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# On Internet Access Technology Specification Model

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***Abstract*—**Internet Access Technologies (IAT) provide a means through which Internet can be accessed. The choice of a suitable Internet technology is increasingly becoming an important issue to ISP clients. Currently, the choice of IAT is based on discretion and intuition of the concerned managers and the reliance on ISPs. In this paper we propose a model and designs algorithms that are used in the Internet access technology specification. In the proposed model, three ranking approaches are introduced; concurrent ranking, stepwise ranking and weighted ranking. The model ranks the IAT based on distance measures computed in ascending order while the global ranking system assigns weights to each IAT according to the position held in each ranking technique, determines the total weight of a particular IAT and ranks them in descending order. The final output is an objective ranking of IAT in descending order.

***Keywords*—**Internet Access Technology (IAT).

## I. Introduction

MANY organizations find themselves compelled to recognize the value of the Internet and its use as a medium for conducting business, providing services, and conducting research. The Internet has aroused enormous popular interest and indeed, it (the Internet) can be called "phenomenon of the decade" [11]. This is reflected in the increasing use of the Internet as a source of information and lately as medium for e-commerce especially in the banking, telecommunication, mass media, airlines, government, and many small-medium enterprises worldwide.

Bates [3] suggests that the problem facing those who would wish to use these technologies is two fold; Lack of the awareness of the existing technologies and inability to know how to choose the most suitable IAT that will address their needs.

The current practice is that the clients rely on their mental models, derived from personal intuition, taste and heavy influence of the vendor marketing tactics. Therefore, the correct choice of IAT presents an opportunity for organizations to focus on the best technology that can help achieve the intended institutional objectives or goals. According to Kelly [10] smart shoppers (client) need not to be satisfied with just having someone (ISPs) tell them what they need but consider the strength of their support system and use a team to help in making a technology decision.

In this study, we seek to address the lack of standard models for specifying and selecting IAT that clients can independently apply to their solutions that will promote their institutional objectives.

The IAT specification model as a support system however, will help reduce the tendency of clients to rely on the ISPs for the choice of IAT. Qualitative and survey approaches as a methodology shall be applied in this study. The survey will help deduce key user requirements such as technology attributes and ISP attributes that are considered crucial while qualitative will be used to establish relevant literature, a suitable model and ranking techniques that can be adopted for implementation.

## II. Related Work

### *A. Internet Access Technologies*

There are many IATs being implemented worldwide. Some of the common technologies are satellite, dial-up modem, cable modem, frame relay, digital subscriber line, asynchronous transfer mode, integrated service digital network, wireless, E1, E3, T1, T3 of late power line broadband. Satellite Internet access according to Federal Communication Commission [6] is the most costly and involving technology as well as an alternative to common wireless IAT methods like microwaves. Sometimes ISPs absorb the cost with various contractual and marketing promotions. However, Newman et al. [14] note that satellite has produced a cost effective means through which data and verbal exchange can take place within companies where communication is otherwise nearly impossible. Wireless Internet access was developed to offer short to medium range communication between devices. The longest-range wireless IAT can achieve is up to 35 miles for the case of fixed wireless Internet access [6]. Cable modem technology utilizes coaxial cables used for cable television (TV) to provide Internet access [6]. It is a shared medium in which the data rate per user depends on the number of users sharing each such a channel at a particular time.

On the other hand, dial-up modems provide the most common type of Internet access and require normal telephone line. Digital Subscriber Line (DSL), just like dial-up modems, uses normal telephone lines for Internet access. The line may also use cables from TV service provider, satellite or wireless technology [15]. It exists in two major forms: symmetric digital subscriber line and asymmetric subscriber line. Integrated Service Digital Network (ISDN) is closely related to dial-up and DSL technologies in terms of infrastructure used. Nevertheless, according to Cisco systems and press [4], it is a perfect replacement of modems and leased lines, which have been dominant in the wide area digital data communications from late 1980s through 1990s. The Internet

access technology that is comparable to ISDN is frame relay. It is a packet switched technology as opposed to circuit switched [4]. Like leased lines, it can be used for real time applications such as video conferencing and web server hosting. Asynchronous Transfer Mode (ATM) is based on statistical multiplexing of fixed length packets called cells [13]. According to Gunnar [7] ATM combines circuit switched routing of public telephone networks, packet switch of private data networks and the asynchronous multiplexing of packets. Cooper et al. [5] also notes that the integration of a variety of communication profiles with different quality of service demands makes ATM suitable for future telecommunication demands in both the public wide area network operator sector and LAN sector. The most current means of IAT is through the use of power line communication. This involves delivery of data over an existing electronic power distribution network. Power line communication uses the existing electric wires and power outlets for delivery of user signals at home [6]. It can be seen as a promising technology since it has the ability to reach virtually every household in the nation.

