Broadcast Agent: Intelligent Agents for TV distribution

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Abstract

Television (TV) is a very powerful and effective communication media, accessible to most population. It was designed to attend the average taste of the entire population through broadcast distribution. However, users want more options. TV and Internet will lead to one: either TV on the WEB or WEB on TV. TV on Demand and also Interactive TV are approaches to merge the two technologies. We addressed the above issues using Intelligent Agents techniques, proposing a model called TV Broker. We are in the stage of implementing the model to show its viability. In this proposal we emphasize the Broad cast Agent on order to optimize the channel allocation during down loading huge amounts of data.

Keywords

Autonomous Agents, Channel allocation, Intelligent Databases, Intelligent Interfaces, Interactive TV

Introduction

Television (TV) is a very powerful and effective communication media. The attendance to consumer's yearnings has been a constant concern of TV systems. The current television (Open TV), with broadcast transmission, offers a rigid program set that have become bored and insufficient to take care audience desire for customization. Cable TV contributed to improve the TV flexibility offering a broader range of TV options. An audacious movement in this personalization direction has been planned in the area of TV on demand and interactive TV. TV on demand allows users to configure, direct or indirect his/her programming agenda. Interactive TV has the same questions of the TV on demand and related others as a script could be counted, beyond the serious problem synchronization of the versions being transmitted.
The TV Broker project presents an approach of massive customization.

TV on Demand [1] [2] is a new way to deliver customized TV programs to individual audience. It works similarly as a digital videocassette that not only records, but also manipulates TV programs delivered through cable or satellites.
The technology includes a piece of hardware (set top boxes) placed to receive and send TV information from TV networks. It buffers program information allowing the audience manipulates the information similarly to with a videocassette even on-live TV.
There are many advantages to this new technology over VCR:

- Receive and manipulate On-live TV programming,
- Extensive recording ability,
- Direct Access to previous recorded information (such as with a DVD),
- Fast search.

Pay per view is another hint that TV Entertainment Business is aware that audience desires more options. It works as a video store that can even handle live TV. Interactive TV requires a new type of video stream. More information must be sent to spectators, so they can determine their "watching" path.
In this paper we present a model for TV on demand emphasizing the broadcast issue in volved.

Intelligent Agents

Agent is an autonomous entity able to execute specific tasks in the name of others human or computational entity [3] [4]. A thermostat is a very simple type of mechanical agent. It senses the environment temperature; compares with expected setting and then change or maintain the air conditioning status; that is, turn on or turn off the air conditioning unit.

There are two main attributes that entitles a software be called an agent:

- Autonomy—the agent must decide by itself the set of actions are needed to carry out a task depending on the context; and
- Mobility—the agent should be able to run in any place. Actually, it should be able to travel through a net and get CPU fuel anywhere.

Generally, agents perform tasks for humans. In this context, intelligence is a crucial characteristic agent must present. Intelligence has gained many controversial definitions. However, all of them include rational decision making, planning and learning as the key features. Rational decision-making is the process of finding alternative solutions, evaluate them and select the most valuable ones in a giving a situation. Planning is the ability to elaborate the set of actions needed to accomplish an objective. Finally, learning is the agent survival feature. Agent must be able to learn to adapt to new situations.

TV was developed for broadcasting programs. Its core idea is programming for the mass. It is an output device. The target audience is a result of statistical manipulation—the average user profile strategy.

TV on Demand aims to satisfy the individual. Consequently, there are two major challenges to win: figuring out what the spectator wants, searching for TV material that matches the needs and, finally, delivering it. Most TV on Demand approaches has addressed the streaming problem for delivering customized TV programs. The underlying premises are users know what they want and what they want is available to be selected.

TV Broker lays on the idea that intelligent agents may do a better job identifying and search for audience satisfaction. They can monitor a spectator's actions, create user's profile dynamically, search TV station offers, negotiate prices and deliver desired programs. User's behavior can be learned to improve user-TV interaction. In addition to using agent technology to assist individual audience, agent can also be used to handle society as a whole.

Our approach is based on using intelligent agents to support TV on Demand as described in the next section.

TV Broker: Model Description

We propose to build a customizable TV environment that allows audiences to receive desired TV programs improving their satisfaction. TV Broker is a distributed agent system, as shown in Figure 1, composed of three essential agents:

- TV Programming Agent;
- Broadcast Agent; and
- Broker.

