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Table of Contents

Engaging Students Through Electronic Response Devices (Clickers)

Sherry Robinson at Penn State University

*Turnover Drivers and Retention Factors Affecting Hourly Workers:
What is Important?*

Patricia C. Borstorff · Michael B. Marker at Jacksonville State
University

A Tool for Pair-Wise Alignment Algorithm

Allam Appa Rao at Andhra University

A New Step on Transforming VoIP into the Ubiquitous Service Era

Andrey Kim · Wang Si · Hoe-Kyun Shin at Kumoh National Institute of
Technology

Engaging Students Through Electronic Response Devices (Clickers)

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ABSTRACT

Net Generation students, those born in the 1980s and later, have grown up with entertaining media such as TV, video games, and the Internet for education as well as amusement. In comparison to these fast-paced, interactive media, traditional lecture classes are likely to be deemed dull and boring. Electronic response devices (clickers) have been found to increase students' engagement with course material while making class more fun. This study will examine students' responses to the use of clickers in business classes at a small campus of a large public university. Not surprisingly, students reported that the use of the clickers increased both their engagement with the class and the likelihood that they would attend class.

Keywords: Electronic Response Devices, Clickers, Learning Games

INTRODUCTION

Students of the Net Generation, also called Millennials, have grown up with entertaining media such as TV, video games, and the Internet for education as well as amusement (Oblinger & Oblinger, 2005). In comparison to these fast-paced, interactive media, traditional lecture classes are likely to be deemed dull and

boring. This poses new challenges for educators who must strive to engage students in learning. Although social, active, learner-centered educational environments are important to all students, Millennials in particular have a strong need for engagement, immediacy and learning in a social environment (Ramaley & Zia, 2005). Electronic response devices (clickers) have emerged as potentially useful technology to help educators meet this challenge. This student examines the responses of students in five business classes to the in-class use of clickers.

NET GENERATION STUDENTS

Net Generation learners pose specific challenges in terms of the instructional methods used. Growing up in a fast-paced environment in which they were entertained and taught through the use of technology, many Millennials have naturally developed an "entertain me" attitude and are bored by traditional lecture (Prensky, 2001). The use of clickers, which combine interactive technology with classroom activities can help educators meet the challenges of teaching the Net generation learner.

Immediate feedback and student involvement are often required to create ideal learning situations (Hequet, 1995; Foreman, 2003). Learning games have been reported to provide just this type of situation in that they create a responsive environment where learners immediately know how they are doing (Cruickshank & Telfer, 1980). In addition, Sugar and Takacs (1999) report that games create an interactive learning experience by transforming inactive learning material into learning episodes where the learners are active players and participants. Using clickers to elicit opinions and informally test students' knowledge could be considered a learning game in that students find them fun and enjoy the tech-based interactivity.

CLICKERS IN THE CLASSROOM

The clickers used in this study were small electronic devices resembling TV remote controls, approximately the size of a deck of cards, but thinner. They were purchased by the university,

rather than by students, to ensure that each student would have a device to use during each class in which clicker-based activities were included. Clickers currently use either infrared or radio frequency technology, with infrared having a lower price, but requiring a clear line-of-sight in order to operate properly. Despite a considerably higher price (approximately \$65 vs. \$15) the latter were chosen to eliminate problems regarding reception.

Responses into clickers are transmitted to a receiver, which plugs directly into the computer with a USB connection. The software for the clickers created an interface with PowerPoint software, making it relatively easy to construct interactive slides.

For one review game, students were presented with multiple choice questions which they answered via the clickers. The percentage of students who chose each answer was shown graphically before the correct answer was indicated with a star. In one rendition of the game, students were allowed to discuss the question with classmates and the classes were “polled” twice, allowing students to change their answers the second time after consulting other students. In almost every case, 100% of the students registered correct answers when the question was asked a second time, leading to the assumption that peer-tutoring (Mazur, 1997) was effective in this situation.

In another game, questions appeared without answers, and teams raced to “buzz in” to win the chance to attempt to answer the question. The clicker software was capable of determining the first to respond, making this a fairer (more accurate) system than depending on a human to determine who had raised a hand first. Similar games without the clickers had been played in class, but this version was more like the TV game show “Jeopardy!” The clickers were also used in opinion polls that were interspersed throughout a lecture. The results of the polls were immediately shown in graphical and numerical form. The purpose of the polls was to create interest and stimulate discussion. Although this was not a “game” per se, students perceived it as fun, meaning it could be considered a game.

The anonymity provided by the use of the clickers as opposed to raising a hand to indicate an opinion is likely to be a positive

feature for students who are shy or afraid to voice an unpopular opinion, especially when discussing personal or controversial issues (Chickering and Ehrmann, 1996; Davis, 2003; Draper and Brown, 2004). On the other hand, students may have a greater feeling of participation as the clickers accurately register the response of every student that participates, even in classes of 250 students (Shapiro, 1997).

Despite these advantages, clicker use provides its own set of problems. Clickers that do not appear to work correctly because of dwindling battery power or other technical problems can frustrate students. Other students may simply be opposed to the increased use of technology in classes (Hatch, Jensen and Moore, 2005; Okan, 2003). Carlson (2005, p. 37) quoted a Millennial student who stated that "technology is a 'hook' for people who aren't going to study anyway."

METHODOLOGY

This study examines students' perception of classroom clicker use to play a review game. Three management classes and two sections of a managerial accounting class were included, and respondents were freshmen, sophomore, juniors and seniors of a small campus of a large public university in the northeast United States. The responses of students who were in more than one class were included only once. Of 66 unique students surveyed, 47% were women and 89% were of traditional college age. The survey itself was conducted through the use of the clickers after the games were completed. Student comments were collected through a secure online site.

RESULTS AND ANALYSIS

The results of the study are shown in Tables 1 - 5, which are named by the question they represent. As shown in Table 1, most students prefer games that use technology, as only 9% of students did not prefer games with technology at least "somewhat." This is not surprising considering that almost 60% of them play video

games (for entertainment) and a similar percentage thought they were "cool." Again, a very small percentage had negative feelings toward clickers.

Table 1. In general, do you prefer games that use technology (are electronic)?

Response	Total	Women	Men
1 - No, not at all	3.0%	6.5%	0%
2	6.0%	3.2%	11.4%
3	21.2%	29.0%	11.4%
4	19.7%	12.9%	25.7%
5 – Yes, a lot	47.0%	48.4%	45.7%
Chi-square 6.042 sig. .196			

Table 2. Do you play video games?

Response	Total	Women	Men
Yes	59.1%	38.7%	77.1%
No	37.9%	61.3%	17.1%
Abstain	3.0%	0%	5.7%
Chi-square 14.339 sig. .001			

Table 3. How would you rate the "coolness" of clickers

Response	Total	Women	Men
1 - Not at all	7.6%	16.1%	0%
2 – OK	31.8%	38.7%	25.7%
3 - Very cool	60.6%	45.2%	74.3%
Chi-square 8.819 sig. .012			

Table 4. Would you be more likely to come to class if you knew we were going to use the clickers?

