Time they want.

The Cable industry is currently going to 150 channels with 1.0 Ghz systems [1], and with compression, greater than 400 channel systems are realistic. But, is this enough channels or maybe more than enough to compete effectively with VTR stores?

This paper will outline a method for answering these questions by using computer simulations of the various NVOD scenarios.

## 2.0 NVOD Scenarios ( Simulated)

1. "Time Shifted Broadcast" uses several copies of the same program with different start times, similar to ATC's Queens project[1]. This method uses fixed scheduled Start times. The scheduled start times are displayed to the potential subscriber via a barker channel.
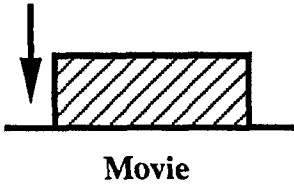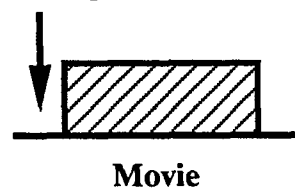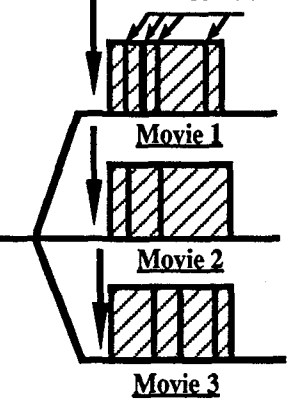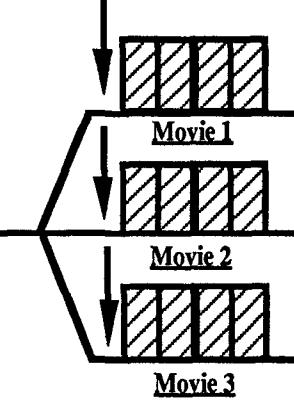
2. "Subscriber Directed Broadcast" is similar to Case 1., but does not exclusively have fixed schedules. This method uses Subscriber requests to modify scheduled start times.

3. "Partial Switch" adds switching to the Subscriber Directed Broadcast system so that more than one Program Title can use the same Channel or Source. This is the Case preferred for CATV.

4. "True VOD" (Telco style)[2] allows a program data base to be switched and dedicated to an individual Subscriber, on Demand. Because each subscriber has a dedicated Channel, the typical functions of VCRs can be implemented, such as Rewind, Fast Forward, Pause, Stop, etc.

In table 1, some features, advantages, and disadvantages of these NVOD scenarios are compared.

## Table 1. Various NVOD Scenarios

| CASE 4<br>True VOD<br>*Video Rental* | CASE 3<br>Partial Switch | CASE 2<br>Subscriber Directed<br>Broadcast | CASE 1<br>Time Shifted<br>Broadcast |
|---|---|---|---|
| <br>1 User<br>Movie | <br>Group User<br>Movie | <br>Group User   Start times<br>Movie 1<br>Movie 2<br>Movie 3 | <br>Group User<br>Movie 1<br>Movie 2<br>Movie 3 |
| Interactive 2-Way<br><br>Fully Switched | Interactive 2-Way<br><br>Part Broadcast<br>Part Switched | Indirect 2-Way<br><br>Broadcast<br>(No Switch) | Indirect 2-Way<br><br>Broadcast |
| Easily Saturated<br>Most Titles<br>Least number users | Reduced Saturation<br>More Titles<br>More users | No Saturation<br>Slightly More Titles<br>Unlimited Users | No Saturation<br>Least Titles<br>Unlimited Users |
| High Customer<br> Satisfaction<br>Most Variety<br>Most Convenient | Convenient<br><br>Good Variety | More Convenient<br>during peak loads. | Least Convenient<br><br>Moderate Satisfaction |

## 3.0 Simulation Model Description

In [3], several authors have discussed several simple NVOD scenarios by using analytical means. In practice, however, the Cases can become very complex, taking into account various conditions, such that closed form solutions may not be obtained.

The model, discussed in this paper, uses building blocks in a computer simulation to test the effect of various input conditions and system configurations.

The Subscriber is introduced into the systems in terms of a *"Demand Function"*, which is made up of several parts such as: popularity of video program title, national and regional viewing habits of consumers, average number of hours people watch TV, probability that a Subscriber will want to watch a movie more than once, availability of Titles, Start times, etc. The *"Demand Function "* allows the Simulation model to test various Subscriber conditions by entering simple curves, similar to "Load Distribution Curves" listed in [5]. As the Simulation runs, the cumulative probability of a Subscriber making a request is calculated at fixed increments and Outputs are generated for calculating financial data, channel usage, and a quality factor, (which is related to Subscriber satisfaction).

