A review of research on enterprise networks in New Zealand

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Abstract

This paper contains a literature review of the research in the field of enterprise networks in New Zealand published since 2000. These research papers are categorized both by research method used and by domain area within the field of enterprise networks. Articles were gleaned from conference papers, journal articles and online publications, 65% of which were peer-reviewed. Enterprise Network research in the domains of network security and infrastructure is being conducted, in the main, within Universities and Polytechnics. Many of the papers reviewed, although having their focus in certain aspects of enterprise networking, also had an educational aspect to them. In addition the surveys, pilot schemes and trials were conducted on or by their academic peers or students either being involved as research assistants or as sample groups. This may be a reason why most of the research methods in papers explored appeared to be qualitative, where academic practice has often favoured grounded theories and case studies, especially for those new to research.

Keywords

Literature review, research methods, enterprise networks

1. Introduction

Exploration of Enterprise Networks is a strong research area in New Zealand, especially within institutions of higher education. In this literature review 40 articles gleaned from conference papers, journal articles and online publications, 65% of which were peer-reviewed. Searching techniques to source these articles are first described within the research methods section. This is followed by a discussion on the scope of enterprise Network research in New Zealand and an evaluation of this research according to research type.

2. Research Defined

The New Zealand Qualifications Authority (1998, p.3) states that: "Research is an intellectually controlled investigation which leads to advances in knowledge through the

discovery and codification of new information or the development of further understanding about existing information and practice"; Bouma (2000, p.12) maintains that "the research process is a disciplined process for answering questions". For the purposes of this literature review these definitions apply to the articles classified.

Qualitative Research Defined

Dey (1993) suggests that "Qualitative" research is focused on finding worth and "Quantitative" research is focused on statistics / percentile data gathering to look at more of a "where we are now". Qualitative research is focused more on finding relevance and quantitative research on adopting a rigorous approach. Qualitative research has been described in many ways (Bouma, 2000, p.19; Cresswell, 2003; Zikmund, 2000). However the description chosen for this paper is: (i) Empirical research in which the researcher explores relationships using textual, rather than quantitative data; (ii) Case study, observation, and ethnography are considered forms of qualitative research; and (iii) results are not usually considered generalisable, but are often transferable.

Quantitaive Research Defined

Similarly quantitative research has been described in many ways. For the purposes of this paper, quantitative research is described as exploring precise relationships with numerical data in controlled conditions. Usually quantitative research results can be generalized.

2.1 Scope, Limitations and Searching Techniques

Forty articles for this literature review were sourced within a four-week period from 7/2/2005 - 5/3/2005. The enterprise network knowledge and skill base of the authors was also a limiting factor. The scope of the field was restricted to Enterprise Network being conducted within New Zealand published both nationally and internationally.

The methodology employed in gaining the forty references involved using electronic databases, journals, white papers, published books, conference proceedings, magazines, online library catalogues and search engines on the Internet such as Google Scholar (www.scholar.google.com). Specialist knowledge and skills of individual authors was employed to advantage in gathering the articles.

Within the scope of the 40 articles gathered for this study, most of the research in Enterprise Networks was being conducted in academia in New Zealand.

3. Enterprise Networks Defined

Gutierrez (2001, p.3) defines an enterprise network as "a super network that interconnects all of an organizations networks (LANs and WANs), regardless of whether it crosses state, national, or international boundaries". Such a broad definition implies that exploration in Enterprise Networks includes research into planning, problem solving, transmission, applications, topology, protocols, security, communication and education.

Enterprise networks have also been described in the following manner: "A network for a large business enterprise. This kind of network may comprise a number of local area networks which have to interface with each other as well as a central database management system and many client workstations. The design and management of an enterprise network can be very complex" (computeruser.com, 2005). This definition encompasses the complexities of Enterprise Networks particularly for design and management.

A third definition for enterprise networks first defines the meaning of enterprise as a large corporate network that spans multiple sites nationwide and possibly worldwide. In this definition a working model of 1000 to 15,000+ users is considered and includes local area network, wide area network, and remote LAN access connectivity (networkcomputing.com, 2005). In this definition interactions with the both wide area

networks and remote LAN access are considered.