Response	Total	Women	Men
Yes	40.9%	24.1%	57.1%
No – always come to class regardless	40.9%	62.1%	25.7%
No – nothing can motivate me to come	9.1%	6.9%	11.4%
Abstain	6.1%	6.9%	5.7%
Chi-square 9.446 sig. .024			

Table 5. Are you more likely to participate in a class opinion survey if you can use the clickers to do the poll, rather than raising your hand?

Response	Total	Women	Men
No – always participate regardless	15.2%	9.7%	20.0%
No – won't participate unless forced	7.6%	6.5%	8.6%
Probably yes	34.8%	48.4%	23.0%
Absolutely yes	42.2%	35.5%	48.6%
Chi-square 4.992 sig. .172			

Although a chi-square analysis showed that there was an association between sex and video game playing (Table 2), with fewer women than men reported playing video games, additional chi-square analyses did not reveal significant associations between question responses and the video game variable. Sex-differences, however, were found in regard to the "coolness" of the clickers (Table 3), with more men giving them the best ratings. This is undoubtedly at least part of the reason more men reported that they would be more likely to come to class on a day when they knew clickers would be used (Table 4).

An important finding of this study is that students believe they

would be more likely to attend class on day when they know clickers are going to be used. While 40% stated they already attend class regularly, an additional 40% indicated they would be more likely to come to class if they knew the clickers were going to be used that day, leaving only 15% who abstained or simply would not attend for their own reasons.

Although men were more likely to report that clicker use would improve their attendance, an apparent reason for this is the considerably higher percentage of women who report that they normally attend class. Combining those who regularly attend class with those who responded they would attend class on a day when clickers are used, women reach 86.2% and men 82.8%. This would be a large gain considering that only 25.7% of men said they would normally attend, compared to 62.1% of women.

Similarly, increased participation in class could be expected as more than 40% reported that they "absolutely" would be more likely to partake in an in-class opinion poll, and an additional one-third saying they "probably" would (Table 5). In this case, the women seem to stand to gain the most from clicker use. While only 9.7% of women stated they already participate fully, 20% of men gave that response. Among women, 83.9% said they would or probably would be more likely to participate, whereas that proportion for men was 71.6%. With both groups, "I won't participate unless I have to" was reduced to less than 9%.

Student comments, shown in Table 6 and representative of overall comments, revealed that students found the clickers to be fun, which could likely lead to better attendance. Students also admitted that they participate more when using the clickers as compared to a normal class in which student volunteer answers for discussion.

These qualitative and quantitative results taken together provide strong support for the use of clickers to improve classroom experiences for students. According to these Net Generation students, attendance would be likely to improve, as would participation during class. From an instructor's point of view, these are positive behaviors that should be encouraged.

Table 6. Student Comments

No.	Comments
S1	I enjoyed the use of the clickers for the in-class learning experience. I prefer the clicker to regular class work and think it's a fun and innovative way to learn.
S2	I think the clickers are a great tool for learning. With the clicker every student is always involved and therefore must pay attention, unlike in the past where sometimes you would just let your fellow group members answer the questions while you sit back. Also everyone is interacting together which is another plus. I would like to see the clickers used again and more often.
S3	I truly believe that these devices guarantee that students are playing an active role during classroom lectures/discussions. These devices help students to think about the material at hand while encouraging them to learn it for a simple in-class "competitive" game. These devices will change the way students learn any material given to them.

CONCLUSION

One important finding of this study that warrants further investigation is that both women and men stand to benefit from the use of clickers in the classroom. The majority of men said they would be more likely to attend class when clickers are used. Such a high proportion was possible because only one-fourth stated that they already attend class regularly. With women, over 60% of whom already attended class, the biggest benefit was seen in the willingness to participate in class opinion polls, taken to mean participation in class. Approximately one-third would "absolutely" participate more, and almost half "probably" would. Despite their higher original proportions for "I already participate fully," almost half the men said they would absolutely participate, with

another quarter saying they probably would.

Students who have grown up being entertained present particular challenges to teachers. This study has shown that clickers can be used to create a more learner-friendly environment for Millennials. If students accurately reported their future behaviors, both attendance and participation should increase with the use of clickers in the classroom. Clearly, future research should investigate not only the use of the clickers, but actual student behaviors related to them.

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Turnover Drivers and Retention Factors Affecting Hourly Workers: What is Important?

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ABSTRACT

People are changing jobs in record numbers, resulting in the highest turnover rate in twenty years (Dobbs, 2001). Therefore, many companies are trying to determine how to retain their employees, including baby boomers with their institutional knowledge and Generation X and Y employees with their technological expertise. Previous research has identified organizational culture, supervision, compensation, and work environment coupled with pay and benefits as being related to employee turnover. An employee survey and interviews conducted at a large international wholesale bakery indicated health benefits, base pay, and life/work balance were most important to hourly workers. Suggestions on a retention strategy addressing employee's needs are given.

Keywords: Employee Retention, Retention Strategy, Turnover Drivers, Organization Culture

INTRODUCTION

Retaining employees is critical in today's business environment. Research by Ernst and Young showed that attracting and

retaining employees are two of the eight most important things investors use when judging the value of a company (Michlitsch, 2000). However, Abbasi and Hollman (2000) identified employee turnover as a factor often jeopardizing organizational objectives. Employee turnover results in monetary costs for employee replacement as well as many “hidden” costs and consequences.

Regarding monetary costs, Taylor (2002) identified unwanted employee turnover as one of the most costly problems that companies face. Losing employees can cost a company as much as eighteen (18) months salary for professionals and six (6) months salary for hourly employees (Thornton, 2001). Another estimate puts the cost at 25% of the employee’s annual salary plus 25% of the benefits package offered (Amig & Jardine, 2001). In addition to the monetary loss incurred by employee turnover, other “hidden” costs include declining productivity, lower employee morale and disrupted customer relations (Abbasi & Hollman, 2001), plus loss of employee expertise and institutional knowledge (Mitchell, Holton, and Lee, 2001). In today’s competitive business environment, it is important that companies focus on retention, gain the commitment of their employees, and manage employee turnover (Galunic and Anderson, 2000). The purpose of this research is to examine employee retention and what work factors and issues are most important in determining intent to stay or leave.

BACKGROUND

Generally, an employee’s decision to resign from a company is complex because factors, called turnover drivers, create an environment that is no longer desirable to the employee (Oh, 2001).

Numerous surveys have been conducted to determine what

influences employee turnover, and the results have varied among surveys. Some factors identified as affecting turnover include organizational culture (Sheridan, 1992), supervisory relationships (Tepper, 2000), compensation (Burgess, 1998), and work environment (Guthrie, 2001; Blum, Gilson, & Shalley, 2000; Huselid, 1995).