The basic model consist of a data base of "Set-Up" conditions which are loaded into the "Simulation Model", (Inputs 1 to 5). These inputs are then run through the Simulator and pre-defined "Outputs" are generated, (Outputs 8 to 10). While the Simulation is running the Operator can also make minor adjustments to some parameters associated with the Set-Up conditions.

The following is a list of the NVOD Simulation Model's Inputs and Outputs.

### Model Inputs (Figure 1)

#### 1. Sources.

    a. Hardware Configuration

    1. Total number of active sources, ,which assumes 1 <u>active</u> source per channel.
    2. Number of Titles allocated to a single source, ( includes total storage capacity of source).

    b. Type

    1. Includes physical parameters of playback device, "Source". ( S-VHS, Optical, digital, etc.).

    c. Storage

    1. Usable media "Storage time", (how many programs can be stored on a single media- -depends on Program lengths and media size).
    2. Access method; Random access, serial tape, etc.

    d. Source Selection Method

    1. Time to locate a specific Source, Queue Program, and Play Program.
    2. Selection method for connecting a Source to a Channel, (Multiplexing method and switch configuration).
    3. Media loading method - ( how does Source get access to Library; hand load, carousel , electronic, etc.

#### 2. Program Statistics

    a. Statistics from "Variety"[4] , " Top 50 Video Titles" are used to assign a probability index to Programs. This allows weighting of different Program titles.

    b. TV ratings from "Nielson", also listed in "Variety" on a weekly basis, allows weighting of the viewing habits of Subscribers in Network and CATV programs against NVOD programs.

    c. Program RUN TIME statistics are derived from movies on the "Top 50 list".
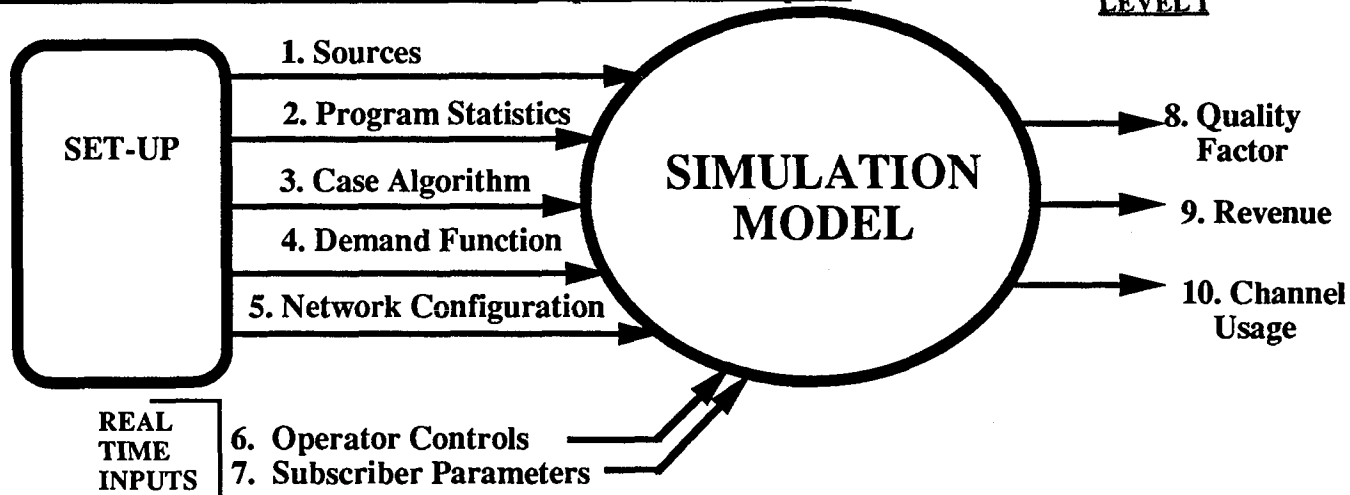
#### 3. Case Algorithm

    a. Time Shifted Broadcast, uses fixed schedules. Similar to ATC's Queens NVOD experiment[1].

