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Title: IMPROVED OIL RECOVERY FOR INDEPENDENT OIL & GAS PRODUCERS

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Improved Oil Recovery for Independent Oil & Gas Producers

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ABSTRACT

There are more than fifty-two hundred independent oil and gas producers operating in the United States today (based on current IPAA membership figures). Many of these companies have instituted improved oil recovery programs in some form, but very few have had access to the state-of-the-art modeling technology routinely used by major producers to manage these projects. Since independent operators are playing an increasingly important role in production of hydrocarbons in the United States, it is important to promote state-of-the-art management practices, including the planning and monitoring of improved oil recovery projects, within this community. This is one of the goals of the Strategic Technologies Council , a special interest group of Independent Oil Gas producers.

This paper will describe a project which focuses on the distribution of advanced reservoir management technologies (geological, petrophysical, and engineering) to independent producers. The evolving information highway serves as the distribution medium, specifically the World Wide Web (W3). The procedure for launching petrotechnical applications and retrieving results over the W3 will be presented. A paradigm for the interaction between the independents, the petroleum service sector, and government will also be presented. Of principal concern is the cost of making high-tech modeling applications accessible to independent operators.

INTRODUCTION

Reservoir management technologies have the potential to increase oil recovery while simultaneously reducing production costs. These technologies were pioneered by major producers and are routinely used by them. Independent producers confront two problems adopting this apporach: the high cost of acquiring these technologies and the high cost of using them even when they are affordable. Effective use of reservoir management tools requires, in general, the services of a professional (geoscientist or engineer) who is already familiar with the details of setting up, running, and interpreting computer models.

This paper describes a project which aims to make these technologies available to the independent operator in a cost effective manner. The central feature of our approach exploits the potential of W3 to deliver software access at low cost. Other details, e.g. the role of expert users, will be described in a later section of this paper. In contrast to the present situation a non-expert independent operator will be able to make simple but meaningful changes to the simulation models, such as changing well parameters, adding wells, changing wells from producers to injectors, for example, to assess the effect of such strategies on oil recovery rates.

It should be emphasized that this is a low cost solution. The independent operator can control his cost of access to the reservoir management technology. He can contract for whatever services he cannot perform for himself. Moreover, the independent operator can access directly the modeling technology, for example, reservoir simulation through interfaces which promote self-sufficiency and allow a range of forecasting options which are intuitive. The more arduous tasks of data conditioning and model building can be contracted to local consultants or expert users. The hardware requirements are minimal: a PC, modem, Internet access, and Web browser. At least two of these are probably already available. Some browers are available as freeware (Mosaic, for example), and Internet access costs little more than Cable TV access.

APPLICATIONS TO BE AVAILABLE

A reservoir management project, in general, involves the steps depicted in figure 1. Available petrophysical data is used to create a deterministic or stochastic geological model. This model provides part of the input to a reservoir simulator which models the reservoir production. In that the geological representation may be uncertain, this process may be repeated with other acceptable representations to give the range of possible production values and thus evaluate the uncertainty and risk in the project. Then the results are analysed for financial viability. At the present time, our project is just beginning. Only the public domain black-oil simulator BOAST is available from our server. As the project progresses we expect to demonstrate links to commercial simulators, with the appropriate access restrictions, and other reservoir management applications, e.g. geological models, geostatistical characterization tools.

ACCESS VIA W3

The internet is already changing the way business is conducted and will almost certainly revolutionize it in the near future. It is basically a group of computers connected together so that they can communicate with one another. It was originally developed for national security reasons, and therefore has significant built-in redundancy. Because of the advent of low cost, powerful personal computers over the last decade, the concommitant increase in the available communication speeds (28.8 kbaud modems are now the norm and significantly higher speeds expected in the future), and its opening to the general public, the internet has metamorphosized into a general purpose information "superhighway" that is being put to a large number of uses.

