Land of the Long Wi-Fi Cloud? IEEE 802.11b Deployment in New Zealand

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There has been significant growth in Wi-Fi networking technology in recent years - both in applications and as the subject of academic research papers, articles in the IT press, and research house reports. How much of this material, predominantly based on overseas experience, is relevant to New Zealand's early-adopter context? This paper reports on a recent survey of large New Zealand organisations, asking about the level of Wi-Fi deployment, reasons for non-deployment, the scope of deployment, investment in deployment, problems encountered, and future plans. Results show that most organisations have at least considered the technology, though a much smaller proportion has deployed it on any significant scale.

We believe that the lesson to be learned from this study may be a useful resource both for teachers and students interested in carrying out further research in the areas of wireless and mobile networking.

Keywords:

Wi-Fi technology, IEEE 802.11b, WLANs, Deployment

1. INTRODUCTION

Wi-Fi technology (also called IEEE 802.11b) has been standardised by the IEEE committee as 11 Mbps wireless LANs. In the generally flat high-tech landscape of the past few years, Wi-Fi stands out as one technology that still attracts a good deal of interest. New Zealanders have generally been early, and keen, adopters of technology. As Myers points out, New Zealanders "have developed innovative [IT] applications to improve the competitiveness of many sectors of the economy" (Myers, 1996). Wireless technologies appear to be no different. According to a recent New Zealand Trade and Enterprise (NZTE) report, New Zealand is a "beacon for advanced wireless innovation" and amongst the global "leadership in the fixed and mobile wireless space" (MediaLab South Pacific, 2003). For instance, NZ Telecom reported that New Zealanders have been quicker than most to access mobile Internet services (Telecom, 2003).

This gives some reason to believe that New Zealand's experience with wireless technologies may differ from that documented in overseas research. However, there is a dearth of published research focusing on New Zealand experiences. The most comprehensive survey in recent times is the NZTE report on New Zealand's fixed and mobile wireless sector (MediaLab South Pacific, 2003). While thoroughly covering the various wireless technologies, it focuses on the experience of developers and vendors. In terms of the end-user experience, what has been published is either detailed case studies of individual organisations (Jackson, 2003; Smith, 2003) or a few wireless-related questions in a survey covering a wide range of IT issues (Bland, O'Neill, & Bell, 2003; Hind, 2003).

This paper reports on a survey of Wi-Fi technology in New Zealand's largest IT end user organisations. The survey seeks to gauge the current level of Wi-Fi deployment in these organisations and some details of the deployment process. To gain insights on the New Zealand experience, we compared our survey results with those of similar surveys conducted overseas. We found that most New Zealand organisations have at least considered Wi-Fi technology, although a much smaller proportion has actually deployed it on any significant scale.

The remainder of this paper is organised as follows. Section 2 reviews recent research highlighting the growth of Wi-Fi technology in New Zealand. In section 3 we briefly describe the development of the survey, the target sample, and how it was administered. The survey results are presented in sec-

tion 4. The results are analysed and interpreted in section 5. Section 6 presents our conclusions.

2. RELATED WORK

This section reviews related work highlighting the rapid growth of Wi-Fi in general, and the current state of Wi-Fi technology in New Zealand.

2.1 Growth of Wi-Fi Technology

The rapid growth in the use of Wi-Fi in the US is clearly illustrated by two surveys. A 2001 survey, commissioned by Cisco found that 10% of US organisations were using Wi-Fi (NOP World - Technology, 2001). A 2003 survey, commissioned by AirMagnet (Ask, 2003) reports that Wi-Fi is used by 57% of enterprises, suggesting a growth rate of 470% in two years. Growth in Europe has been much slower, due to competition from the High Performance Radio LAN (HiperLAN) standard (Collins, 2002). Recent research from Instat/MDR reports that in 2002 the Asia-Pacific region had the fastest growth in the use of Wi-Fi, driven largely by the rapid uptake in Japan and Korea (Collins, 2002; Griffith, 2002).