## NVOD Simulation  Figure  1.

### NVOD Simulation Model, Inputs and Outputs

LEVEL I

**SET-UP**

1. Sources
2. Program Statistics
3. Case Algorithm
4. Demand Function
5. Network Configuration

**SIMULATION MODEL**

8. Quality Factor
9. Revenue
10. Channel Usage

**REAL TIME INPUTS**

6. Operator Controls
7. Subscriber Parameters

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### MODEL  INPUTS

**1. Sources**
Configuration
Type (Characteristics)
Storage
Selection Method

**2. Program Statistics**
Top 50 Video Rentals
AM ratings (Nielson)
Program RUN TIME

**3. Case Algorithm**
* Broadcast, fixed schedule
* Broadcast, user influenced schedule
* Partially Switched
* True VOD.

**4. Demand Function**
Viewer statistics
  * Global, (Nielson, etc.)
  * Regional
  * Individual
Ordering Statistics
  * Request / Buy  Rate
  * Cancel Rate

**5. CATV Network Configuration**
Total Subscribers.
Channel Line Up
Node size.

### REAL TIME INPUTS

**6. Operator Controls**
Changes to Operating Parameters

**7. Subscriber Parameter**
Changes to Subscriber Parameters

### MODEL OUTPUTS

**8. Quality Factor**
Efficiency of channel usage
Customer satisfaction.
Growth factor / current profit

**9. Revenue**
Rev./Sub, Rev./Ch.,  Rev. / Title
Profit
Fixed cost
Variable cost

**10. Channel Usage**
Avg. # of Ch. used
Peak usage
Unused channel capacity.

b. Broadcast, with Subscriber influenced scheduling. In this algorithm the specific start times of Programs are allowed to vary as a function of both Subscriber "Demand" and a fixed schedule.

For example; The 8:00 P.M. showing of Program A may not start until 8:04 P.M. in order to allow more Subscribers to order the program. Or it may start earlier to reduce waiting time and increase buy rate.

c. Partially Switched uses algorithm b, but also allows simple switching of sources, such that if some channels are not fully utilized, other Programs can be substituted.

d. True VOD is the case of dedicating a source and a channel to a single Subscriber. Although this case is most like the Video Tape Rental scenario, it is expected that Resources are under utilized.

In "Cases" "b" and "c" a "Real Time" Two-Way data transmission system is required. Cases "a" and "d" can use "Store and Forward" technologies as currently used for PPV.

Case "c" is the case which best utilizes modern CATV system resources, with a broadband transmission to the Subscriber for Programs and a narrowband return channel for Subscriber requests.

4. Demand Function

The "Demand" function is a semi-random function which statistically models the viewing habits of Subscribers, by Global, Regional, and Individual statistics.

This function is developed such that it can update the pre-loaded statistical data bases , used for generating Subscriber requests and specific Subscriber's ordering and buying patterns. (ie., a Subscriber who has already watched a Program once, will have a reduced probability of requesting the same program a second and third time.

5. CATV Network Configuration

Specific CATV system parameters are added to the Model. These parameters can be changed during a simulation.

a. Total number of Subscribers
b. Node size
c. Channel Line-Up, including Basic, Extended Basic, Pay, PPV, Audio, Data , NVOD.

**Real Time Inputs**

6. Operator Control

Operator Control is a means for the person who runs the Simulation to change certain operating parameters during the Simulation.

7. Subscriber Control,

Subscriber Control is a means to change certain Subscriber parameters, specific to the "Demand" function, during a Simulation .

**Model Outputs**

8. Quality Factor

a. A measure of the efficiency of using NVOD channels, ( NVOD channels versus other channels).

b. A measure of Subscriber satisfaction. Measured as a ratio of Requests versus Purchases of NVOD and is dependent on Program availability and Subscriber availability.

c. Growth factor versus current profit is a measure of the revenues and cost of current plant relative to the potential for expansion, such as adding channels, adding switching, adding titles, etc.

9. Revenue

This is the primary measured system performance criteria for the Cable Operator and it consists of :

a. Revenues
b. Costs - fixed
   variable
c. And a breakdown of financial data such as Rev./Sub., Rev. / Ch., Rev. / Title. etc.

10. Channel Usage.

This output has two primary functions.

a. To determine an optimal size for a specific system with given specifications.
b. To be used as feedback in the actual operation of the Simulation, (and potentially in real CATV systems), to adjust and control the current configuration of switched programs dependent on previous conditions.

## 4.0 NVOD Simulations (Figure 2)

To begin a Simulation the *Simulation Preset Conditions* are batch loaded into the Simulation program prior to start-up. In this way different "Source Configurations", "Case Algorithms", and CATV "*Network Configurations*" can be simulated.