Organizational culture, defined as the cornerstone values, beliefs, norms, standards, and assumptions concerning work that members of an organization share in common, has a potent effect on the motivation of employees to continue working for their employers (Mainiero, 1993). Sheridan (1992) observed that an organization's cultural values have an effect on all interactions with employees, and noted that other researchers have argued that the fit between an organization and an employee is important to retention and that individuals are attracted to certain organizations, and when they do not "fit" in an organization they will leave. Autry (2003) also found a relationship between personal-organizational fit, job satisfaction and intent to stay. In a time where pay and benefits are expected, an organization's culture can be the deciding factor in an employee's decision to remain with their employer.

Another factor that influences an employee's decision to stay is the relationships employees maintain with their bosses and co-workers. Studies show that managers and supervisors can have a significant impact on employee turnover. A Gallup Organization study found that the length of an employee's stay is determined largely by his relationship with a manager (Dobbs, 2001). Eisenberger, Stinglhamber, Vandenberghe, Sucharski, and Rhoades (2002) found supervisor support correlated with employees' intent to stay. Taylor (2002) notes that employees want leaders who know them, understand them, treat them fairly, and are supervisors that they can trust. Another study found subordinates whose supervisors were more abusive reported

higher turnover, less favorable attitudes toward job, life, and organization, greater conflict between work and family life, and greater psychological distress (Tepper, 2000). Also, with many of today's organizations utilizing a more diverse workforce, supervisory relationship with employees is extremely important for retention. According to a survey conducted by Alignment Strategies, Inc., quality supervisory relationships make the difference in bonding young (age 21-30) and culturally diverse (black, Latino/Hispanic, Asian/Pacific Islander or Native American) employees to their organizations (Dixon-Kheir, 2005).

Poorly designed wage policies where salaries and benefits are not competitive can lead to turnover, and studies show that turnover is higher in plants with lower wages (Burgess, 1998). Traditionally, raises and promotions have been the incentives offered to workers to stem turnover. Benefits that meet an employee's individual needs are also becoming more important to employees (Withers, 2001). Additionally, soft benefits such as flex-time and flex-hours have helped many firms maintain employee commitment (Ulrich, 1998).

The work environment also affects employees. A survey of 2,200 individuals found employees with a favorable work environment have higher job satisfaction and lower intentions to leave. Factors that enhance job satisfaction include job autonomy, challenge, control, importance, and receiving encouragement from supervisors. On the other hand, factors that diminished job satisfaction include the existence of rigid procedures, use of surveillance, lack of resources, and restricted control over work procedures (Blum, Gilson & Shalley, 2000). Mitchell (2001) found being asked to do something against one's beliefs; observing unfair employment practices; having a major disagreement with a boss; employee discomfort with the company's culture; and a lack of feeling of belonging were correlated with intent to leave. Also, Longenecker (2003) found

intent to leave correlated with a better job opportunity, more money, a bad boss, a lack of appreciation, and an inability to get time off from work. Additionally, over the past twenty years employees have increasingly focused on personal growth and happiness and less with how they are defined by organization affiliation. Younger generation employees identify with their formal title and nature of work; however, they do not commit themselves to the organization, instead they commit to themselves (Jurkiewicz, 2000). Yet, with the fastest growing segment of employee---those 55 years and older--- work issues may be different. The Generation X and Y workforce requires managers to lead; they respond to asking, not telling. They want a chance to showcase talents and be involved in the decision making process of the organization (Abbasi and Holman, 2000).

It is important to understand what work issues are important to employees. Research results varied in what employees identified as important for continuing their employment. A 1999 Hay Group study of more than 500,000 employees in 300 companies found that, of 50 retention factors, pay was the least important. The three top retention factors in this study included career growth, learning and development; exciting work and challenge; and meaningful work (Jordan-Evans & Kaye, 2001). Extensive research of hundreds of companies by the Corporate Leadership Council revealed that base pay, manager quality, and health benefits were the most important to employees (Burleigh, Eisenberg, Kilduff & Wilson, 2001). Lord (2002) found that that good supervision, family-work balance, benefits, and pay were motivation factors across all age groups. Since the results varied among previous research, a survey was administered and interviews were conducted of hourly workers at a large any in order to determine the work issues that were important to them.

METHODS

Participants in this study are hourly workers at the second largest bread and bakery products producer in the United States. The company makes breads and operates leading fresh packaged bread and refrigerated dough businesses in the US and Europe. The plant surveyed is located in the southeastern US, is highly unionized and is represented by the Bakers, Confectioners, Tobacco, and Brand Millers' Union. The truck drivers are represented by the Teamsters' Union. The plant employed 892 people; 70 percent were male, 30 percent female and approximately 4% were minorities. Net Sales for the fiscal year were \$2.6 billion. The plant manager agreed to a survey and follow-up interview of employees on the three shifts of one product line.

Questionnaires were given to all 110 hourly employees. Respondents were told that their help was needed in determining what is important to employees in the area of continued employment. The hourly workers rated eleven work issues on an importance scale of 0 to 7, with 0 having no importance and 7 being the most important. The work issues included base pay, challenging work, health benefits, hours, job fit, life/work balance, opportunity for advancement, recognition, supervisor quality, union representation, and work environment. In addition, they were asked about satisfaction with work at the plant and perceptions of pay, benefits, communication, respect and flexibility. Of the employees surveyed, 59% were men and 32% were women. The ages of the respondents were: 14% were 19-29 years old; 24.5% were 30-39; 41% were 40-49 years old; 17% were 50-59; and 3% were 60-69. Thirty-six percent of the employees surveyed have been employed with the company for 5 years or less; 16% for 6-10 years; 5.5% for 11-15 years; 4.5% for 16-20 years; 20% for 21-25 years; and 14.5% for 26-30 years. The data was not analyzed

by race due to the limited number of minorities responding to the survey.

RESULTS

As table 1 indicates, individual scores from the survey were compiled and averaged for each work issue. Overall health benefits topped the list with an average score of 6.8 (out of a possible 7.0), making it the most important retention factor. Base pay and life/work balance rated high with scores of 6.4, whereas hours and work environment were rated somewhat high with 6.3 and 6.2 respectively. Supervisor quality had a 5.7 score, with recognition and challenging work rating the lowest with scores of 5.2 and 4.7 respectively.

Results on job satisfaction reveal that different employees share similar opinions. In our sample, health benefits and pay rated as top priorities. Also, employees regard work-home balance as a top priority. The individual analysis based on gender was not significant as far as pay and health benefits. The only significant difference was in recognition and job fit with females placing a higher importance on these two work issues. Recognition scored 5.8 for females versus 5.1 for males and job fit scored 6.1 versus 5.5 for males. Females wanted more recognition for a job well done. This recognition could come as bonuses, merit pay, or even communication of a job well done. Women seemed to desire respect from their employer more than men. This plant was 70% male and located in a small southern town. Some residue of antiquated ways of dealing with females could have been present. In addition, females were interested in being in a job that fit with their knowledge, skills, and interests.