### B. Factors that Affect IAT Specification

The three factors, which affect IAT specification, can be classified as:

#### i. Specification Attributes

These can be classified as; Technology and ISP. Technology attributes constitute the most critical features in the choice of IAT. According to Imran [9], speed and reliability are the top most concerns in the choice of IAT. This is supported by Walker [19] who argues that "Bandwidth" and its effects on the access to the Internet is one of the major issues of concern for users while introducing cost as another critical feature.

Whereas Bates [3] considers cost a strong discriminator between technologies and often the first issue considered by institutional decision makers, Australian Communication Authority [1] sees it as a performance discriminator. ACA [1] also notes that security is a factor, which ISPs should consider educating their clients on since some IATs expose corporate resources to an ever-increasing number of security vulnerabilities [17].

Security and Quality of Service (QoS) also constitute features that must be considered. Laurel [12] in their findings note that switched and routed networks including services have made QoS a critical requirement in all types of service provider networks. They also explain that QoS mechanisms are required to manage inevitable network congestion and guarantee applications sensitive to delay, jitter and packet loss.

According ACA [1] choosing an ISP can sometimes be an overwhelming decision. They suggest that an ISP can be chosen based on billing, help and installation, communication, and service availability. However, Imran [9] suggests that clients need to gauge the quality of ISPs based on questions such as how many different types of services does the ISP offer, capability of the technical support staff, kind of clients the ISP deals with, what the redundancy features of the ISP are, does the ISP provide twenty four hours and seven days a week support (24/7 service availability), record of ISPs network outages and what other value-added services it offers, thereby driving towards the conclusion that support, experience, location, number of users, service availability, billing, communication, and technology availability must be considered as attributes for the right choice of an ISP.

#### ii. Ranking Models

Two ranking models; single and multiple [8], formally developed for e-service ranking are reviewed.

#### iii. Ranking Techniques

Ranking techniques define a process through which IAT can be selected. Two types of ranking techniques are reviewed; Distance measures and Multi-Attribute Resource Intermediary (MARI) [8], [18].

Distance measures: Distance measures are used to compute distances between two vectors [8]. Table 1 shows common distance measurement techniques, where; $x_i$ = user preferences level; $y_i$ = Internet technology attribute level; D= Proximity measure to an Internet access technology.

TABLE I
UNITS LIST OF DISTANCE MEASURES [11]

| Distance | Equation |
|---|---|
| Euclidean Distance | $D=\left[\sum_{i=1}^{n}\left[\left\|x_i-y_i\right\|\right]^2\right]^{\frac{1}{2}}$ |
| Manhattan Distance | $D=\sum_{i=1}^{n}\left[\left\|x_i-y_i\right\|\right]$ |
| Canberra Distance | $D=\sum_{i=1}^{n}\left[\left\|x_i-y_i\right\|/\left\|x_i+y_i\right\|\right]$ |
| Squared Chord Distance | $D=\sum_{i=1}^{n}\left[\left\|\sqrt{x_i}-\sqrt{y_i}\right\|\right]^2$ |
| Square Chi-squared Distance | $D=\sum_{i=1}^{n}\left[\left(\left\|x_i-y_i\right\|\right)^2/\left\|x_i-y_i\right\|\right]$ |

Multi-Attribute Resource Intermediary (MARI): In MARI based approach, attributes of the user are classified as flexible or fixed. Fixed attributes consist of predefined set of permissible values from which the user must select an acceptable set [8]. For flexible attributes, the system infers attributes weight using the equation (1).

$$Weight(p)=\left(1-\frac{\text{permissible ranges of } p}{\text{possible ranges of } p}\right)/\left(\sum_i 1-\frac{\text{permissible ranges of } i}{\text{possible ranges of } i}\right) \quad (1)$$

Where p = a given (flexible) attribute, and i= ranges over all flexible attributes.