## 3.1 Enterprise Networks in Education

The research in these areas contributed 10/40 of the articles reviewed. Two thirds of the papers reviewed were written by academics and only one third originated from industry (Figure 1). Because three of the authors are also academics it is likely that this has influenced the final selection of papers for this literature review.
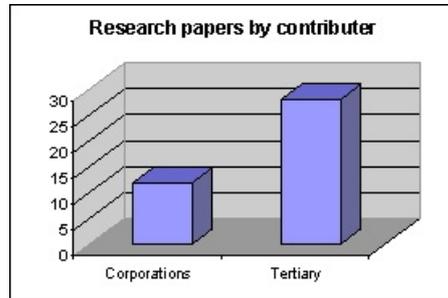
Figure 1. Research papers by contributor

A search on Google Scholar resulted in similar percentages of research papers from academic institutions from around the world. This may be due in part to the filtering methods that Google Scholar employs which favour peer-reviewed papers. Many of the papers critiqued, whilst focusing on the domain of Enterprise Networking, also had an educational aspect to them. The educational papers also used surveys, pilot schemes and trials conducted on or by academic peers or students either as research assistants or as sample groups. In this sample of 40 papers these educationally-based papers were also found to use case studies as a methodology with a small sample size.

The most common data gathering method appeared to be by conducting surveys, in either a quantitative or mixed based methodology.
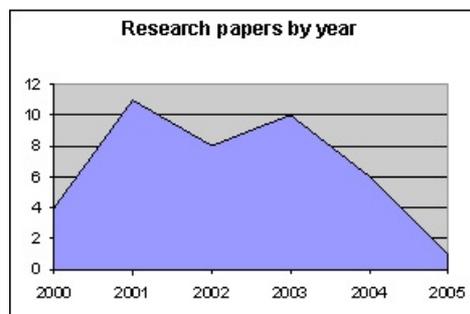
Figure 2. Research papers by year

An analysis of the 40 papers by year showed that more 2001 papers were found (Figure 2) in this sample of papers gathered between 2000 and 2005 (there was only one paper published in 2005). The trend does appear to indicate less research papers being produced in recent years, and the six 2004 papers cover a wide range of topics - with two in the ever popular network security area. With a sample size so small and in a highly specialised area it is important to treat the results with caution. Comparisons with trends worldwide would add validity to these findings.

A comparison between Google, Google Scholar and Google New Zealand indicates that the comparative figures appear to be aligned internationally, academically, and within New Zealand. Although these "results" will list many unrelated sites, it does indicate that New Zealand researchers in the domain of Enterprise Networks are as active as their international colleagues.

Table 1. Search hits for Enterprise Networks

Keywords	Google	Google Scholar	Google NZ only
Enterprise, Networks, quantitative	371,000	10,300	596
Enterprise, Networks, qualitative	334,000	11,400	625
Enterprise, Networks, education, research	6,130,000	18,400	54,400

Many of the papers reviewed mentioned in their conclusions that the research was either on-going or had sparked interest in related fields. It was also apparent that expertise in the various subject areas is concentrated at particular academic institutions. For example many of the papers on network security originate from Unitec New Zealand.

The various research methods, their appropriateness by discipline, subject, sub grouping and application can be confusing. The majority of articles critiqued for this literature review fall within the influence of critical theory and positivism (Niglas, 2004). Twenty out of 40 articles utilized either a quantitative or a mixed-method approach.

4. Review Strategy

In order to conduct this literature review within the limitations described above, a disciplined process for collecting articles was established for the authors. Boundary setting for this review included: establishing Enterprise Network scope; and clarifying the different approaches adopted in conducting research in this arena. Definitions for qualitative and quantitative research were adopted to categorize the articles collected according to qualitative and quantitative research types.

Finer distinctions for both quantitative and qualitative research were made within each category.

Scientific method and quantitative research

Scientific research is generally deductive and research in which the researcher tests hypotheses and theory with numerical data. Scientific research therefore is considered quantitative. It is also tightly focused, conducted within controlled conditions and objective. Data gathered is based on precise measurement using clearly defined collection instruments (Bouma, 2000). A scientific mindset underpins much of the research that is conducted in enterprise networks and as such is not described explicitly when scientific research is reported. This makes it difficult for such research to be analysed when a literature review is conducted.

Qualitative Research

Whilst scientific research is tightly defined, narrowly-focused and precisely measured, qualitative research is more fluid, based on particular situations and conducted within social settings. The unit of measurement is not 'a variable to measured' but rather a person, group of people, department or whole organization considered within a particular environment and usually from one or more points of view. A wider focus is adopted, the research is exploratory and patterns are sought from the rich data gathered. Whilst statistically or scientifically precise reports are produced for quantitative research, qualitative research reports are contextualized, socially constructed and interpretative.