Table 1. Individual Scores

Retention Factors	Score
Health Benefits	6.8
Base Pay	6.4
Life/Work Balance	6.4
Hours	6.3
Work Environment	6.2
Supervisor Quality	5.7
Job Fit	5.6
Opportunity for Advance	5.4
Union Representation	5.4
Recognition	5.2
Challenging Work	4.7

In the survey, the results varied among age groups within the organization. The survey results agreed with previous studies confirming the importance of the supervisor relationship to the Generation X employees (Dixon-Kheir, 2005). The analysis based on age categories revealed that health benefits ranked most important in every age division. The 19-29 year age division placed significantly more importance on supervisor quality, opportunity for advancement, and recognition than the older age divisions.

The results from the exit interviews conducted at the company are in line with the results reported from the survey. Analysis of the exit interviews revealed that the employees' decision to leave was mainly due to better job opportunities and family circumstances. Salary and benefits were considered to be strengths of this particular company while opportunity for advancement, policies and procedures, and work environment were scored as weaknesses. The employees did not believe that

the company offered career advancement opportunities. The policies were considered to be bureaucratic with little room for compromise. The work environment was considered to be rigid and controlled by production quotas. In the area of satisfaction, employees were most dissatisfied with their work schedules. Supervisory relationships were rated as an important factor when deciding to stay with the company. The follow-up interviews revealed the following influencing dissatisfaction and intent to leave: perception of little supervisory support, not feeling appreciated by the organization, poor performance appraisal feedback, and feeling as if the supervisor does not appreciate them. Other comments were “my supervisor never listens to me,” and “I feel overworked and stressed out.” However, when asked what they liked least about their job, 48% of the comments were related to the call-in system and hours worked.

DISCUSSION

Retaining Generation X and Y workers is important for businesses today. These workers bring critical technology skills with them. In addition, the younger workers have shown a propensity to turnover for small increment gains in pay or due to perceived poor treatment by a supervisor.

At this plant, once employees are hired, they are considered call-in employees and work as needed by the plant. They may work less than 20 hours one week and more than 50 hours the next week, and on different jobs. Since the plant runs to order, its needs change from week to week and even day to day, making it hard for call-in employees to plan their work life and their personal life.

With numerous lines and numerous varieties on each line, the staffing requirements can be difficult to manage. Each line is staffed with a base crew that is typical of their production needs.

However, some of the more complex varieties require more people, and this creates fluctuations in the staffing needs from day to day. For example, on the Hearth line, the staffing needs double when Parmesan Garlic Bread is produced. Employees from the call-in list are called upon to fill these requirements. Flexibility is definitely required for call-in employees since their job requirements can change from day to day.

RECOMMENDATIONS

Since the most potential for turnover is within an employee's first three years with a company (Burleigh, Eisenberg, Kilduff & Wilson, 2001), conducting feedback sessions and communicating individually with new employees every 4 months during their first 2 or 3 years could be a powerful tool for reducing turnover. This communication would help provide valuable insight to any issues that, if addressed, might prevent the employee from leaving the organization.

Exiting employees stated in the survey that the call-in system was one area where they were most dissatisfied. Improving the call-in system for new employees could lead to a significant reduction in turnover. Since this is a complex issue that could have a large financial impact on the plant, a team approach to help improve the call-in system could be productive. Representatives from management and hourly employees would be best suited to address this issue.

Supervisors must also be attentive to the life/work balance of their employees. It has direct bottom-line implications that are driven by retention, productivity and on-the-job-performance. Clearly, this survey showed employees regard the ability to balance their personal and work lives as a priority, with work/life balance ranked high in importance to workers—behind only benefits and base pay. The first step in addressing the work/life

balance issue is to evaluate the company's policies to see if they are supportive of a work/life balance. If not, steps should be taken to change the policies or make them more flexible to accommodate the needs of the workforce. Managers and supervisors should then be held accountable to be in tune with their employees' needs and accommodate them whenever possible. It is some times difficult for managers to support work/life programs especially while trying to balance the demands of their responsibilities, therefore programs and training in the area of work/life balance clearly reflect commitment of an organization to these issues. One way to reduce work-family disconnect would be the use of a temporary workforce to fill staffing situations; however; the union has strongly opposed using temporary employees.

Once an employee is hired, quality relationships with their manager or supervisor can be important to the employee's decision to stay with the organization. With the tremendous cost associated with employee turnover, it is imperative that organizations identify and address the issues that lead to employee turnover. The supervisory relationship not only influences job performance, career development, recognition and rewards, it also extends to such matters as teamwork, communication, organizational resources, and relationships with co-workers, customers, and other managers. The workplace, the ways of conducting business and the nature of work are shifting, and organizations and managers must adapt to keep up. The changing demographics of the workplace and the global nature of work mean that supervisors need the skills to develop and sustain quality relationships with employees of diverse cultures, races, religions, and languages. The old models of "top-down" and "team-based" communication in one language with a monolithic group of subordinates already oriented to U.S. culture are obsolete. Focusing on the supervisory relationship is important with all workers, but especially with the Generation X workers. A good

supervisor relationship is also important to retaining employees in their twenties.

FUTURE RESEARCH

There seems to be distinct and unique differences between what influences employee retention for hourly workers and managerial workers. In the Hay Group studies of managerial workers, pay was the least important and career growth, learning and development; exciting work and challenge; and meaningful work were the top retention factors. In our study of hourly workers, health benefits, base pay, life/work balance, and hours worked were work issues that were important. This study was limited by the number of differentiating work issues investigated. Future studies may want to investigate other variables as well as the influence of union membership on choices made. Comparing the differences in perceptions between the three shifts would have made this research stronger. Finally, this study was limited to one large company. Broader-based samples will need to be the norm in future studies in order to rule out variables attributing to the differences other than those under investigation.

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A Tool for Pair-Wise Alignment Algorithm

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ABSTRACT

Bioinformatics is the application of computational techniques to the management and analysis of biological information. The relationship between a query sequence, commonly termed as probe and other sequence, known as subject can be quantified and their similarity can be assessed. This similarity can be used to identify the evolutionary relationship between a newly determined sequence and a known gene family. When the degree of similarity is low, the relationship must remain competitive, until evidence has been gathered. The purpose of this research is to implement various methods for Pair-Wise alignment techniques and design a tool with a good user -interface for aligning two sequences and output the score of the alignment. This research uses the various pair wise alignment algorithms, like Needleman-Wunsch global alignment, Smith-Waterman algorithm to find the optimum alignment (including gaps) of two sequences. Dynamic programming methods ensure the optimal global alignment by exploring all possible alignments and choosing the best. The user will be provided a good user-interface for giving the input sequences and opting for the required algorithm. The algorithm uses the BLOSUM50 substitution matrix for computation, and outputs the Functional matrix(F-matrix), Optimal Alignment and the score. The total alignment score is

calculated as a function of the identity between the aligned residues and the gap penalties incurred. The input sequences can be taken from a file stored on the disk.