2.2 Wi-Fi Technology in New Zealand

In discussing Wi-Fi technology, the NZTE report suggests that wireless local area networks (WLANs) are becoming increasingly common in small businesses and private homes, although no details are given (MediaLab South Pacific, 2003). Wi-Fi technology is being used to create metropolitan area networks (MANs) in urban areas, such as Queenstown, Auckland and Wellington (Watson, 2002a, 2002b, 2003). It also forms the basis of some wide area networks (WANs) in provincial areas, delivering broadband Internet access as part of the government's Project PROBE (Watson, 2002d). Wi-Fi technology has been used to provide public wireless hotspots in Auckland airport, hotels, restaurants and service stations (Watson, 2002c). Auckland is also the base of the New Zealand Wireless Data Forum (NZWDF), established in 1999. Setup initially to educate New Zealand organisations in wireless data solutions, it has recently adopted a more commercial focus, aiming to enable the wireless economy.

The NZTE report surveys 105 vendors of wireless technology in New Zealand, with 28% identifying Wi-Fi as their 'base product'. In terms of a market for Wi-Fi, a survey of Australian and New Zealand organisations by CIO Magazine reports that 20% were using Wi-Fi at the end of 2001 (Hind, 2003). This increased to 38% at the end of 2002, indicating a growth rate of 90% for the year. An IDC survey of New Zealand organisations reports that 9% were using Wi-Fi in 2001 (Broatch, 2002). This increased to 20% in 2002, indicating a growth rate of 122%.

In these surveys, Wi-Fi was just one of many issues that respondents were asked about and only a few questions were asked regarding Wi-Fi. For more detail on how Wi-Fi is being deployed and used in New Zealand, one must turn to case studies of individual organisations, some examples of which have been referenced in this section. To the best of our knowledge, there are no New Zealand surveys dealing specifically with Wi-Fi, in the manner of the Cisco and AirMagnet surveys of US organisations referenced above. This paper is a first step in filling that gap. In the following two sections we address the detailed survey of Wi-Fi technology in New Zealand.

3. SURVEY

This section briefly describes the development of the survey, the target sample, and how it was administered.

3.1 Purpose and Structure

The primary purpose of the survey was to determine the level of deployment of Wi-Fi technology in large New Zealand organisations, and compare it with results from overseas. There were also two secondary aims. One was to compare the results with the NZTE survey's finding that New Zealand organisations are unaware of the value and potential of wireless technology. This was supported by asking questions about why Wi-Fi is not being used, how it is being used, and how it will be used in the future. The other secondary aim was to compare the results with NZTE survey's finding that New Zealand organizations are unable or reluctant to invest in wireless technology. This was supported by asking questions about the investment of money, time and staff resources.
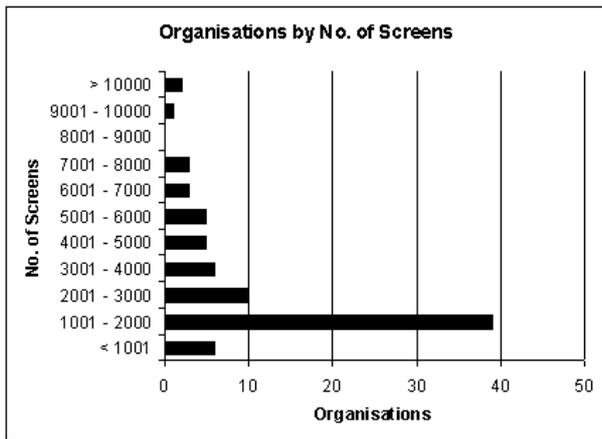
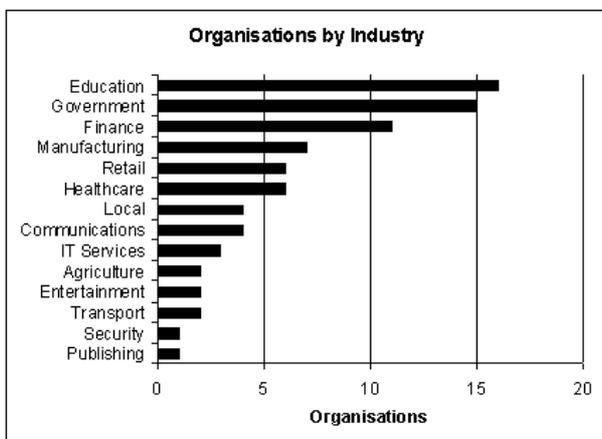**Figure 1. Organisations by Number of Screens.**

Figure 2. Organisations by Industry

Figure 3. Current Deployment.