W3 supports extremely user-friendly interpretation protocols (HTML,etc.) which support the transmission of graphic images and movies as well as text. In fact, links to other documents are as simple as a mouse click on highlighted portions of text (the hypertext capability). In the W3, certain computers are servers which are configured to provide information and services to all who request it (the reservoir management software resides on one such server), while others are clients which access the information. The clients must have "browser" software installed. This browser software allows the client to display the data properly, that is, as text, graphics or movies as required.

Our server may be accessed by opening the link

http://x-div.lanl.gov/XPA

and clicking on the oil and gas highlighted text. A browser, e.g. Mosaic, or Netscape®, must be installed on the client.

RUNNING A JOB

After clicking on oil and gas the screen shown in figure 2 is displayed. At this point in time two options are available. The first, for a new user, simply runs the BOAST simulator for a predetermined problem with an input file stored on our computer. This might be appropriate for someone visiting the server site for the first time. When this option is invoked, the screen shown in figure 3 is displayed. One simply fills out the form by replacing the default entries with entries for <your name> and <problem id> and then clicking on <submit> (do not change the pressure). After a hopefully brief interval, graphs of simulator output showing the reservoir production will appear on the client's screen as illustrated in figure 4. Alternately, one can leave the window and get the results later by clicking the <view results> button on the oil and gas page. This first option also allows one to change the bottom hole pressure in one of the wells and rerun the problem to compare the reservoir production with the original case. The user clicks on the appropriate button, fills out the form (this time with the bottom hole pressure specified), and then clicks on <submit>. As before, the graphical results will be disposed to the user's computer after a brief interval.

The second option is to run one's own input file. When this option is invoked, the screen in figure 5 is displayed. The server will transfer the input file from the specified directory on the client's computer by **ftp** (file transfer protocol) and will return output graphics files to the client by **ftp**. An e-mail message appears when the job has finished. The files may be viewed with the graphics viewer of choice or the <view results> button may be used, if the user's computer is a web site.

AN INTERNET PARADIGM FOR INDEPENDENTS

The preceeding sections illustrates how access to reservoir management applications, specifically reservoir simulation, can be distributed to independent operators on W3. Our paradigm does not postulate any abrupt changes in the modeling software, nor in the training of independent operators to use these tools. We believe that the demands of their businesses will probably always confine independent operators to interactions with these tools like those illustrated above. We postulate that the missing expertise can come from sources already available: the expert user and the local consultant. Fortunately, W3 can distribute the access required by these professionals to supplement the independent operator.

The expert user will generate the reservoir models to be used by the independent operator. He will be supported in this role by the local consultant, who may already be familiar with the independent operator's properties. The local consultant will

- collect data to support the expert user

- provide expert knowledge to interpret this data and guide the model development

- interpret model results for the indepedent operator

The local consultant need not be an expert user himself, but should have a good understanding of the goals of the project and of regional geology, petrophysics, and production practices. Moreover, the data which the local consultant collects will usually come not only from the independent operators files but also statutory databases, commercial databases, PTTC resources and government and university sources. Increasingly these resources are available on W3.

The W3 distributes access to the management software, provided by the software vendor, to the expert user, the local consultant, and the independent operator. For example, the local consultant may digitize well logs from the files of the independent operator which he then transfers to the expert user. In turn the expert user accesses, via W3, statistical/stochastic modeling tools in order to create reservoir realizations. This reservoir characterization effort will form the geological foundation of the simulation model. The simulation model itself may be generated by yet another expert user via W3. He will access the geological output of the first expert over the internet. None of these resources, except the local consultant, need be proximate neighbors of the independent operator.

