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Term Project
WIRLESS WORLD

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ABSTRACT

In this report, we are discussing the feasibility to provide wireless connections over cities. We discuss how this service should be implemented and what is the best solution to achieve that. We illustrate the different technologies available to carry this service and compare them using different technologies including the cost. However, we first investigate the information available about these technologies then we go through all the phases involved in a Value Engineering job plan. Finally, we end up with giving out the best solution.

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2TABLE OF CONTENTS

I. EXECUTIVE SUMMARY

In this report we are proposing the implementation of a new idea not currently employed, at least on full scale. However, the implementation of this idea involves a large cost. Therefore, applying value engineering in the early stages of such a project has a potential of realizing a lot of savings. We'll go through applying the steps of value engineering on such a project from information phase till implementation phase.

II. INFORMATION PHASE

Unlike the majority of products, what we are going to study is not a product but rather a service. In today's world, nobody can deny the need of connectivity between digital devices like personal computers, laptops, PDAs, servers, cellular phones … etc. Whether this connectivity is to the rest of the world through Internet or inside an organization, it is now essential. However, the majority of these connections are through network cables or to put it plainly by wires.

The question is, "Is there another way to be online without wires?" In other words, can we provide a service in which a connection to a network or Internet can be established without cables or wires? In that sense, our goal is to provide a service where you can send an important e-mail while you are on the beach or you can search for information about a product you are about to buy while you are shopping. All you have to do is to open your laptop or PDA and press a few buttons.

Different technologies have emerged to relief us from wires like **Infra-red** and **Bluetooth** technologies. However, they couldn't replace wires because they lack speed in data transfer and range of coverage.

Required Criteria

Currently, two new technologies that support wireless connectivity have emerged. They are called **Wi-Fi** (Wireless Fidelity) and **WiMAX** (Worldwide Interoperability for Microwave Access). These recent technologies promise us to live in a "**Wireless World**". However, for these technologies to proliferate and to be adopted they have to provide the following:

- **Reliable Connection.** That is, a device can connect to a network easily without delay and when connection established, it shouldn't disconnect.

- **Decent Data Transfer Rate.** It would be a desired feature if the new wireless technologies can compete with the wired technologies like **Ethernet,** and **DSL**. However, since these technologies are new a required rate of data transfer would be 10Mb/s to be accepted by users.

- **Security.** This is most important to keep the confidentiality of sensitive information especially in business transactions like the number of a credit card. This is possible through the provision of encryption.

Desired Criteria

The abovementioned criteria are required but don't eliminate the addition of other features. That is, if the new technologies can meet the required criteria and add to them then that would be a plus. These features include:

- Ability to cover a wide range of wireless connection of about 50 meters radius and above for household residents.

- More than 500 meters range of coverage for small towns and more than 1 kilometer for cities.

- Ability to connect to a network or Internet while moving in a vehicle like a bus or a car under a speed of 120 km/hour or less. This is called **Mobility**.

Consultation Record

Most information acquired was from Internet sources. The reason is that the technologies we are discussing are new and not adopted widely in the market especially WiMAX. Please refer to the **REFERENCES** part of this document for the sources of our information.

Cost Data and other data

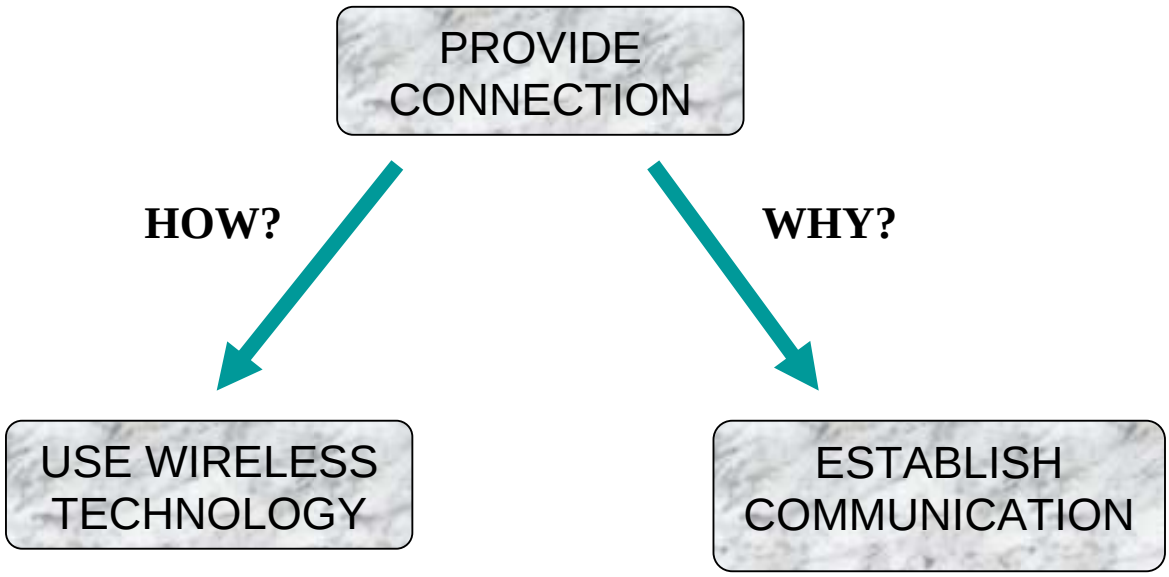
In this section we summarize the data gathered about different wireless technologies. However, some data like maintenance cost are not available for some technologies are recent. Nevertheless, we will try to make our estimates for these costs according to available information. Table 1 below illustrates information gathered.