3.2 Target Sample

The target sample consisted of 80 organisations. They were selected from amongst the largest end users of IT in New Zealand, as these were considered to be the most likely market for the wireless vendors surveyed for the NZTE report. The number of end users in an organisation was approximated by the number of screens, consistent with the approach of MIS magazine (Bell, 2003). Figure 1 shows a breakdown of organisations by number of screens. The organisations were from a range of industries, with most classified as Education providers and Government departments. A breakdown of organisations by industry is shown in figure 2.

3.3 Administering the Survey

A hardcopy of the survey questionnaire and a covering letter was sent to each organisation in the target sample in July 2003. A reply-paid envelope was included for the return of the completed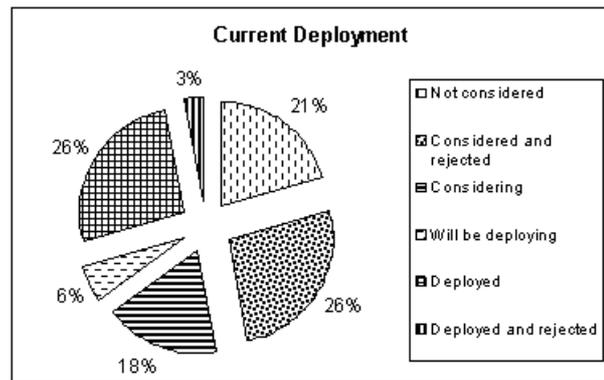 survey. We opted for a postal survey, rather than an email and/or Internet based survey, because of the rash of viruses that was afflicting the Internet at the time. Over the course of six weeks, 34 responses were received. This response rate of 42.5% was considered acceptable.

4. RESULTS

In this section we present some of the key results of the Wi-Fi survey. The results are presented in five themes: level of deployment; reasons for non-deployment, scope of deployment, investment in deployment, and future plans.

4.1 Level of Wi-Fi Deployment

All respondents were asked for the current state of Wi-Fi deployment in their organisation. Figure 3 shows that about 79% have at least considered deploying Wi-Fi. Of these organisations, there is an almost equal split between those that have or will be deploying Wi-Fi (40%), and those that have rejected it (37%), with 23% still considering.