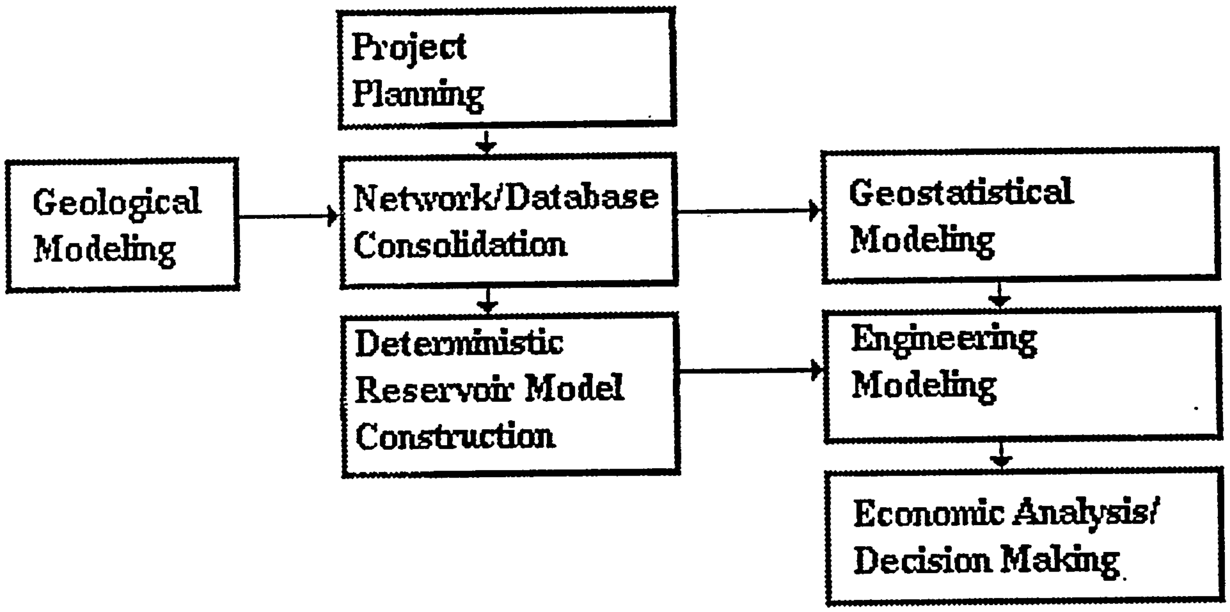
Issues like model validation and forecast design are the provence of the expert user. The independent operator addresses the reservoir management tools through an interface tailored to his needs to understand the impact of the various reservoir management operational parameters within his control on the profitability of the project. He would not be expected to assemble data or models. All of these users are tied together by the servers depicted in figure 6.

The software vendor may participate in this paradigm in several ways. He may maintain his own web server which provides access to the expert user, the local consultant and the independent operator. Or, he may sublicense his applications to the expert user who then provides this access. At this point, the former seems more likely.

CONCLUSIONS

This paper has described the beginning of a project with an ambitious goal: to bring the power of advanced reservoir management technologies, validated by the majors, to independent operators. The basic price of access is modest-only a PC, modem, and web browser plus internet access. Unlike the situation with the majors, full-time engineering and geological support is not required. Rather, the independent operator will contract with local consultants and expert users on a case-by-case basis. All will access the reservoir management technology over the W3. The unique feature of this approach is that it places portions of the technology directly into the hands of the independent. The interface between the independent operator and powerful modeling applications is simple enough that the need for specialized training is minimized. The independent operator can control his costs by performing as much of the work as he is capable of himself and by limiting his access to outside resources to the greatest extent possible.

Fig 1



Project Planning
Geological Modeling
Network/Database Consolidation
Deterministic Reservoir Model Construction
Geostatistical Modeling
Engineering Modeling
Economic Analysis/ Decision Making

NCSA Mosaic: Document View

File Options Navigate Annotate Help

Document Title: Oil and Gas Simulators and Viewers

Document URL: http://www-xdiv.lanl.gov/XPA/boaster/

OIL AND GAS SIMULATORS AND VIEWERS

One may run one of the following:

- BOASTCRAY SIMULATOR – DEFAULT PROBLEM Run the default problem, and try minor changes such as changing the flowing bottomhole pressure of one of the wells.
- BOASTCRAY VIEWER – DEFAULT PROBLEM View the output of the default run.
- BOASTCRAY SIMULATOR Run your own problem.
- BOASTCRAY VIEWER View the output of your own problem.
- BOASTCRAY – KILL JOB Kill an executing simulation run that uses your own input (not the default input). See your email for the numeric job identifier to be used.