Keywords: *Bioinformatics, Pair-Wise, BLOSUM50, Needleman-Wunsch, Smith-Waterman, Dynamic Programming*

INTRODUCTION

Determination of protein/peptide sequences is a basic requirement for biomedical research, including cancer research. It is absolutely essential for characterising and identifying proteins or peptides. Imagine you are a Biologist, who has discovered an unknown peptide, perhaps theoretically translated from a nucleotide sequence, or isolated from a gel, which can be sequenced. In this process is to look for similarities with already discovered peptide sequences/proteins. The purpose of this research is to implement various methods for pair-wise alignment techniques and design a tool with a good user -interface for aligning two sequences and output the score of the alignment. The sequence alignment is a linear comparison of amino-acid sequence in which insertions are made in order to bring equivalent positions in adjacent sequences into the correct register.

BACKGROUND

Most biological databases consist of long strings of nucleotides (guanine, adenine, thymine, cytosine and uracil) and/or amino acids (threonine, serine, glycine, etc.). Each sequence of nucleotides or amino acids represents a particular gene or protein (or section thereof), respectively. Sequences are represented in

shorthand, using single letter designations. This decreases the space necessary to store information and increases processing speed for analysis. While most biological databases contain nucleotide and protein sequence information, there are also databases which include taxonomic information such as the structural and biochemical characteristics of organisms. The power and ease of using sequence information has however, made it the method of choice in modern analysis. Not only can computers be used to store and organize sequence information into databases, but they can also be used to analyze sequence data rapidly. The evolution of computing power and storage capacity has, so far, been able to outpace the increase in sequence information being created. Theoretical scientists have derived new and sophisticated algorithms which allow sequences to be readily compared using probability theories. These comparisons become the basis for determining gene function, developing phylogenetic relationships and simulating protein models. The physical linking of a vast array of computers in the 1970's provided a few biologists with ready access to the expanding pool of sequence information. This web of connections, now known as the Internet, has evolved and expanded so that nearly everyone has access to this information and the tools necessary to analyze.

IMPLEMENTATION PROCESS

The implementation part has three phases. They are

1. Input

The two sequences are read from the user and are feed to the selected algorithm. The sequences may be taken from a file stored on the disk also.

2. Alignment

The sequences are aligned for global and local alignment using Needle-man and Wunsch algorithm, Smith-Waterman algorithm, repeated matches with simple gap costs, and overlap matches with simple gap costs. The functional matrices are computed along with the score and optimal alignment.

3. Output

The optimal alignment, score and the functional matrices are printed on their respective fields.

ALIGNMENT ALGORITHMS

Given a scoring scheme, we need to have an algorithm that computes the highest-scoring alignment of two sequences. We will discuss alignment algorithms based on dynamic programming. Dynamic programming algorithms play a central role in computational sequence analysis. They are guaranteed to find the optimal scoring alignment. However, for large sequences they can be too slow and heuristics (such as BLAST, FASTA, MUMMER etc) are then used that usually perform very well, but will miss the best alignment for some sequence pairs. Depending on the input data, there are a number of different variants of alignment that are considered, among them global alignment, local alignment and overlap alignment. We will use two short amino acid sequences for illustration: HEAGAWGHEE and PAWHEAE. To score the alignment we will use the BLOSUM50 matrix and a gap cost of $d = 8$. (Later, we will also use affine gap costs.) Here they are arranged to show a matrix of corresponding BLOSUM50 values:

Table 1. A Matrix of Corresponding BLOSUM50 Values

	H	E	A	G	A	W	G	H	E	E
P	-2	-1	-1	-2	-1	-1	-2	-2	-1	-1
A	-2	-1	5	0	5	-1	0	-2	-1	-1
W	-3	-3	-3	-3	-1	15	-3	-3	-3	-3
H	10	0	-2	-2	-2	-1	-3	10	0	0
A	-2	-1	-5	0	5	-3	0	-2	-1	-1
E	0	6	-1	-3	-1	-3	-3	0	6	0

Gap penalties

Gaps are undesirable and thus penalized. The standard cost associated with a gap of length g is given either by a linear score.

Or an affine score

$$y(g) = -g^d$$

$$y(g) = -d \cdot (g-1)e,$$

where d is the gap open penalty and e is the gap extension penalty. Usually, $e < d$ with the result that less isolated gaps are produced, as shown in the following comparison:

Global alignment: Needleman-Wunsch algorithm

For obtaining the best global alignment of two sequences, the Needleman-Wunsch algorithm is applied as a dynamic program to solve this program.

Idea: Build up an optimal alignment using previous solutions for optimal alignments of smaller substrings.

Given two sequences $x = (x_1, x_2, \dots, x_j)$ and $y = (y_1, y_2, \dots, y_j)$. We will compute a matrix. $F: \{1, 2, \dots, n\} \times \{1, 2, \dots, m\} \Rightarrow \mathbb{R}$, in which $F(i, j)$ equals the best score of the alignment of the two prefixes (x_1, x_2, \dots, x_i) and (y_1, y_2, \dots, y_j) . This will be done recursively by setting $F(0,0) = 0$ and then computing $F(i, j)$ from $F(i-1, j-1)$, $F(i-1, j)$ and $F(i, j-1)$.

The Recursion

There are three ways in which an alignment can be extended up to (i, j) . We obtain $F(i, j)$ as the largest score arising from these three options. This is applied repeatedly until the whole matrix $F(i, j)$ is filled with values. To complete the description of the recursion, we need to set values of $F(i, 0)$ and $F(0, j)$ for $i \neq 0$ for $j \neq 0$. The final value $F(n, m)$ contains the score of the best global alignment between x and y . To obtain an alignment corresponding to this score, we must find the path of choices that the recursion made to obtain the score. This is called a trace back.

Algorithm

Input: two sequences X and Y
Output: optimal alignment and score α
Initialization:
 Set $F(i, 0) := -i \cdot d$ for all $i = 0, 1, 2, \dots, n$
 Set $F(0, j) := -j \cdot d$ for all $j = 0, 1, 2, \dots, m$
For $i = 1, 2, \dots, n$ **do**:
 For $j = 1, 2, \dots, m$ **do**:
 Set $F(i, j) := \max \begin{cases} F(i-1, j-1) + s(x_i, y_j) \\ F(i-1, j) - d \\ F(i, j-1) - d \end{cases}$
 Set backtrace $T(i, j)$ to the maximizing pair (i', j')
 The score is $\alpha := F(n, m)$
 Set $(i, j) := (n, m)$
repeat
 if $T(i, j) = (i-1, j-1)$ **print** $\begin{pmatrix} x_i \\ y_j \end{pmatrix}$
 else if $T(i, j) = (i-1, j)$ **print** $\begin{pmatrix} x_i \\ _ \end{pmatrix}$ **else print** $\begin{pmatrix} _ \\ y_j \end{pmatrix}$
 Set $(i, j) := T(i, j)$
until $(i, j) = (0, 0)$.