4.2 Reasons for non-deployment of Wi-Fi

We asked those respondents who have not considered deploying, or had rejected Wi-Fi, the reason for this decision. As can be seen from figure 4, security is the overwhelming concern, accounting for almost half these responses. Lack of a business case and expense are a problem for 25%, performance ('Too slow' and 'Using 802.11a') for 17%, and uncertainty over standards ('Immature') for 8%.
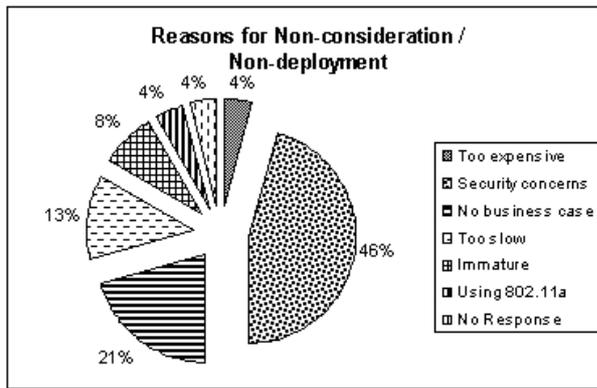
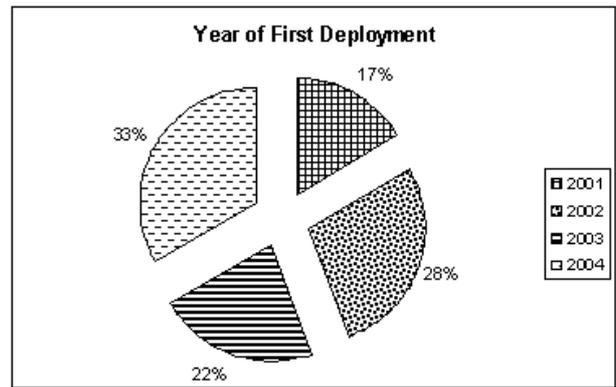**Figure 4. Reasons for Non-consideration/ Non-deployment.**
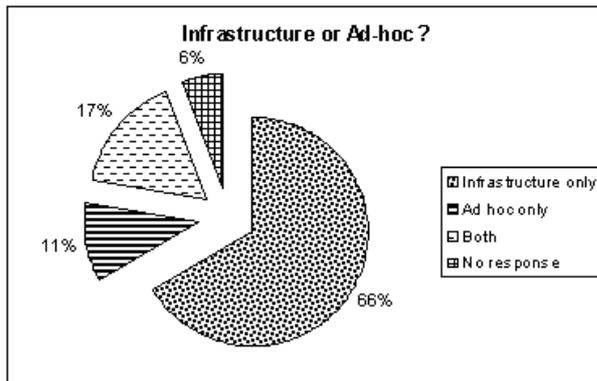

Figure 6. Year of First Wi-Fi Deployment.

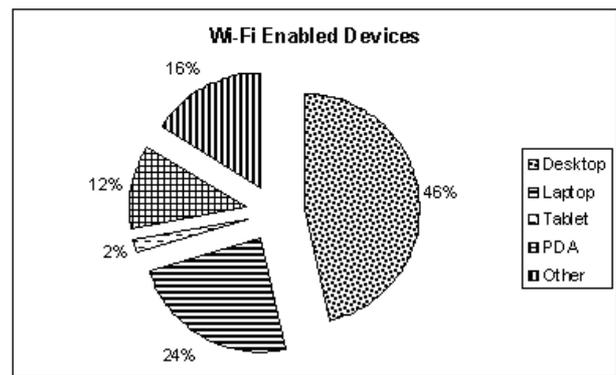

Figure 5. Infrastructure or Ad-hoc?

Figure 7. Wi-Fi Enabled Devices

4.3 Scope of Wi-Fi Deployment

We asked questions regarding Wi-Fi deployment of those respondents who are considering, will be deploying, or have deployed, Wi-Fi.

Respondents were asked whether Wi-Fi was used in infrastructure or ad-hoc mode. The results, in figure 5, show that 83% of respondents are using infrastructure WLANs, whereas 28% are using ad-hoc.

A question was asked about the year in which the organisations first deployed, or plans to deploy, Wi-Fi. Figure 6 shows that 2001 was the first year Wi-Fi was deployed by NZ large organisations. This is two years after the Wi-Fi standard was approved. Approximately 9% of all respondents had deployed Wi-Fi by the end of 2001, 24% by the end of 2002, and 35% by the end of 2003. We might expect around 53% of respondents to have deployed Wi-Fi by the end of 2004.

Another question asked for a breakdown of devices that are, or will be, Wi-Fi enabled. The results, in figure 7, show that desktop PCs make up almost half the devices being attached to Wi-Fi

WLANs. In comparison, the AirMagnet survey (Ask, 2003) reports approximately the same proportions for tablets and PDAs, but much lower for 'other' devices (2%) and for desktops (16%), and much higher for laptops (71%).

The device breakdown for the individual respondents that completed this question is shown in table 1.

The high proportion of desktops in figure 7 is concentrated in two respondents. The support for laptops and PDAs is more widespread. This data also suggests that most organisations are deploying Wi-Fi on a relatively small scale. The organisations sampled had an average of approximately 2100 desktops and 270 laptops, tablets and PDAs. Yet half of the respondents shown above are using fewer than 100 Wi-Fi enabled devices.