In addition, there are two data sources central to the model:

- Product Catalog Database: This Database stores all the programs offering catalogs with adequate indexing techniques. The movies, operas, shows, interviews, humor plays, sports programs, entertainment and educational programs need to use the same indexing criteria used by the TV Programming Agent to generate and maintain user's profiles. Fuzzy logic will be used to accommodate the thresholds of offering and demand.
- Storage Center: The Storage Center must possess capacity to store the historical quantity of movies of approximately 350 Terabyte [6]. Considering an equivalent capacity in shows and short movies, we can estimate more or less 700 Terabyte that needed to be stored. It occurs that the Storage Center does not need to be universal; therefore, the regional movie production without cultural affinities can be recorded outside the Central Storage Center and only requested when it will have specific demands. In consequence of that, storage capacity can be estimated in the order of 250 Terabyte in magnetic disks and 500 Terabyte in robot tape units.
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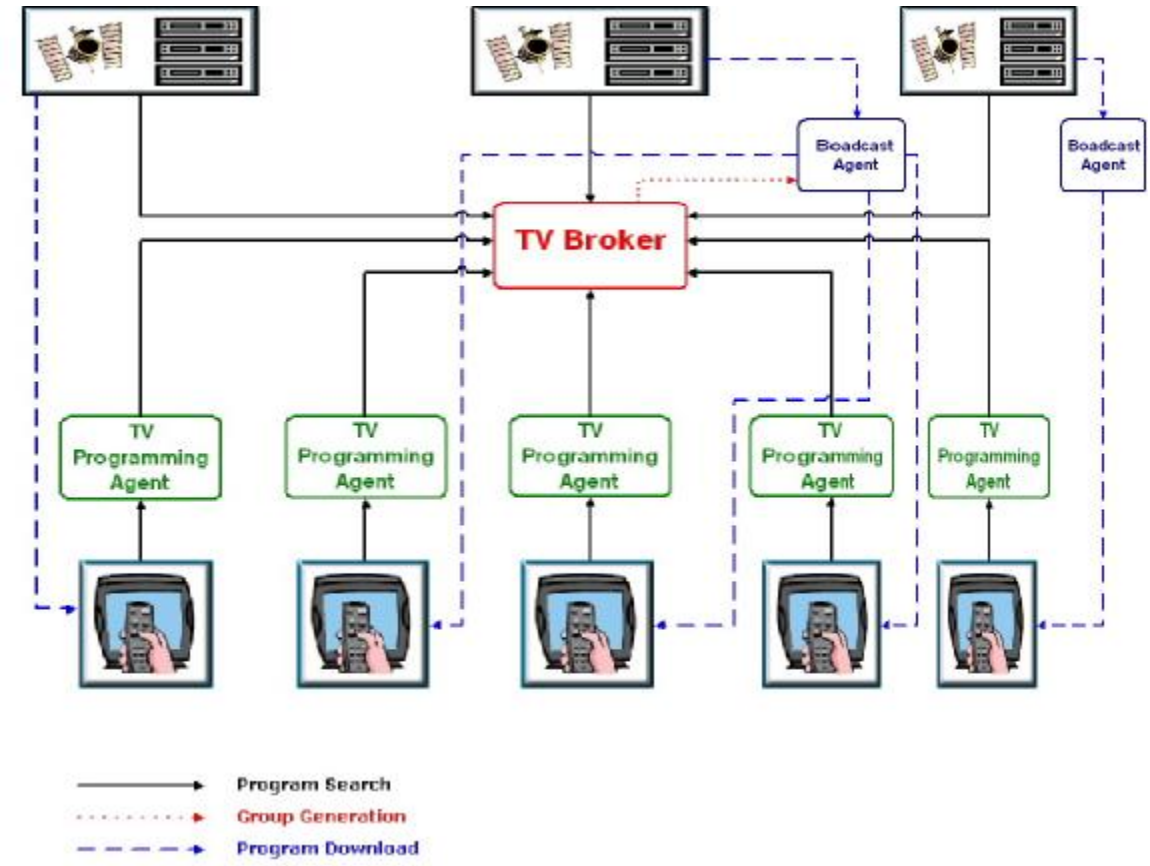
These agents lay on four distinct locations:

- Storage Center Place: to host the storage center.
- Processing Center: The processing Center hosts the main part of the intelligence of the System. Even though we considered a distributed architecture, the processing center controls the Broker and Broadcast agents main operations and all supporting controls such as billing.
- Neighborhood Center: Each Neighborhood Center receives the TV programming schedule for a given time period (six hours for instance) and takes care of its 500 (five hundred) users. One expects that each user, in average, requests no more than one movie every 6 (six) hours interval. We can consider that 50% of the TV sets are turned on and that 50% of the online users will accept the TV Programming Agent suggestions. Among the users looking for customized attendance, suppose 50% of them accepted being part of a group. The remaining audience chooses customized movies or programs. These figures generate a reasonable first hint for the needed capacity of the Center St orage Area.
- Set-top Box: These devices are composed of computers making use of standard peripherals such as keyboard and hard disks, being able to store the download stream to give support of the interactive TV, slow motion, the break, the rollback and the storage of selected displayed items. The low level tasks responsible by all these services are
  - Ø Interface TV set - Network
  - Ø Decode MPEG stream when needed (programmed individual use - movies and shows),
  - Ø Frame equalization,
  - Ø Hard disk control, and
  - Ø Video control.
  - Ø The user profile is stored in the hard disk of TV Programming Agent, which periodically sends a back-up copy to the System's Headquarter (Processing Center).