Complexity

We need to store $(n+1) \times (m+1)$ numbers. Each number takes a constant number of calculations to compute: three sums and a max. Hence, the algorithm requires $O(nm)$ time and memory. For biological sequence analysis, we prefer algorithms that have time and space requirements that are linear in the length of the sequences. Quadratic time algorithms are a little slow, but feasible. $O(n^3)$ algorithms are only feasible for very short sequences. Something to think about: if we are only interested in the best score, but not the actual alignment, then it is easy to reduce the space requirement to linear.

Local alignment: Smith-Waterman algorithm:

Global alignment is applicable when we have two similar sequences that we want to align from end-to-end, e.g. two homologous genes from related species. Often, however, we have two sequences x and y and we would like to find the best match between substrings of both. For example, we may want to find the position of a fragment of DNA in a genomic sequence. The best scoring alignment of two substrings of x and y is called the best local alignment. The Smith-Waterman local alignment algorithm is obtained by making two simple modifications to the global alignment algorithm.

In the main recursion, we set the value of $F(i, j)$ to zero, if all attainable values at position (i, j) are negative:

$$F(i, j) = \max \left\{ \begin{array}{l} 0, \\ F(i-1, j-1) + s(x_i, y_j), \\ F(i-1, j) - d, \\ F(i, j-1) - d. \end{array} \right.$$

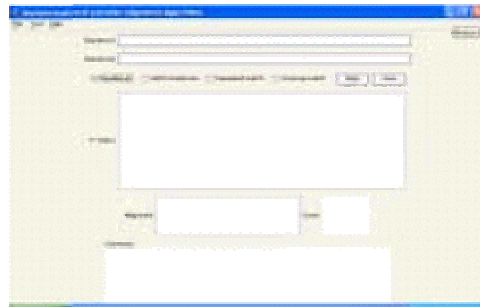
The value $F(i, j) = 0$ indicates that we should start a new alignment at (i, j) . This is because, if the best alignment up to (i, j) has a negative score, then it is better to start a new one, rather than to extend the old one. Note that, in particular, we have $F(i, 0) = 0$ and $F(0, j) = 0$ for all $i = 0, 1, 2, \dots, n$ and $j = 0, 1, 2, \dots, m$.

Instead of starting the trace back at (n, m) , we start it at the cell with the highest score, $\operatorname{argmax} F(i, j)$. The trace back ends upon arrival at a cell with score 0, which corresponds to the start of the alignment. For this algorithm to work, we require that the expected score for a random match is negative, i.e. that where q_a and q_b are the probabilities for seeing the symbol a or b at any given position, respectively. Otherwise, matrix entries will tend to be positive, producing long matches between random sequences.

Algorithm

Input: two sequences X and Y
Output: optimal alignment and score α
Initialization:
 Set $F(i, 0) := -j \cdot d$ for all $i = 0, 1, 2, \dots, n$
 Set $F(0, j) := -j \cdot d$ for all $j = 0, 1, 2, \dots, m$
For $i = 1, 2, \dots, n$ **do:**
 For $j = 1, 2, \dots, m$ **do:**
 Set $F(i, j) := \max \begin{cases} F(i-1, j-1) + s(x_i, y_j) \\ F(i-1, j) - d \\ F(i, j-1) - d \end{cases}$
 Set backtrace $T(i, j)$ to the maximizing pair (i', j')
 The score is $\alpha := F(n, m)$
 Set $(i, j) := (n, m)$
repeat
 if $T(i, j) = (i-1, j-1)$ **print** $\begin{pmatrix} x_i \\ y_j \end{pmatrix}$
 else if $T(i, j) = (i-1, j)$ **print** $\begin{pmatrix} x_i \\ - \end{pmatrix}$ **else print** $\begin{pmatrix} - \\ y_j \end{pmatrix}$
 Set $(i, j) := T(i, j)$
until $(i, j) = (0, 0)$.

Results



The User -Interface.

The following sequences were taken as an example for implementing the algorithm.

SEQUENCE 1:

```
AGGCTCAGAACGCGTCCAGAAATCAGGGGAAGGAGACCCCTAT
CTGTCCTTCTTCTGGAAGAG CTGGAAA
```

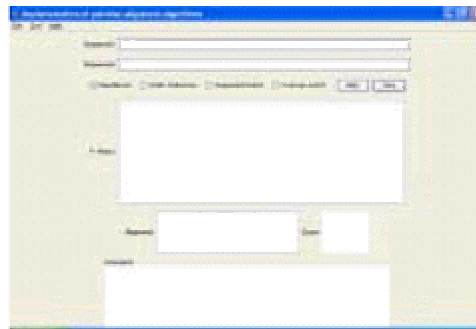
SEQUENCE 2:

```
ATGGGTGACT GGGGCTTCCT GGAGAAGTTG CTGGACCAGG
CCAGGAGCA CTCGACCGTG
```

The output screens for various algorithms are shown below.

- a) Optimal Alignment Using Needleman - Wunch Algorithm:
- b) Optimal Alignment Using Smith – Waterman Algorithm
- c) Optimal Alignment Using Repeated - Match Algorithm:
- d) Optimal Alignment Using Overlap - match algorithm:

Clearing the previous sequences and their results. A predefined example



CONCLUSION AND FUTURE RESEARCH

Bio-Informatics is the study of complex biological information using computational techniques. The role of the computers in Bio-Informatics is required for their processing speed of complex data and for their problem solving power. Bio-Informatics include Molecular Biology, Bio-Physics and Computer Science, Mathematics and Statistics. This requires solidarity among Biologists, Mathematicians, Engineers and Computer scientists to provide effective solutions for scientific problems. Accelerating Biological research projects using computer databases and algorithms. In this project we have implemented the various pair-wise alignment algorithms like Needleman and Wunsch algorithm, Smith-Waterman algorithm and designed a tool for the user through which he can input the sequences that are to be aligned, select a particular algorithm and compute the optimal alignment along with the functional matrix and score. The results are displayed on the

screen.