4.4 Investment in Wi-Fi Deployment

The questions in this section were asked of those respondents who are considering, will be deploying, or have deployed, Wi-Fi technology.

One question asked for the amount they spent on deploying Wi-Fi. Figure 8 shows the median cost

Table 1. Wi-Fi Enabled Devices by Respondent

Respondent	Desktop	Laptop	Tablet	PDA	Other
1		4			
2		10			
3		10			
4	10	2			
5		10		20	
6		60			
7		50		20	
8		100	10	10	
9		100	10	100	
10	150	70		10	
11					350
12				400	
13		600			400
14	1000				
15	1000	100	50		

Table 2. Wi-Fi Enabled Devices and Cost by Respondent

Respondent	Desktop	Laptop	Tablet	PDA	Other	Cost(NZ$)
1		10				< 10,001
2		10		20		< 10,001
3		60				< 10,001
4		10				10,001 - 20,000
5	10	2				10,001 - 20,000
6		100	10	10		10,001 - 20,000
7		100	10	100		10,001 - 20,000
8		4				30,001 - 40,000
9		50		20		70,001 - 80,000
10	1000					80,001 - 90,000
11	150	70		10		> 100,000
12					350	> 100,000
13				400		> 100,000
14	1000	100	50			> 100,000

(in NZ$) of deploying Wi-Fi is in the range $30,001 - $40,000. However, the distribution is skewed to the extremes, with the two largest proportions spending less than $10,000 and more than $100,000.

Table 2 shows the combined data for the number of Wi-Fi enabled devices deployed and deployment cost, for the 14 respondents who answered both questions. This shows very little correlation between the two. For instance, respondent #7 deployed 210 Wi-Fi enabled laptops, tablets and PDAs for $10,001 - $20,000, while respondent #8 required $30,001 - $40,000 to deploy 4 Wi-Fi enabled laptops.
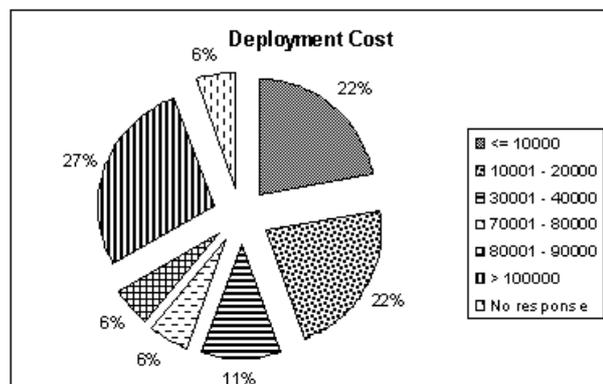

Figure 8. Deployment Cost.

Figure 9 shows that nearly half of respondents were able to deploy the Wi-Fi using only in-house
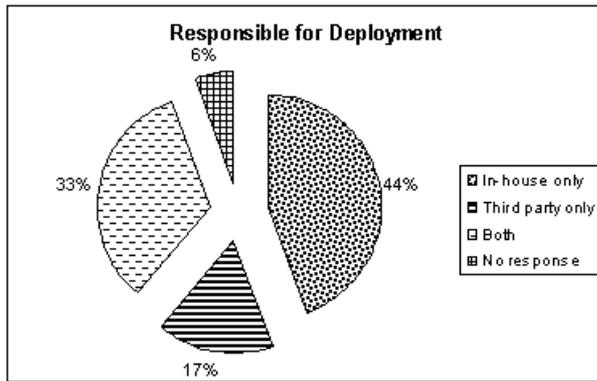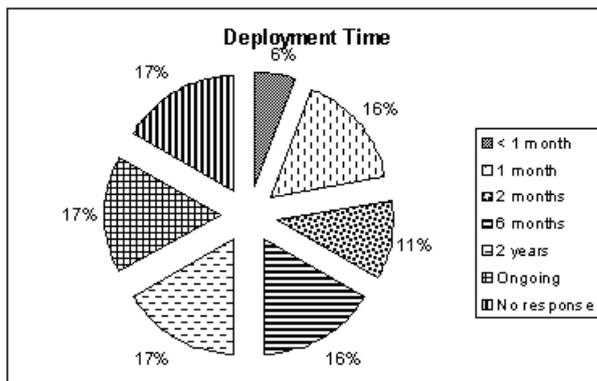
Figure 9. Responsible for Deployment.