Once the Simulation has "Started" the *Simulation Timer* provides the primary control of the NVOD Simulations . It provides daily and weekly schedules for the normal Broadcast Channels . It is also used to activate various elements of the "Demand " function, such as scheduling of normal Broadcast TV.
It also provides a *Random Number Generator* to be used for generating Subscriber "Requests" and "Orders" on a statistical basis.
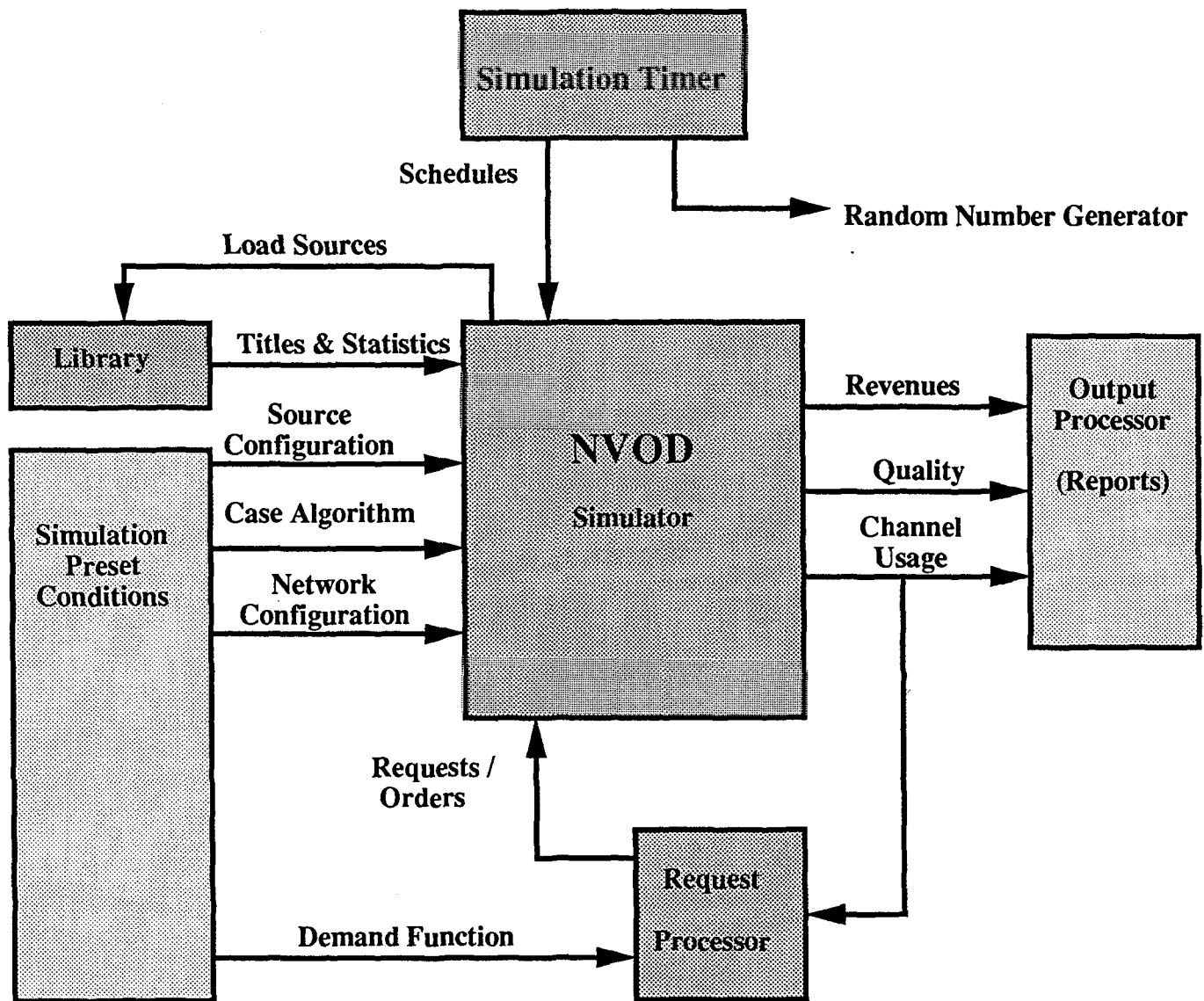
Figure (3) shows a typical "Program Packet". All programs transmitted throughout the CATV system can be modeled as a time ordered Matrix of Program Packets. A complete Simulated system is made up of a matrix of these Program Packets, which represents the traffic on all channels.