Meeting the individual audience instead of mass program is the goal of TV Broker. The considered paradigm

is the same of the World Wide Web where information are released fast become accessible quickly to all users, but hardly to find ("Where is Wally" dilemma).
Finally, choosing the communication channels to distribute the programs also requires decision-making that can be included in a computational agent—Broadcast Agent. There are some challenges to be overcome:

- Data transmission;
- Data compression;
- Quality of the programming; and
- Interactivity of the media.

In TV Broker model we can devise three operating scenarios:

- Massified use.
- Personal use.
- Group use.

The user profile will be characterized by a collection of attributes specified in the TV Programming Agent software. User profile interpretation is dynamic, incremental and transparent to end-users. TV Programming Agent is an eternal running program, recording user's behavior toward the TV settings creating a user's log that can be used to learn more about him/her.

The Communication Network

Communication channels will be of very high speed (OC-12 or ATM 622 Mbps) between the Storage Center and the Neighborhood Centers. The information exchanges between the Broker and the Storage Center, and between the Neighborhood Centers and set-top boxes is text form information with small volumes. This exchange can flow through voice channels. The download of catalogues flows along the communication channels between the Neighborhood Centers and the set-top boxes, as described in Dixit [7].

Origin	**Destination**	**Channel**	**Capacity**
Storage Center	Neighborhood Center	OC-12	622 Mbps
Neighborhood Center	User	HFC	4 Mbps
		ADSL	6,4 Mbps
		FTTC	6,2 Mbps
User	Broker	Voice channel	64 Kbps
Broker	User	Voice channel	64 Kbps
User	Neighborhood Center	Voice channel	64 Kbps
Neighborhood Center	User	Voice channel	64 Kbps

The network "last mile", meaning the link between the user and the system, can enjoy a variety of new choices currently available, as CATV, ISDN and XDSL services. The down stream transmission can perfectly be made by ADSL. Unhappily it is judged that UADSL or ADSL Lite will not have enough capacity for what is desired and thus we recommend the use of full-blown ADSL.

Communication Protocols and Interfaces

We need to use isochronous streams for live TV and Quality Of service is fundamental for the success of the System. ATM adoption is a natural choice. The data compression is supposed to be made by MPEG with program Stream for audio and Transport Stream for video.

The Broadcast Agent

The Broadcast Agent is responsible for receiving, store and forward the programming download. These tasks need to be made in the adequate data rates and coding system ordered by the Broker.

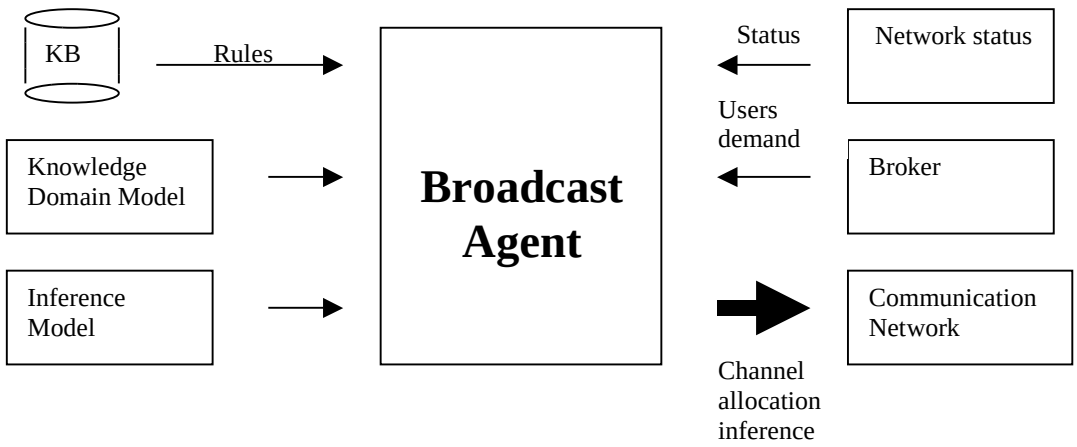
Our initial hypothesis of the data figures in channel capacity and security storage space is shown to follow.