The attribute weight defines how important a particular attribute is to the user [8]. Let n = the number of Internet technologies; $f_i$ = Specific utility function corresponding to attribute i; $x_i$ =the client specific value of the attribute i; and $w_i$ = weight associated with attribute i, then the derived attribute weight together with the utility functions can be used to evaluate the IAT using equation (2) [18].

$$\text{Valuation} = \sum_{i=1}^{n} f_i(x_i) * w_i , \qquad (2)$$

## III. Results

The presentation of results is based on the comparative results between the ranking techniques.

For comparative results to be generated, a set of rules were defined and applied in the system development. These were:

a. All the fields subjected to choice were to be specified;
b. Concurrent or stepwise ranking mode were to be specified;
c. Under stepwise ranking process, a user was required to carry out at least two experimental runs each with a different ranking technique before the global (automatic) ranking process could be performed on the output;

For concurrent ranking process, a single experimental run was conducted so as to trigger the global ranking process.

### A. Internet Access Technology (IAT) Specification Model

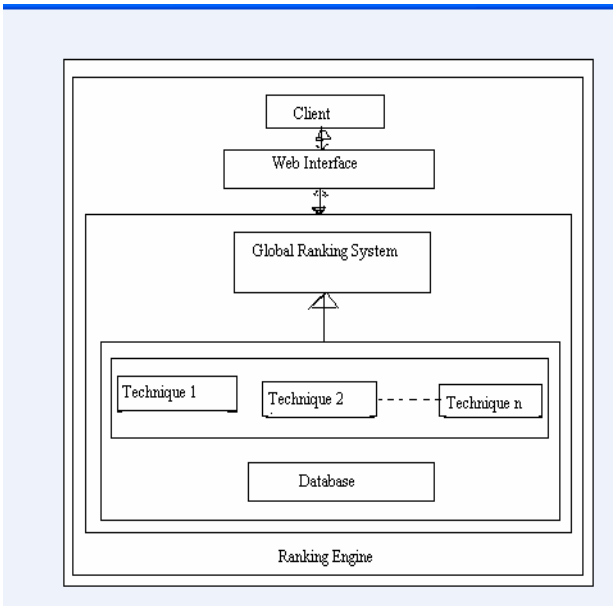


Fig. 1 Multiple ranking model **(*Adopted: E-service Model*)** [8]

The proposed IAT specification model as shown in *Figure 1* consists of the following enhancements; Concurrent ranking, Stepwise ranking, and Weighted ranking.

The three modifications introduced, are aimed at eliminating bias in a particular ranking technique. Under concurrent ranking process, all the ranking techniques perform independent ranking of the IAT before the global ranking system can be applied to perform the final ranking based on the weighted ranking technique. On the other hand, stepwise ranking technique provides the users with an opportunity to choose ranking techniques they prefer one after the other. However, this ranking process offers a constraint in such a way that two or more ranking techniques have to be applied so as to give chance to the global ranking system to carry out the final ranking.

#### *i. Algorithms used for Enhancement Implementation*

The pseudocode technique of expressing algorithms was used for; Ranking techniques, Global ranking, Stepwise ranking mode, and Concurrent ranking mode algorithms [2].

### *B. Experimentation*

To evaluate the model, a prototype was developed and 20 experimental runs were performed. Different sets of Interviewees were selected to carry out the experiments so as to avoid bias, which may otherwise occur with the interviewees who had participated in the initial interviews. Sample output results were obtained for both concurrent and stepwise ranking as shown in Figure 2 and 3 and discussed as in *section 3.3*.