Technology	Infra-Red	Bluetooth	Wi-Fi	Wi-Fi (Enhanced)	WiMAX
Cost $	15	30	150 – 250	350 – 600	10,000 – 20,000
Range	< 5 meter	10 – 100 m	100 m	500 m	10 – 48 km
Area/Cost	-	1047	157	1570	15708
Data transfer Rate	128 KB/s	50-720 KB/s	54 Mb/s	54 Mb/s	100-512 Mb/s
Security	Yes	No	Optional	Optional	Mandatory
Mobility	No	No	No	No	$\leq$ 75 miles/hour
Line of Sight	Yes	No	No	No	No
Peer 2 peer	Yes	Yes	No	No	No

Table 1Cost and other data for wireless technologies

III. FUNCTIONAL PHASE

As mentioned earlier, we are talking about a service and not a product. The proposed service is new in its functionality and it is supposed to replace an already existing one. Therefore, we will consider our present function as, "**Provide Connection**". The purpose of the existing service is to provide connectivity between different devices, mainly personal computers through wires. On the other hand, our proposed service is to provide connectivity also, however, wirelessly. Therefore, we can describe its functionality as, "**Provide Connection**", "**Connect Wirelessly**". However, a combination of the latter two would be more self-explanatory. In other words, we can state our function in 3 words as, "**Provide Connection Wirelessly**". Follows a visual representation of the proposed functionality.



Function-Cost-Worth

The service discussed is composed of only one function. Therefore, we can't apply the Cost-Worth of functions for the present service because it employs different technologies like **Modem, DSL, ADSL, Cable Modem**. Assessing the cost-worth of these technologies for an Internet Service Provider **(ISP)** is considered out of the scope of this project. The reason is due to time limitation and there are many technical issues to be considered when comparing Wired and Wireless connectivity like data transfer rate, security, bandwidth … etc. The purpose of our study is to compare the different wireless technologies to find the best alternative. The reason is

that many ISPs are using Wi-Fi technology to provide wireless connections to users because it is the first technology launched to the market. After our comparison we'll see if this is a wise decision made by ISPs or should they adopt other technologies.

IV. CREATIVE PHASE

Here we list all ideas we can think of to establish a wireless connection between devices. We'll not judge these ideas in this generation phase. Here is a list of the generated ideas.

1. Use Infra-Red technology only.
2. Use Bluetooth technology only.
3. Use standard Wi-Fi technology only.
4. Use enhanced Wi-Fi technology only.
5. Use WiMAX technology only.
6. Use any combination of the preceding technologies.

V. JUDICIAL PHASE

This is where we will filter our ideas and at the end we choose the idea that suits our situation the best. However, prior to that we'll go through different steps to find the best alternate. First we'll rank our ideas according to feasibility in which we will eliminate some ideas. Then we will compare the chosen ideas by listing their advantages and disadvantages. Then we will create our scoring and evaluation matrices.