Subject	Value
Users in a neighborhood	500
Tax of occupation	50%
Active users	250
Tax of acceptance of suggestion	50%
Users desiring personalization	125
Users accepting group programming	63
Number of formed groups	7
Users desiring individual programming	62
Daily Films in individual programming	2
Films from individual Programming in a three hours interval	62
Films from group Programming in a three hours interval	95
Films to down load in a three hours interval	157
Storage space needed for a film (GB)	4
Storage space needed in a three hours interval (GB)	628
Storage space to down load in a second (MB)	58,15
Throughput (Mbps)	465,19
OC-12 line capacity (Mbps)	622
Back-up storage space for a 30 minutes interval (GB)	105

Data Centers are currently available and cheap reliable network backbones are commodities and mature autonomous agents are new players and gave new guidelines to the project. The local loop contains various choices of broadband and the integration of TV and Internet is not a dream anymore.

There is no doubt that TV Broker was projected to store and transfer data at outstanding volumes and rates. The new facts, that made the project affordable, are that nowadays these challenges are feasible.

Broadcast Agent model can be shown in Picture 2. It is composed of a Knowledge Domain Model, that stores the details of the resource being distributed, an Inference Model, that stores the rationale for the distribution channel choice, a set of distributed Agents for detect the network status, the Broker sending its requisites and the communication network.



Picture 1 Broadcast Agent Model

The Knowledge Domain Model keeps track of characteristics of the domain, as type of flow, possibility of multiplexing, compatibility of distinct flows to share the media, switching devices and delays,

importance of jittering and other related information,

The Inference Model maintains how to choose the best solution using weighting functions to obtain the virtual path length used in shortest path algorithms and the routing algorithms themselves.

The Knowledge Base stores the network topology, resources and alternative paths.

This project was destined to data transmission but if we adapt the parameters for the most adequate path ("shortest" path) it can be used for power electricity lines also.

To prevent congestion our model uses Agents and Managers. The distributed Agents search the ATM switches and record the ER (Exchange Rate) fields of RM (Resource Management) cells. These cells are a kind of OAM (Operation and Maintenance) padding ATM cells. The ER value indicates the flow rate desirable in order to avoid cell discard. Our Manager uses the ER data as a parameter value used in the virtual path length that defines the shortest path to be elected. The shortest path algorithm combines cost, distance, bandwidth, average traffic, mean queue length, measured delay and ER to suggest the best link in each case.

The services provided by the Broadcast Agent are a choice of standard routing methods. The communication companies usually prefer other methods because they intent to serve multiple users and the characteristics of the users mix differ of the needs of a single user and then compromise solutions are often preferred. In our case, however, the data to be moved indicates a special treatment as suggested by the Broadcast Agent.

Value Aggregation

Value aggregation occurs when an existing product or service becomes more valuable to its customers or more profitable to its providers. That's exactly what will be obtained by TV Broker operations.

Current TV models have their own value by looking for the average audience needs and preferences. TV Broker is looking for individual needs and preferences. This difference is a scale leap forward. In spite our satisfaction to be "one of the members of the group" we always prefer the "one", or to be the more equal among all the equals.

The opportunity opened by acquiring the user profile is a very important step to drive social, educational, political, marketing and entertainment initiatives towards a full attendance of customer's needs and preferences.

It's important to say that the architecture of TV Broker model in not new. It has been a dream by almost a decade. What is new is the use of inference models that can override the impossibilities of that ar chitecture. To download programs in an effective time and at an effective cost can be considered achievable using Broadcast Agent.

The Broadcast Agent is an attempt to face the huge challenges of data flow requisites that make this project feasible with the current technology.

References

1 HODGE, W.W., Martin, S., POWERS, J.T., Jr.: "Video on Demand: Architectures, Systems, and Applications," Society of Motion Picture and Television Engineers Journal, vol. 102, pp. 791-803, Sept. 1993.

2 NELSON, M.N., and LINTON, M.: "A Highly Available, Scalable ITV System," Proc. Fifteenth Symp. on Operating Systems Prin., ACM, pp. 54-67, 1995.

3 NISENBAM, F. – "Software Agents and User Autonomy" – ACM-Agents'97 Conference – Marina Del Rey - 1997.

4 NWANA, H. S. – "Software Agents: An Overview" – The Knowledge Engineering Review 11 (3) – Cambridge – 1996.

5 GARCIA, A. C. B. – "Active Design Documents: A New Approach for Supporting Documentation during Preliminary Routine Design," Ph.D. thesis, Stanford University, 1992.

6 TANEMBAUM, A. S. - Computer Networks, Prentice Hall PTR, Upper Saddle River, 1996.

7 DIXIT, S., and MILLER, SKELLY, P.: "MPEG-2 over ATM for Video Dial Tone

Network, “ IEEE Network Magazine, vol. 9, pp. 30-40, Sept./Oct. 1995.