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Available:

<http://www.cellmatrix.com/entryway/products/pub/wang2002.pdf>

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Appendix:

Sample Project Code in Java

```
import java.io. *; import
java.awt. *; import java.awt.
event. *; import
javax.swing. *; import
java.util. *; abstract class
Substitution { public
int score;

void buildscore(String residues,
int[][] residuescores) { // Allow
lowercase and uppercase
residues (ASCII code <= 127):
score = new int[127][127]; for
(int i=0; i<residues.length();
i++) { char res 1 =
residues.charAt(i);
for(int j=0; j<=i; j++){ char
res2 = residues.charAt(j);
score[res1][res2] =
score[res2][res1]
= score[res1][res2+32] =
```

```
score[res2+32][res1] =  
score[res1+32][res2] =  
score[res2][res1+32] =  
score[res1+32][res2+32] =  
score[res2+32][res1+32] =  
residuescores[i][j]; }
```

```
abstract public String getResiduesQ; }
```

```
class BlosumSO extends Substitution {
```

```
private String residues = "ARNDCQEGHILKMFPSTWYV";
```

```
public String getResiduesQ
```

```
{ return residues; }
```

A New Step on Transforming VoIP into the Ubiquitous Service Era

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ABSTRACT

Over the coming years, operators will be using IP networks to replace their current PSTN. VoIP opens doors of opportunities such as cost saving and increased flexibility as well as for the uninvited users, viruses, worms and other unexpected threats from the network. In this paper, I have described benefits and threats that VoIP should face to get the leading place in providing the public phone service. By deploying a mobile wireless networking technology, we can step into the ubiquitous VoIP era. However, only talking about the service model and high-technology challenges is not enough. More facets should be tackled like regulatory requirements.

Keyword: VoIP, PSTN, service model

INTRODUCTION

During the past 10 years, the Internet has been widely adopted by both vendors and consumers. That led to the creation of the electronic marketplace, which swept out business barriers such as time, geography, language, currency, and culture. Consumer goods on the Web can be reviewed by millions of customers worldwide and be purchased at a low cost.

Except services that usually accompany the brick-and-mortar product purchasing context, the online stores offer a great number of Web-based services such as product reviews, product comparison tools, personalized shipping, personal offering, and other services that are tailored to individual customers (Chellappa and Kumar, 2005). Products on the Web are not just generic products but they are actually augmented products (Levitt, 1980), and this augmentation is the result of services that envelop a product to create a consumer's product purchasing experience. In a telecommunication industry, consumer selects a company that offers other services, except phone call service, he or she would like to have at the lowest price. With the rapid emergence of a new voice-over-IP (VoIP) service, the range of services has been expanded and many of them are "free". This exerts more pressure on telecommunication industry and impacts on the revenue growth (Shin, 2006).

The objective of this study is to describe the VoIP conceptual and service models. There are benefits and threats that VoIP should face to get the leading place in providing the public phone service in ubiquitous era. The VoIP service model is described by the Levitt's model (Levitt, 1980).

LITERATURE BACKGROUND OF VoIP

How VoIP works

IP technology treats voice as an application, destroying the old distinctions between "voice" and "data" that are a standard part of Public Switched Telephone Network (PSTN). With VoIP,

telephony signals are digitized and transmitted as packets to their destination, just as an email, streaming video or any other kind of IP transaction. Figure 1 depicts a simplified VoIP network layout.

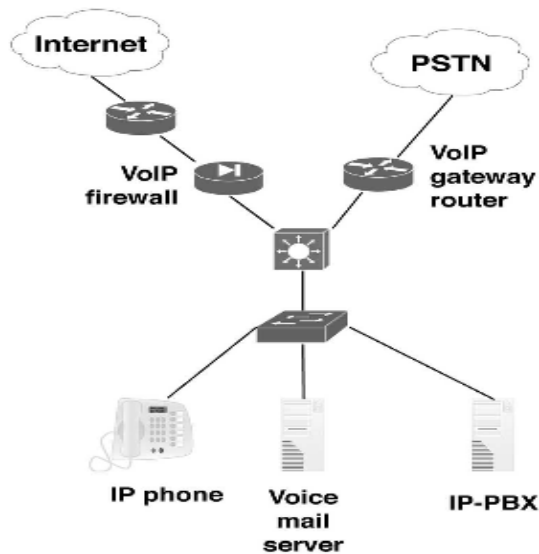


Figure 1 Simplified VoIP network layout

A VoIP transmission can be performed among terminals or endpoints, a means of setting up the call, through the gateways that connect different networks. The endpoint is the phone - a traditional phone with an adapter, a dedicated IP-phone, or computer with a microphone. Call signaling is carried out by a call processing manager or “IP-PBX” (Private Branch eXchange), which sets up the call, handles routing, and provides configurations to endpoints. The two major signaling protocols are H.323 and Session Initiation Protocol (SIP). Both signaling protocols use known ports or ranges of ports for call setup, but the actual conversation takes place over high UDP ports negotiated on the fly (Edelson, 2005).

A gateway compresses and packetizes voice data and sends it to the IP network. It must translate VoIP signaling protocols to SS7,

the signaling protocol used in the PSTN. To make a call – or access voice mail, or have a telephone number – a VoIP client registers with an IP-PBX. The client sends a request to a gateway which resolves the telephone number to a network address. When a connection is established using one of the signaling protocols, the caller's voice is digitized, compressed, possibly encrypted, and packetized using Real Time Protocol (RTP). RTP packets are then wrapped in UDP datagrams. These travel directly between the participants and are re-assembled by a voice processing application, based on sequence numbers and timestamps in their headers (Edelson, 2005). There are four different types of connections providing VoIP (Kim and Parameswaran, 2004):

- IP to PSTN through Internet
- IP to PSTN without Internet
- IP to IP
- PSTN to PSTN.

Security issues

As well as introducing opportunities for the wide use of VoIP, increased flexibility and cost savings, IP networks also introduce a number of security concerns. These include traditional threats such as hacking and viruses, as well as those associated with the voice environment, including privacy, service theft, denial of service attacks, and service reliability (Edelson, 2005; Rowe, 2005; Whitworth, 2006).

Even though a company is not able to implement 100% military level security, it can choose the appropriate security measures to mitigate the risk that is related with VoIP. The main requirements for VoIP security (Edelson, 2005):

- VoIP network components should be dedicated, both for security and performance.
- Voice and data traffic should be separated.
- Firewalls are needed where traffic might legitimately flow between voice and data networks.

- Simple packet filtering should be fully done where no cross-traffic is allowed.

Wireless network presents more challenges for VoIP security.

Benefits

The main reason of why people and organization choose to VoIP is cost. Cost benefits associated with a move to VoIP typically reach savings of around 30% (Whitworth, 2006). Along with the traditional phone service, VoIP providers introduce new innovation such as area code mobility, real-time billing and service provisioning, and easy conference calling. Personal digital assistant (PDA) allows consumers to send voice over a WiFi to the Internet. Broadcasting content can be viewed over cellular phones or other dedicated terminal by implementing digital multimedia broadcasting. Each of this embeds IP voice and can be regarded as VoIP (Shin, 2006).