Feasibility Ranking

	A. STATE OF THE ART 10 = Off the shelf 1 = New technology	**B. COST TO DEVELOP** 10 = No Cost 1 = High Cost	**C. PROBABILITY OF IMPLEMENTATION** 10 = Excellent chance 1 = No Chace	**D. TIME TO IMPLEMENT** 10 = Extremely Short 1 = Extremely Long	**E. POTENTIAL COST BENEFIT** 10 = Large Savings 1 = No Savings	**F. AREA COVERED** 10 = Large Area 1 = Small Area	**TOTAL RANKING**
1. Infra-Red	10	3	1	7	2	1	24
2. Bluetooth	10	4	2	8	2	1	27
3. Wi-Fi	9	8	6	8	3	2	36
4. Enhanced Wi-Fi	7	6	7	7	4	3	34
5. WiMAX	3	2	7	4	9	10	35
6. Combination of any	2	2	4	2	6	5	21

According to the feasibility ranking table above, we will discard the ideas that scored lower than 30 which are: Infra-Red, Blutooth and Combination of the different technologies.

Idea Comparison

In this part of the report we will compare the feasible ideas in terms of their advantages and disadvantages. In the following table we list each idea, its advantages and disadvantages.

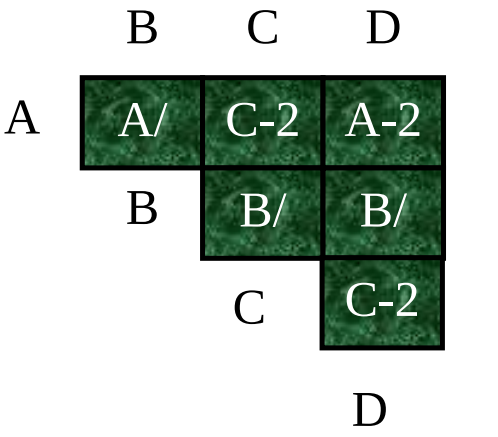
IDEA	ADVANTAGES	DISADVANTAGES	RANK
Standard Wi-Fi	1. Low Cost 2. High Speed	1. Weak Signal. 2. Low Range.	3
Enhanced Wi-Fi	1. Powerful Signal. 2. Low Cost.	1. Not IEEE standard. 2. Low Range.	2
WiMAX	1. Big Range. 2. High Speed. 3. Mobility.	1. Standard War. 2. High Cost.	1

Determining Weights for Evaluation

Here we will develop our criteria for determining the best alternative. Each criterion will be assigned a raw score after developing a scoring matrix. Then each criterion will be assigned a weight out of 10 depending on the raw score. The following table and figures show each criterion, the assigned weights and the scoring matrix.

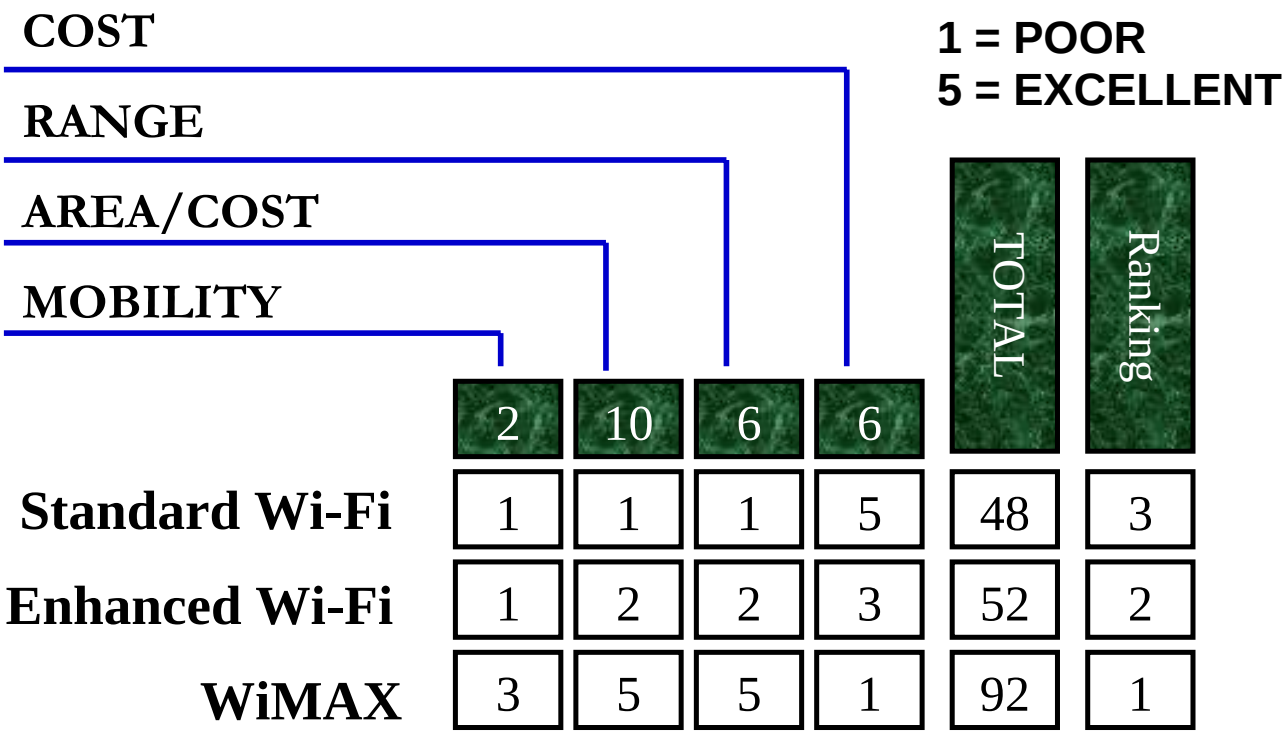
CRITERIA	RAW SCORE	ASSIGNED WEIGHT
A. COST	3	6
B. RANGE	3	6
C. AREA / COST	5	10
D. MOBILITY	1	2