Figure 10. Deployment Time.

Table 3. Deployment Cost and Responsibility by Respondent

Respondent	Cost(NZ$)	Responsibility
1	< 10,001	In-house only
2	< 10,001	Both
3	< 10,001	In-house only
4	< 10,001	In-house only
5	10,001 - 20,000	In-house only
6	10,001 - 20,000	In-house only
7	10,001 - 20,000	In-house only
8	10,001 - 20,000	In-house only
9	30,001 - 40,000	Third-party only
10	30,001 - 40,000	Both
11	70,001 - 80,000	Both
12	80,001 - 90,000	Both
13	> 100,000	In-house only
14	> 100,000	Both
15	> 100,000	Third-party only
16	> 100,000	Both
17	> 100,000	Third-party only

Figure 11. Future Deployments.

staff, while just 17% required full service from a third party.

Table 3 shows the combined data for deployment cost and responsibility for deployment, for 17 respondents who answered both questions.

This shows a very strong correlation. Of the respondents using only in-house staff, just one spent more than $20,000. Of the respondents using any degree of third party assistance, only one spent less than $30,000.

The next question asked about the time taken for the deployment. The results, in figure 10, show that 49% of the respondents took 6 months or less to deploy their Wi-Fi, with 17% making it an ongoing task.

4.5 Future Plans for Wi-Fi

The final question, plans for future Wi-Fi use, was asked of the respondents who had deployed Wi-Fi technology. Figure 11 shows that most were expecting to increase the use and coverage of Wi-Fi within their organisation. It is interesting to note that those respondents nominating an upgrade path have preferred 802.11g over the recommendation of Gartn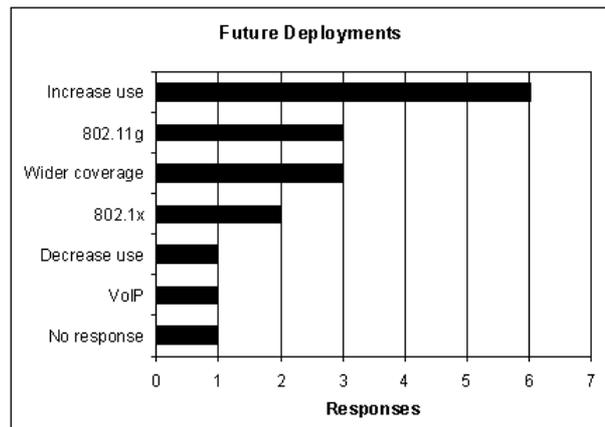er Research (Dulaney, 2002) and Forrester Research (Dolinov, 2003) for 802.11a. Given the widespread concern about Wi-Fi WLAN security, it is also surprising to see that only 20% of respondents have specifically referred to adopting the IEEE 802.1x standard, or some other means of improving it.

5. ANALYSIS

This section compares the Wi-Fi experience of large New Zealand organisations with that encountered overseas, as presented in section 2. It also discusses whether survey results support the findings of the NZTE survey.

5.1 Growth of Wi-Fi WLAN

It would appear that Wi-Fi is one technology that large New Zealand organisations have not adopted particularly early or quickly, compared to other countries. Figure 6 suggests that Wi-Fi WLANs were not deployed in New Zealand until 2001. This is two years after the IEEE 802.11b standard was finalised, the Wi-Fi Alliance began certifying Wi-Fi WLAN products, and the NZWDF was founded. Figure 3 indicates that 26% of large New Zealand organisations are currently using Wi-Fi with 6% planning to do so. This is approximately half the level of large US organisations, according to the AirMagnet survey (Ask, 2003). It is also well below the CIO magazine's survey showing the usage for combined Australian and New Zealand organisations at 38% at the end of 2002 (Hind, 2003). This suggests that a greater proportion of Australian organisations are deploying Wi-Fi.

