

# Linux Networking in NZ Industry and ITP Education

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## Abstract

This paper has a focus on the networking services that can be (and in some cases are being) taught using the Linux operating system. It first collates information from the literature regarding global industry trends of different server operating systems over the past few years, allowing the reader to see the position of the Linux server operating system in this market.

The second part investigates the demand for Linux knowledge and skills in comparison to other technologies sought after in networking or telecommunication jobs by a quantitative analysis of networking job advertisements in New Zealand.

Linux networking services are currently taught to varying degrees by New Zealand ITPs. In the last part of the paper the extent to which particular Linux networking services are taught is broken down into the subject areas they are taught in across different ITPs.

*Keywords:* Linux, networking, operating system, computing education

## 1 Introduction

There are many different aspects to the Linux operating system, some of which are taught across different courses and subject areas in New Zealand Institutes and Polytechnics (ITPs). This paper has a particular focus on the networking services offered by Linux.

It is important that fundamental platform-independent knowledge/skills are taught when teaching computing. In relation to networking and telecommunications, platform independent skills could include things such as; ip-addressing, subnetting, routing, routing protocols, file transfer and terminal emulation. It is also important that the tools used to teach computing such as the operating system and vendor specific software are chosen in such a way that it helps with student employability, as this is one of the aims of New Zealand ITPs (ITPNZ 2007). To this end we investigate industry technology trends and employment demands so that educators may choose to include technology in their teaching that continues to reflect the dynamically changing use of technology in the workplace that students are likely to encounter.

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The particular Linux networking services and the subject areas in which they are taught across different NZ ITPs are investigated in this paper. These results are of value when considering the Linux networking services to include in teaching and determining whether the skills they teach are consistent with other institutes. They may also be of value to those considering a national ITP collaborative computing degree (Corich, 2006) in New Zealand.

This work was motivated by the authors own experiences and observations of networking and operating systems papers at a major ITP in New Zealand. It was evident that although a wide variety of useful and important services were taught on some of the courses, there was room for further aspects of Linux to be included in the papers.

## 2 The Linux Operating System

Linux is part of the open source development movement that is seen as economically sustainable (Perens 2005), although some see flaws (Levesque 2004). It is considered a flexible, reliable (high uptime) and interoperable operating system supported by a large open source community of more than 400,000 developers worldwide (Computer Associates 2004). Kshetri (2004) suggests that in order for Linux to be more successful it should be more user-friendly and also more compatible with Windows applications. Some of these changes are already seen to be taking place (Fontana 2006).

## 3 Linux in the Market

Linux has shown major growth in the IT industry (Cartwright 2004). It is mainly used as a server operating system with a 25% share of the global server operating systems market reported in 2004 (Wikipedia 2007) and with continual growth since then up to 2006 (IDC Press Release 2006) with forecasted growth until 2008 (Beaverton 2004, Wikipedia 2007, Cass and Predd 2007).

Morgan (2006), Shankland (2006) and others indicate that Microsoft Windows and Unix are clearly leaders in this global server operating systems market. Though they say different things about who is actually in top place, they agree that these two are fairly close.

The rapid growth of Linux has drawn attention to the point that it is considered another major player in the market (Cass and Predd 2007). It has been reported (IDC Press Release 2006) that "For the full year, Linux server revenues were \$5.7 billion, placing it in third place for the first time from an operating system perspective as customers continued to expand the role

of Linux servers into an increasingly wider array of commercial and technical workloads.”

The growth of Linux in the global market also appears to be consistent with trends observed in New Zealand and Australia (Varghese 2003).

To a much smaller extent Linux is also used as a desktop operating system (2.8% in 2004 (Wikipedia 2007)) coming well after all versions of Microsoft Windows and the Macintosh Operating System (Operating System Market Share, 2007). Though its presence in the desktop environment has been noted to be quite small in the past (Johnson, 2005), Linux has been growing in popularity (Cass and Predd 2007, Cartwright 2004). In particular, the Ubuntu distribution (for desktops and servers) is becoming very popular (Vaughan-Nichols 2006, Beer 2006).

#### 4 Quantitative analysis of technologies in NZ networking job advertisements

To estimate the demand for Linux in comparison with other technologies sought after by networking/data communications employers, job advertisements from two well-known job advertising websites in NZ were analysed on the same day (27/11/2006). The websites used were Seek ([www.seek.co.nz](http://www.seek.co.nz)) and the ‘Tradme jobs section’ of TradeMe ([www.tradme.co.nz/Trade-me-jobs/index.htm](http://www.tradme.co.nz/Trade-me-jobs/index.htm)).