1. Minor preference
2. Medium preference
3. Major preference



Evaluation Matrix

The following Matrix determines the rankings of the ideas according to the evaluation criteria and scores assigned to them.



As we can see, the WiMAX scored the highest total and therefore ranked first. This implies that we should implement this technology to realize the best combination of quality and cost savings.

VI. DEVELOPMENT PHASE

As mentioned above, WiMAX is our proposed technology to provide wireless connections between different digital devices. The main reason is that WiMAX provides a high Area/Cost ratio score and many other advantages compared to the Wi-Fi technology. To verify our judgement we will carry out a small study to show the initial cost savings that would be realized from using WiMAX instead of Wi-Fi.

Consider that we have a city of a rectangular shape. It has a length of 20 kms and width of 15 kms. Thus, its area is 300,000,000 m^2. 1 WiMAX covers, assuming it has a range of 10

kms, 314,159,265 m^2. This means that 1 WiMAX is enough to cover the whole city but we need to use 2 to ensure reliability in case one WiMAX went down. The total cost would be $40,000.

On the other hand, 1 enhanced Wi-Fi covers an area of 785,398 m^2. That means we need 382 Wi-Fis which would cost $191,000. That is a $151,000 difference. The WiMAX solution would save us 71% of the Wi-Fi solution total cost.

Life Cycle Cost Analysis

The technologies at hand are new in the market, especially the WiMAX, and thus we lack some costing information. However, we will try to provide close estimates.

This is taken to provide service to the above case	**Enhanced Wi-Fi (382 units)**	**WiMAX (2 units)**
Initial Cost	$191,000	40,000
Operating Costs	10 X 382 = 3,820 (over 2 yrs)	5,00 X 2 = 1,000 (over 5 yrs)
Salvage Value	50 X 382 = 19,100 (after 2 yrs)	5,000 X 2 = 10,000 (after 5 yrs)
Present Worth (discounted at 10%)	$181,844	$37,581

Implementation Plan

The plan is to implement the idea as soon as possible. However, it should go through calculated steps. We need to make sure that the technology is reliable enough to replace any cable or wired networks. The following steps can help us accomplish that:

- First of all, we don't need to build everything from scratch. That is, a WiMax needs a tower (base-station) to hold it. Thus we can use the Saudi Telecommunication Company (**STC**) towers to place the WiMAXs.
- We Should try the new technology over a specific area for testing purposes.

- We should then evaluate the technology depending on our tests and others from the world.
- If it proves its worth, then we can start replacing the wired networks.
- However, we should first study the best places to place the WiMAX base-stations to minimize the costs.
- The implementation plan should be carried out by the municipalities of main cities supported by the specialized people in both the networking technologies and the Value Engineering field.
- The implementation plan should take no longer than 2 years over each city. There is no deadline required.

VII. PRESENTATION PHASE

In this section we provide the outline of our presentation. For the whole presentation, please refer to the accompanied floppy disk.

- INTRODUCTION
- WIRLESS TECHNOLOGIES
- BASIC FUNCTION
- EVALUATION CRITERIA
- ALTERNATE SOLUTIONS
- STUDY CASE
- CONCLUSION

VIII. CONCLUSION

There is no doubt that the WiMAX according to our study is far superior to Wi-Fi and it provides the best solution for wireless networking until now. The reason is not only that it saves us a large amount of money but because it has low maintenance cost, more reliable, secured and faster when it comes to downloading and uploading data.

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