Specific *Demand Functions* are loaded into the *Request Processor*. The *Request Processor* then generates random *Requests / Orders* which reflect Subscriber Demand as it relates to the specific *System Configuration* modeled, *Channel Usage*, and pre-loaded statistics. The random nature of the *Request Processor* comes from the *Random Number Generator* output of the *Simulation Schedular*.

The *NVOD Simulator* is a logical block which manipulates various matrices. The logic is fixed, but certain "Real Time" inputs allow changing System and Subscriber parameters such as, Node Size, Total Subs., relative ratios of Demand Function.

As the Simulation program runs NVOD Programs need to be changed, since after a period of time, (which is statistically determined from the "Top 50 Video Titles" listings and the actual viewing by the Subscribers ), the probability that a Subscriber would want to watch a particular Program changes. To simulate this function , the *Library* is accessed to load new Program Titles into the input matrix.
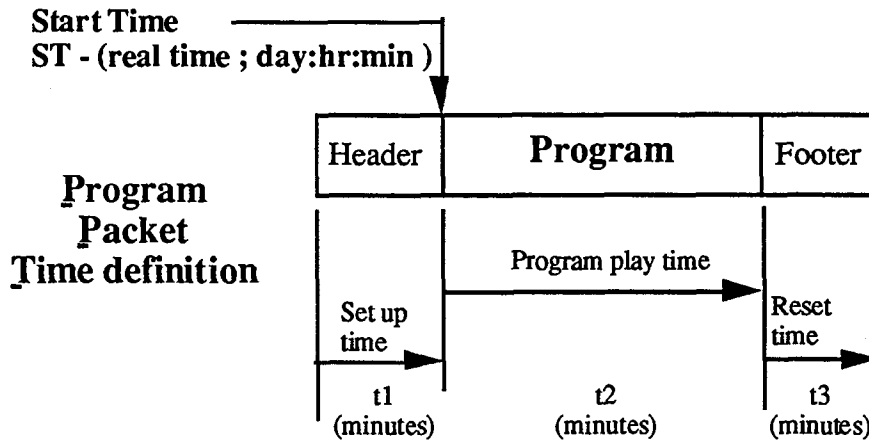
The *Output Processor's* primary function is for producing reports and to give the Simulation operator a view of what is happening during a simulation. The *Channel Usage* output is used to feedback to the NVOD Simulator the actual system activity, ie. what programs are actually being sent to what Subscribers.

## Simulation System Configuration
### Figure 2

# PROGRAM PACKETS -
Analysis uses Packet concept for Programs.

**Start Time**
**ST - (real time ; day:hr:min )**

**Program**
**Packet**
**Time definition**

| Header | **Program** | Footer |
|--------|-------------|--------|

Program play time

Set up time

Reset time

t1
(minutes)

t2
(minutes)

t3
(minutes)

t1 - Set up time ; time to queue Program to starting point. Including head-loading, seek-tiem, etc.

t2 - Program play time ; average time to play Program from beginning to end.

t3 - Reset time ; time from end of program to Header of next program. Includes Rewind time.

## Figure 3

## 5.0    Conclusion

The task of determining how to provide NVOD Services in a cost effective and competitive manner, to Video Tape Rental stores, is quite complex.  To launch most NVOD services, such as those envisioned by the Telephone and CATV industries, requires large capital investments.  These large investments will require a quick inexpensive method to evaluate potential Return On Investment.  The current method chosen , by Telephone and CATV companies, is to do a limited experiment with a small segment of Subscribers and with a limited selection of Program Titles.  This  is an evolutionary method and would probably be a good approach if it weren't for the competition among industries and the rapidly emerging technologies such as Compression and HDTV.

To further complicate the problem, different industries and communication networks will implement NVOD services in different ways.  A method is needed which will inexpensively test the differences for providing NVOD by Telephone , CATV, or DBS networks.  And an inexpensive method of comparing different cost effective NVOD schemes within industries is also needed.  This paper recommends a viable approach.   That is to develop a "robust" Simulation model which will be able to adjust to various NVOD schemes and will be able to include the random variations of consumer's demands.

It is envisioned that the Network which is able to deliver the most cost effective and Subscriber friendly system will enjoy a successful future.  After all, there is only so much money the Subscriber has to spend on entertainment; or is there ?

# Bibliography

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