##### 4.1 Job Analysis Methodology:

For each website the job-search needed to be defined in a way that it would find jobs relating to networking and telecommunications. The relevant jobs discovered had a wide variety of titles for example; Network administrator/engineer, systems administrator, IT specialist/consultant, security engineer, IP systems engineer, all of which are applicable to this research. Systems analyst and programmer/developer jobs were not included. Care was taken to avoid duplicate job advertisements (another advertisement for the same position) though these were relatively few it was important to exclude them.

From reading the advertisements, technologies of interest were noted and grouped into three main categories/elements:

- **Must have:** Skills that the advertiser/employer specifies are required for the successful applicant.
- **Preferred:** Skills that the advertiser/employer mentions the successful applicant would ideally possess.
- **Nice to have:** Skills that the advertiser/employer mentions would be an advantage for the successful applicant to possess.

A simple weighted analysis was used whereby the elements were prioritised and given a numerical weighting (or judgement) as shown in table 1.

**Table 1: Category Weightings**

Category	Numerical Weighting
Must Have	3
Preferred	2
Nice to have	1

Even though this paper is mainly interested in the results for the Linux, Microsoft and Unix operating systems, there are other technologies that were also observed to appear frequently in these job advertisements. These are also included in the results to give the reader a better sense of where Linux is placed. The technologies chosen for this paper are: Linux, Unix, Microsoft, Cisco, Citrix, Novell, Other. “Other” refers to the situations where the technology was not specified in the advertisement or when the technology mentioned was not one of the ones of interest such as those relating to cellular networks and VoIP etc which were comparatively few.

##### 4.2 Job Advertisement Observations:

There was a reasonably clear distinction between Unix and Linux in the job advertisements as usually the Solaris operating system was coupled with Unix. There is a possibility that Linux was not mentioned as a ‘nice to have’ when Unix was sought after and vice versa as the two operating systems have strong similarities (Wikipedia 2007). This possibility is ignored in the following results analysis as it is not tangible.

It is also important to note that Microsoft has a wide variety of software products in different job advertisements. For the following results it was decided to combine these into one heading ‘Microsoft’ as the breakdown of specific Microsoft technologies is not necessary to this research which has a focus on Linux.

##### 4.3 Job Advertisement Results:

For the Seek website, jobs relating to networking/telecommunications were under the ‘Information Technology and Telecommunications classification (IT&T)’. There were two sub-categories that found relevant jobs, the results of which are shown in tables 2 and 3.

From these results we can see that the ranking of the technology from the table 2 is: Microsoft (46%), Unix (27%), Linux (16%), Cisco (13%), Citrix (7%), Novell (3%) and the ranking from the table 3 is: Microsoft (53%), Cisco (38%), Citrix (22%), Linux (11%), Unix (8%), Novell (8%).

For the TradeMe website, the main classification was called: ‘Information Technology and Computing’ (IT&C) and there was just one sub-category of interest called ‘Networks & Systems’ which is similar to the one from Seek. These results are shown in table 4 and ranks the technology in the following order: Microsoft (58%), Unix (23%) & Cisco (20%), Linux (14%), Citrix (8%), Novell (5%). (Cisco and Unix were very close and can be considered equal as there were a finite number of advertisements used).

**Table 2: Results from the Seek website for the 'Network & Systems' sub-category**

Date: 27/11/2006 Website: <b>seek.co.nz</b> Search Specifics: classification: IT&T, sub-category: <b>Network &amp; Systems</b> Number of Hits: 305 Total jobs surveyed: 161							
Technology	Microsoft	Unix	Linux	Cisco	Citrix	Novell	Other
Must Have (not-weighted)	66	38	20	20	6	5	0
Recommended (not-weighted)	5	6	5	1	3	0	0
Nice to Have (not-weighted)	3	0	1	1	2	0	25
Not weighted Total (% of total ads)	74 (46%)	44 (27%)	26 (16%)	22 (13%)	11 (7%)	5 (3%)	25 (16%)
Weighted Total	<b>211</b>	<b>126</b>	<b>71</b>	<b>63</b>	<b>26</b>	<b>15</b>	<b>25</b>