Back Forward Home Reload Open... Save As... Clone New Window Close Window

NCSA Mosaic: Document View

File Options Navigate Annotate Help

Document Title: BOASTCRAY Reservoir Simulator : default Execution

Document URL: http://www-xdiv.lanl.gov/XPA/boaster/boastcray/boastcr

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BOASTCRAY RESERVOIR SIMULATOR: EXECUTION OF DEFAULT PROBLEM

One may execute the BOASTCRAY reservoir simulator default problem or minor modifications of it by filling in the items below and clicking on the submit button. Please use only letters (capital or small), numbers, underscores (_), dashes (-) or periods (.).

Generic verbosity

When the simulation is finished, output plots will be displayed in this window if the connection to the machine is not broken. Otherwise, use the simulator viewer accessible from one level up. The simulation should finish in about 12 minutes if you are the only one using the machine. If other people are on, it may take significantly longer to finish.

Please specify your last name: generic_name

Please specify the identifier for this run: default

Please specify the flowing bottom hole pressure of the fed11 well. The value must fit inside the box. The default is 1400 psi. The default problem may be run by not changing this value: 1400.

Press this button to submit the query: Submit.

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File Options Navigate Annotate Help

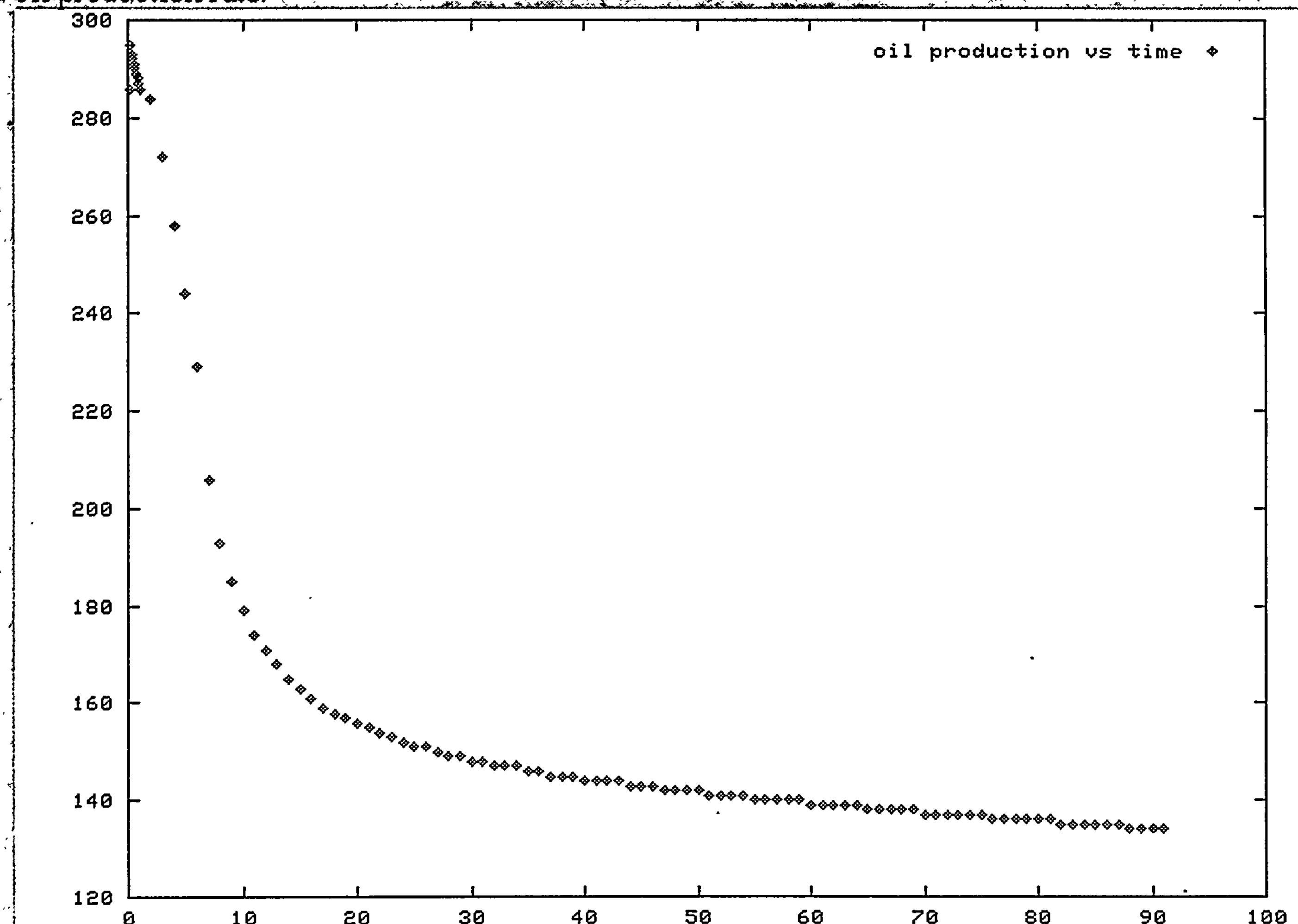
Document Title: BOASTCRAY OUTPUT

Document URL: http://www-xdiv/XPA/boaster/cgi-bin/boastcraydef1?input_name=

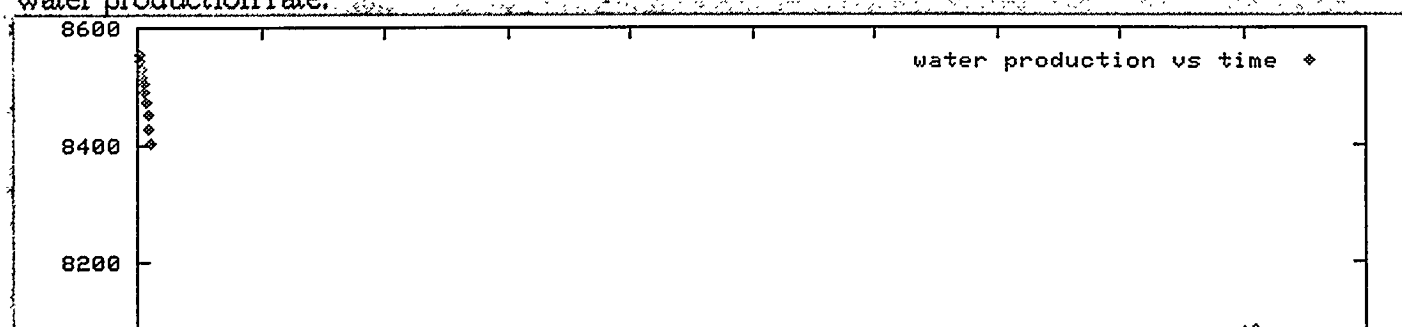
BOASTCRAY RESULTS

The flowing bottom hole pressure for the fed11 well is: 1400.

oil production rate:



water production rate:



Data transfer complete.

Back | Forward | Home | Reload | Open... | Save As... | Clone | New Window | Close Window

NCSA Mosaic: Document View

File Options Navigate Annotate Help

Document Title: BOASTCRAY Reservoir Simulator Execution

Document URL: http://www-xdiv.lanl.gov/XPA/boaster/boastcray/boastcray.htm

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BOASTCRAY RESERVOIR SIMULATOR: EXECUTION

One may execute the BOASTCRAY reservoir simulator by filling in the items below and clicking on the submit button. Please use only letters (capital or small), numbers, underscores (_), dashes (–) or periods (.).

When the simulation is finished, output plots will be displayed in this window if the connection to the machine is not broken. Otherwise, use the simulator viewer accessible from one level up.