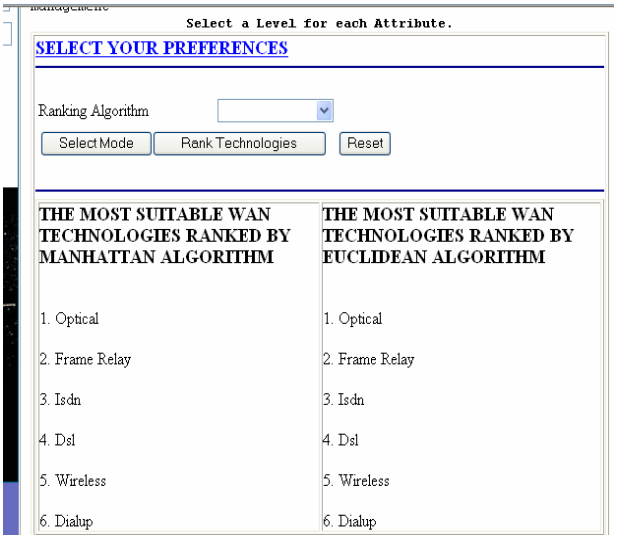


Fig. 2 Output of the stepwise ranking process

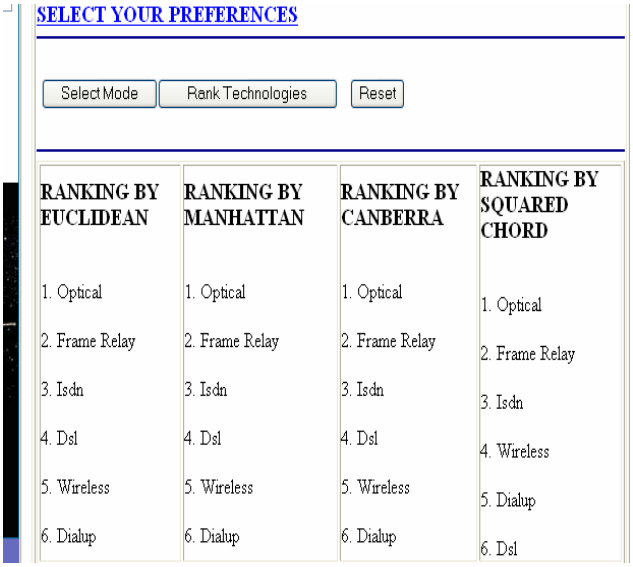


Fig. 3 Output of the Concurrent ranking process

### C. Discussion

Based on the results generated by the concurrent ranking process, the ranking by the techniques can be categorized as majority, tie or desperate. A desperate ranking represents a situation in which each ranking technique in a particular position ranks different IAT. Since there are four ranking techniques that are implemented, when an IAT is ranked by two or more techniques at a particular position then its percentage is determined accordingly. If a situation does not occur in which all the ranking techniques have ranked different Internet technologies in a particular position then it implies zero (0 %) disparity is occurring. This can also be summarized as a percentage measure based on two runs and shown in *Table II.*

TABLE II
EXPERIMENTAL RESULT STATISTICS

| Experimental Runs | Majority (%) | Tie (%) | Disparity (%) |
|---|---|---|---|
| Run 1 | 79.17 | 20.83 | 0 |
| Run 2 | 87.5 | 12.5 | 0 |

No disparate ranking is shown by any of the ranking techniques, demonstrating high accuracy in the output. For stepwise ranking process, categorizing the ranking into majority, tie or desperate does not apply. This is because only two ranking techniques are expected to be used in the global ranking process. Allowing more than two choice attempts equates to concurrent ranking process. Otherwise, this does not suggest that the results of stepwise ranking are less accurate as compared to those of concurrent ranking. The user under stepwise ranking has an opportunity to choose ranking techniques of choice, resulting in reliable output. However, taking a decision on which IAT to implement at this stage may result in biased decision. The global ranking system is applied in this case so as to produce an output that can best be relied on. The weighted approach employed as a ranking technique in the global ranking system ensures that results of the decision process are not dependent on any ranking technique. The results are also arranged in order of priority to a client. This implies that a system can be relied on as a decision support system by decision makers on IAT implementation issues as argued by Kelly [10]. The major limitation was in accessibility to mobile agent software that could be used to search databases like those of ISPs to determine the cost and attempt to obtain automatic updates on IAT advancements.

## IV. CONCLUSION

The study presents IAT specification model that uses multiple ranking techniques. The algorithms implemented in the model provide customized results according to the system user choices. It offers minimal intelligence through the global ranking system and also uses statistical ranking techniques so as to output appropriate Internet technologies for implementation. The suggested model also presents system users with the flexibility to choose the level of preference for each attribute implemented. The study in general provides the first insight towards ranking IATs through software process hence the issue of an awareness of existing IAT and inability to choose an appropriate IAT as noted by Bates [3] would cease to exist. However, there is need to incorporate more advanced ranking techniques such as MARI in the ranking engine and introducing more intelligent global ranking techniques as alternative to the current heuristic based approach, developing software that keeps available IAT at ISP database and integration of mobile agents into the suggested specification model such that it can get updates of new technologies available in the market.

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