**Table 3: Results from the Seek website for the 'Network: Engineer' sub-category**

Date: 27/11/2006 Website: <b>seek.co.nz</b> Search Specifics: classification: IT&C, sub-category: <b>Engineer: Network</b> Number of Hits: 106 Total jobs surveyed: 90							
Technology	Microsoft	Cisco	Citrix	Linux	Unix	Novell	Other
Must Have (not-weighted)	38	23	13	8	6	5	0
Recommended (not-weighted)	6	5	2	0	1	0	0
Nice to Have (not-weighted)	3	6	5	2	0	2	14
Not weighted Total (% of total ads)	47 (53%)	34 (38%)	20 (22%)	10 (11%)	7 (8%)	7 (8%)	14 (16%)
Weighted Total	<b>129</b>	<b>85</b>	<b>48</b>	<b>26</b>	<b>20</b>	<b>17</b>	<b>14</b>

**Table 4: Results from the TradeMe website for the 'Network: Engineer' sub-category**

Date: 27/11/2006 Website: <b>trademe.co.nz</b> Search Specifics: classification: IT&T, sub-category: <b>Network &amp; Systems</b> Number of Hits: Total jobs surveyed:							
Technology	Microsoft	Unix	Cisco	Linux	Citrix	Novell	Other
Must Have (not-weighted)	62	25	22	14	7	6	0
Recommended (not-weighted)	5	1	2	1	2	0	0
Nice to Have (not-weighted)	2	1	0	1	0	0	19
Not weighted Total (% of total ads)	69 (58%)	27 (23%)	24 (20%)	16 (14%)	9 (8%)	6 (5%)	19 (16%)
Weighted Total	<b>198</b>	<b>78</b>	<b>70</b>	<b>45</b>	<b>25</b>	<b>18</b>	<b>19</b>

#### 4.4 Job Advertisement Results Analysis:

For the Seek website there were two sub-categories that displayed networking jobs. They appeared to retrieve different job advertisements though the actual job-types appear to be quite similar.

Of these two sub-categories there were many more hits for the 'Network & Systems' subclass. They both show

that Microsoft has the most demand, Cisco has a medium demand and Novell has the lowest demand. Also Linux stayed fairly consistently at an average of 12.3% of the total sites. It is noted that the demand for Unix varies quite significantly falling below Linux in the 'Engineer: Network' sub-category but in second place for the 'Networks & Systems' subclass. The job

**Table 5: Combined Results for the Seek website for both sub-categories**

Technology	Microsoft	Cisco	Unix	Linux	Citrix	Novell	Other
Weighted Total:	340	148	146	97	74	32	39

**Table 6: Combined Results for the Seek and TradeMe websites for the ‘Network & Systems’ sub-category**

Technology	Microsoft	Unix	Cisco	Linux	Citrix	Novell	Other
Weighted Total:	538	224	218	142	99	50	58

positions for both Seek sub-categories were similar, so it is reasonable to combine them as done in table 5.

These results indicate that the technologies are ranked in the following order: Microsoft, Cisco & Unix, Linux, Citrix, Novell.

It is observed that the results from TradeMe have the same ranking as the combined results from the Seek website (table 5). Another valuable comparison would be to combine the same sub-category (Networks & Systems) from the two different websites which seem to agree in the most part except that Cisco was notably lower in the Seek results and Linux was higher in the Seek results. Table 6 presents the second combined results and indicates that technology is ranked in this order: Microsoft, Cisco & Unix, Linux, Citrix, Novell.

#### 4.5 Job Advertisement Results Summary

The combined results of both the Seek sub-categories, the combined results of TradeMe and Seek for the ‘Network & Systems’ subcategory and the results for TradeMe, all agreed on the following ranking of the technology demand: Microsoft, Unix & Cisco, Linux, Citrix, Novell.

All results indicate that Microsoft had the most demand. All results indicate Novell has the lowest demand. All results (with one exception) indicate Citrix had the second lowest demand.

Cisco and Unix are fairly close in the majority of cases, consistently followed by Linux. In relation to this paper we can conclude that there is some demand for Linux skills and knowledge for networking jobs in New Zealand, though this demand falls below the Microsoft and Unix operating systems. This is consistent with the global industry trends described earlier.

#### 5 What about Unix?

Based on the current market and job advertisement results above, it would be fair to say that Unix would also be a useful operating system to use in teaching (after Microsoft). The author is not intending to deter anyone from doing so, but this paper is drawing attention to the validity of including Linux components as an option for teaching networking concepts and the different skills that can and are taught. It should also be noted that Linux is Unix-like (Wikipedia 2007) so skills developed in one technology will be highly useful when learning the other. They are both quite different from Microsoft Windows giving students an

alternative view of how networking can be done. Also, as indicated previously it is observed (Economides and Evangelos 2005) that Microsoft and Linux are the operating systems that appear to be gaining market share whereas Unix seems to be fairly stable if not slightly declining, though the future is notoriously hard to predict!