In addition, it seems that about half of large New Zealand organisations that are using Wi-Fi are doing so on a small scale, or perhaps a trial basis. Table 1 suggests that six of the 15 respondents have less than 10% of their devices Wi-Fi enabled.

It should be noted that there are ways that this survey could have been designed to show a higher level of usage. The Cisco survey (NOP World - Technology, 2001) suggests that organisations in different industries have different levels of Wi-Fi usage. In particular, the average US educational institution is two-and-a-half times more likely to use Wi-Fi than the average US organisation. Although educational institutions make up 20% of the target sample for this survey, it is not known what proportion of respondents they represent. The AirMagnet survey suggests that small organisations are more likely than large organisations to deploy Wi-Fi, whereas this survey has focused on large organisations.

5.2 Value and Potential of Wi-Fi Technology

Figure 4 shows that making a business case for Wi-Fi WLANs is a problem for only about 13% of large New Zealand organisations, which is noticeably less than the AirMagnet survey of US organisations. This calls into question the NZTE survey's finding that New Zealand organisations are unaware of the value and potential of wireless technology.

Large New Zealand organisations that have deployed Wi-Fi seem more interested in the potential productivity benefits than in simple cost reduction. Table 1 shows that 11 out of 15 respondents (73%) are using Wi-Fi only with mobile devices, suggesting that they are hoping to increase productivity through anytime/anywhere access. Only 27% of organisations are using Wi-Fi primarily for desktops, suggesting that they are focusing on reducing cabling costs.

On the other hand, the NZTE survey's finding that New Zealand organisations are unable or reluctant to invest in wireless technology seems justified. Figure 9 shows that half of respondents spent about $40,000 or less deploying their Wi-Fi WLAN. However, table 3 suggests that when organisations do seek the assistance of wireless vendors the price will almost certainly increase substantially. In addition to the extra cost, one respondent suggested that wireless vendors don't invest enough in their relationships with organisations: "Vendors are willing to deploy, but not to understand security and business requirements."

5.3 Limitations

We could not pilot test this survey because of time constraints. It is apparent from some responses that certain questions could have been worded more clearly. For instance, some respondents seem to have taken different interpretations of 'spending' on Wi-Fi deployment.

The sample size is small, due to the desire to sample only large organisations. Anonymity was promised to respondents, to encourage participation. The combination of these two factors has, to some extent, restricted the results that can be presented in this section, and the analysis presented in the next section.

5.4 Future Work

Further research on the role that an organisation's industry and size plays in Wi-Fi usage is suggested. A survey with a larger number of smaller organisations seems like the next logical step. Repeating this survey on a regular basis, perhaps annually would also be of some benefit, allowing a picture to be built up of how large New Zealand organisations' use of Wi-Fi changes over time. A case study of Wi-Fi technology adaptation in specific set-

tings, such as the hospital environment, is also suggested for future work.

6. DISCUSSION AND CONCLUSION

We have surveyed 80 large New Zealand organisations about their level of Wi-Fi deployment, reasons for non-deployment, the scope of their deployment, their investment in Wi-Fi deployment, and their future plans for Wi-Fi. Results show that Wi-Fi has not been adopted quickly or widely, compared to other countries. Though large New Zealand organisations seem to be aware of the potential benefits of the technology, many are choosing not to deploy Wi-Fi, or to deploy them on a small scale. They are particularly concerned about security and performance issues. Other issues identified in overseas research, such as difficulties making a business case, uncertainty over standards, and a lack of expertise, do not appear to be so pronounced in large New Zealand organisations.

It is hoped that this report will prove to be of value to New Zealand's large IT end user organisations and wireless vendors. End user organisations may reflect on the scope, investment, and issues experienced in previous deployments of Wi-Fi in planning their own. Wireless vendors may find the data on the level of deployment, investments, and future plans useful in formulating their future products and services.

We believe that this paper also contributes to filling a research gap in how New Zealand organisations use Wi-Fi technology. As such, it may be a useful resource for both teachers and students interested in carrying out further research in the areas of wireless and mobile networking.

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