VoIP service model

A product on the Web is more than the core value it provides or its price; rather, it is the bundle of attributes, services and perceived benefits that accompanies its purchase (Chellappa and Kumar, 2005). This view has been adopted from Levitt (1980) from his observation of physical markets: “In the actual world of markets, nothing is exempt from other considerations, even when price competition rages” In this paper I adapted Levitt’s total product concept to describe the VoIP service in Figure 2:

- 1) the generic service sought by customers – telecommunication;
- 2) the expected service, which represents the customer minimal purchase conditions – “Free” PC to PC communication, including calls, conferences;
- 3) the augmented service, which is the addition of extra or unprompted augmentations or benefits to the expected

product – “Free” PC to Phone, Phone to PC and Phone to Phone communication over IP ;

- 4) the potential service, which refers to everything potentially feasible to attract and keep customers – Ubiquitous “Free” VoIP by mobile IP

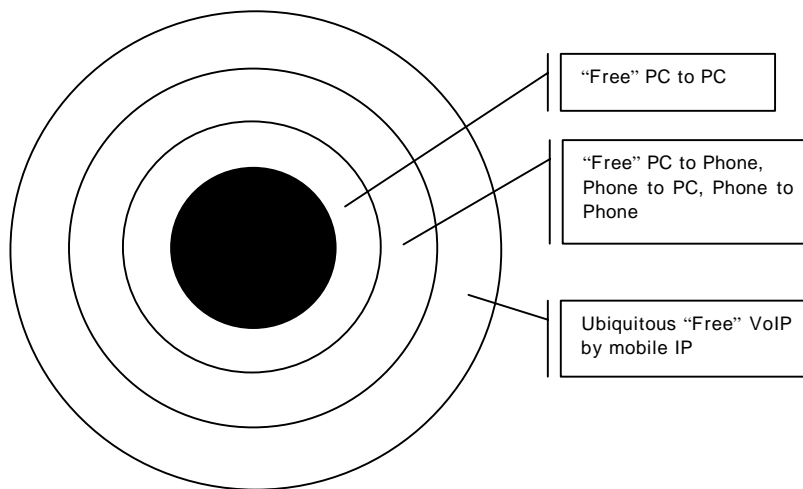


Figure 2 VoIP service model

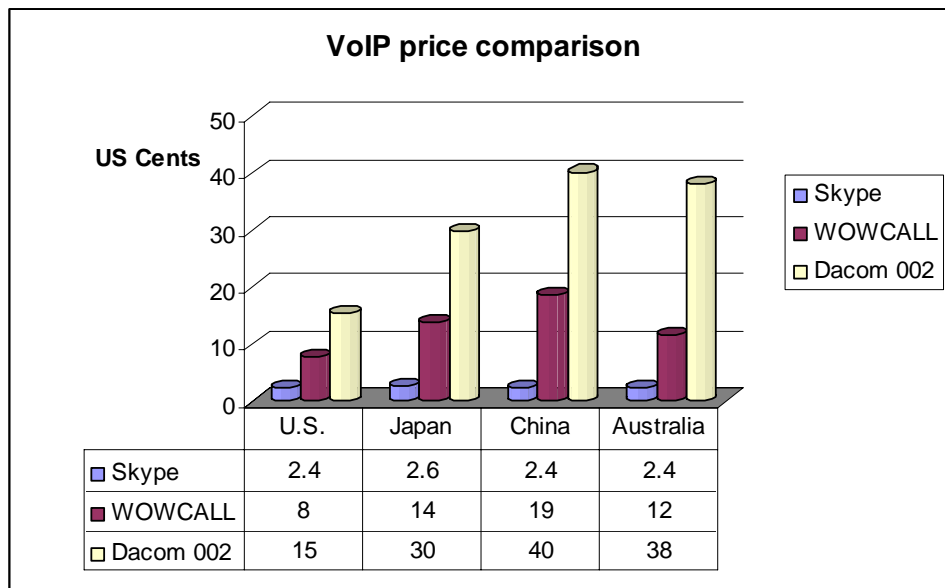
On the market of VoIP providers, a lot of companies have emerged that offer PC to PC communication for free. Skype, owned by online auctioneer eBay, is undoubtedly the leader. Competitors such as Yahoo, AOL, MSN, NateOn are integrating more call features into their instant-messaging clients in order to catch up with the leader (Marguerite, 2006). We can regard this as an expected service. By offering the service for free, companies try to involve as many potential customers as it is possible, who can be charged for the extended features. More vivid combat among vendors for the customers is going on in the augment service area, since for this services customer has to pay.

The following list shows more popular vendors that offer augment services:

- Skype

- Vonage
- Yahoo + Dialpad
- AOL
- WOWCALL
- Internetcalls

The list is far more incomplete, since more and more companies spring up on the horizon. They try to attract more customers by offering competitive conditions such as low-rate per minute plans or monthly plans for unlimited calls. Graph 1 shows the prices that different VoIP vendors offer today (Dacom 2006; Skype 2006; Wowcall 2006).



Graph 1 VoIP price comparison

Recently Skype started offering a free calling to phones in U.S. and Canada till the end of the year (Marguerite, 2006). In above cases customers cannot use services if they are on the move. Future generation wireless networks can enable mobile users to switch network access and experience uninterrupted service continuity anywhere, anytime. If this happens,

telecommunication companies will face tremendous competition, since VoIP offerings will be at significant lower cost.

Presently, telecommunication companies offer a broadband access to the internet over general packet radio service (GPRS), which is still pretty expensive. On the other hand, mobile wireless technology has gained tremendous popularity due to its ability to provide ubiquitous information access to users on the move (Siddiqui and Zeadally, 2006). Since wireless network technologies are not homogeneous, the next generation should face challenges of constituting different types of access technologies (Deshpande, 2002). The heterogeneity that will characterize future wireless systems instigates the development of intelligent and efficient handoff management mechanisms that can provide seamless roaming capability to end-users moving between several different access networks. And it can be called a ubiquitous VoIP. Ubiquitous VoIP is a potential service that can bring a competitive advantage to a company on the telecommunication arena.

CONCLUSION

In this article, we have presented overall overview of VoIP, benefits and risks that are accompanied while using VoIP. Over the coming years, operators will be using IP networks to replace their current PSTN. VoIP eventually can become the dominant provider of public phone service. By deploying a mobile wireless network technology, we can step into the ubiquitous VoIP era. But talking about the service model and high-technology challenges only is not enough. More facets should be tackled like regulatory requirements.

Some countries prohibit VoIP service where governments have monopolies in telephone and telecommunication service. Other restricts it to communication from computer to computer. Another countries permit without putting any technological standards or quality of service requirements (Shin, 2006). In the U.S., FCC has imposed the e911 requirement on VoIP providers that obliges

them to support emergency calls (Federal Communication Commission, 2004).

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