#### 6 Linux networking taught in NZ ITPS

To determine which Linux networking services are taught in ITPs around New Zealand an email survey was sent in February 2007 of which 9 institutes responded. This is 47% of the total number of ITPs in NZ. Respondents were from both the North and South islands.

##### 6.1 Survey methodology and results

In the survey a list of networking services were provided (table 7 and 8) and it was queried as to whether or not the service was taught using Linux and if so in which course/subject-area it was taught in. Respondents were also able to note down any other Linux networking service(s) they teach but was not on the list. The level of complexity to which each service is taught was not surveyed as we were only interested in whether the component is present in the course for this research. If the respondent indicated that the service was only briefly mentioned then it was not included in the results. Tables 7 and 8 show the survey results.

**Table 7: Percentages of surveyed institutes that teach particular network service using Linux in any course**

Linux Networking Service	%
Telnet or SSH	89
Samba Share	78
DHCP	67
DNS	67
CUPS	56
Routing	56
Any Linux firewall application	33
VPN	33
LDAP	33
iptables as a firewall	22
Imap	11
nmap tool	0

**Table 8: Percentages of surveyed institutes that teach particular network service using Linux across different subject areas**

Linux Networking Service	% Teach in Networking	% Teach in Operating Systems	% Teach in Systems Administration	% Teach in Web Development	% Teach in Programming	% Do not teach
Telnet or SSH	22	44	11	0	13	11
Samba Share	33	33	11	0	0	22
DHCP	44	11	11	0	0	33
DNS	33	11	22	0	0	33
CUPS	11	33	11	0	0	44
Routing	56	0	0	0	0	44
Any Linux firewall application	22	0	0	11	0	78
VPN	22	11	0	0	0	67
LDAP	33	0	0	0	0	67
Iptables as a firewall	11	0	0	11	0	89
Imap	11	0	0	0	0	89
Nmap tool	0	0	0	0	0	100

## 6.2 Survey analysis

The results indicated that five out of the nine (56%) institutes that responded teach at least half of the Linux networking services surveyed with four (44%) teaching less than half of the networking services using Linux.

We can observe that the Telnet/SSH and Samba Share services are the most commonly taught services and the DNS and DHCP services are also widely taught. The nmap tool was not taught using Linux.

Most of the Linux networking services are taught in networking papers with many in operating system papers as well. They are also taught in system administration, programming and web development papers to a smaller extent. There didn't appear to be any other subject areas (e.g. databases, e-commerce etc) that they are taught in.

There were also other Linux networking services that were said to be taught such as; Wireless LANs, Network and Port Address Translation, VoIP and SNMP though there was not much commonality for these services across the institutes.

Due to the fact that the number of institutes that responded to the survey is 47% of the total in NZ, it is not feasible to extrapolate these findings to all institutes, as each is quite unique. In other words there is a possibility that the results may be different had there been more respondents. However there are enough results to give us a reasonable idea of type of Linux services that are taught and subject areas in which they are taught. One concrete conclusion that can be made is that there are some NZ ITPs (42% of those surveyed) that teach less than half the services investigated using Linux.

## 7 Summary and Conclusions

The literature indicates that Microsoft and Unix are considered leaders in the global server operating systems market and Linux is considered the third major player with observed and forecasted growth. The results of the job advertisement analysis are consistent

with these trends and indicate that there are a significant number of employers looking for Linux networking skills in this field. As a result of this first part of the research we can conclude that it would be beneficial for students if educators include Linux networking services along side Microsoft, Cisco and Unix so that technology used in teaching reflect those in industry and the job market.

The last part of the paper discovered that Linux networking services are taught to a varying degree in the NZ ITPs surveyed. There are some NZ ITPs that teach less than 50% of the services surveyed using Linux. The results relating to the common Linux services taught and the courses they are taught in provide a good direction for those who may wish to include more Linux networking services in their teaching.

## 8 Glossary

SSH	Secure Shell
DNS	Domain Name Server
DHCP	Dynamic Host Configuration Protocol
CUPS	Common Unix Printing Services
VPN	Virtual Private Network
LDAP	Lightweight Directory Access Protocol
LAN	Local Area Network
VoIP	Voice over IP
SNMP	Simple Network Management Protocol
ITPs	Institutes of Technology and Polytechnics

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