Please specify your last name: generic_name

your email address: u079689@lanl.gov

and the identifier for this run: default

****The input file should be called identifier.in (i.e., default.in).****

For this input file, please specify:

the internet location: laws.lanl.gov

the login name: u079689

the password: ******

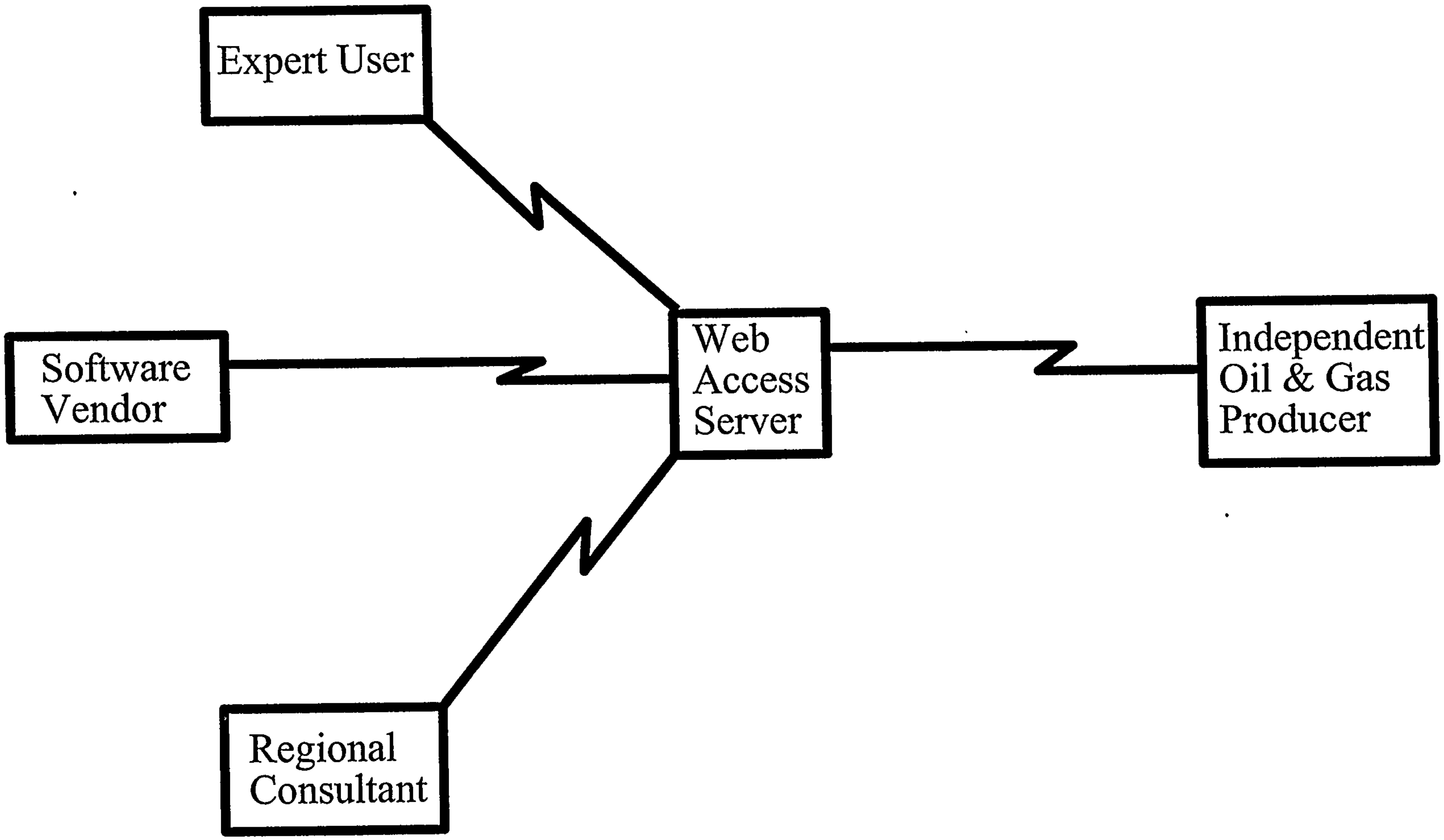
and the directory containing this input file:

/www/htdocs/XPA/boaster/boastcray/usrscr

Press this button to submit the query: Submit.

Back Forward Home Reload Open... Save As... Clone New Window Close Window

An Internet Access Paradigm



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