4.1 Research Method Analysis

On the first pass of the articles gathered using the research type criteria contained in Table 1 it was discovered that 18/40 articles could be classified as qualitative research, 14/40 as quantitative research and 8/40 as mixed methods (Table 2).

Table 2. Qualitative and quantitative methods distribution

Research Method	Frequency
Qualitative	18
Quantitative	14
Mixed Qualitative & Qualitative	8

4.1.1 Analysis of research methods sub-groups

When the finer distinctions as indicated in Table 2 were employed the breakdown then became as shown in Table 3. It is interesting to note that case studies and conceptual modeling account for 9/13 purely qualitative research methods employed by researchers in enterprise networks. 8/12 purely quantitative research studies were experimentation, design or testing. The most common method utilized to triangulate studies was by conducting a survey (9/40). Most of the research conducted used a single method, either qualitative or quantitative (32/40). The only methods used to triangulate studies were surveys and action research. Pilot studies were used in both qualitative and quantitative research as were observations.

Table 3. Analysis of research methods

Sub-group	Qualitative	Quantitative	Mixed	Total
Case Study	5			5
Conceptual Model	4			4
Evaluative	2			2
Comparative	1			1
Reflective Analysis	1			1
Practical Experimentation		3		3
Scientific Experiment		2		2
Standard Test		1		1
Prior Knowledge		1		1
Scientific Design		1		1
Survey		4	5	9
Action Research	2		3	5
Pilot Study	2	1		3
Observations	1	1		2
TOTAL	18	14	8	40

4.1.2 Enterprise network categories

Articles in this literature review on Enterprise Networks included research in the following areas (Figure 2): nine papers on network security; nine papers on network infrastructure; 4 papers on data communication; three papers on networking; three papers on network performance; 3 papers on application development; two papers on wireless networking; and two papers on network planning. The remaining four papers covered the areas: problem solving; network processing; IS management and education.

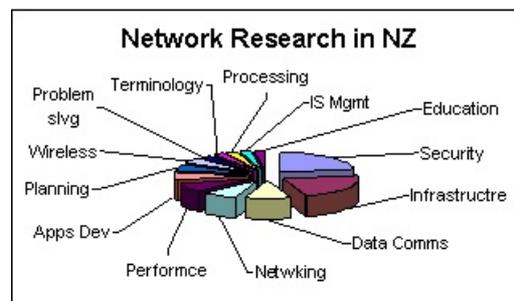### 4.1.3 Research methods in enterprise networks

It can be seen from Table 3 that there is a spread of research methods being utilized in Enterprise Networks in New Zealand. Some research methods (case study, pilot study, observation) can be considered as a 'snapshot in time'. Ten of the articles reviewed adopted this approach. It is interesting to note that only three articles were considered to be experimentation. Nine articles indicated some level of reflection within the research method (action research, reflective practice, evaluation, comparison). Five articles were categorized as design or conceptual modeling. Only one article was based solely on prior knowledge. In a research domain like Enterprise Networking it would seem to be important that more emphasis be placed on design and experimentation. This was note evident from this collection of forty research articles.

This should be kept in the context that as a country there are only 4 million people, where in the period of 2000 to 2005 the University of Canterbury shows that there were 44 computing honours students reports published (Canterbury, 2005). It appears that this one institution is establishing itself as an Enterprise Network research centre in New Zealand.

It is also interesting to see that people involved in research in New Zealand are collaborating with international researchers that are a good indicator of quality for research in New Zealand.

5. Discussion

Research is spread across the many topic areas within Enterprise Networking in New Zealand. Network security and network infrastructure were the two most common research areas within this domain followed by data communications and research labeled as 'networking'. Other research areas include network performance, application development, network planning, wireless networks, network problem solving, network terminology, network processing, network management and network education (Figure 3).

Figure 3. Network research in New Zealand

6. Conclusion

It can be seen that qualitative research appears to be the predominant research method used in the Enterprise Network area for this sample of 40 papers. Surveys were the most common form of data gathering, particularly for mixed methods. Experimentation and pilot surveys also appeared as significant methods used and may be influenced by the majority of research papers coming from the University or Polytechnic arenas.

Whilst academic research provides many new questions to existing practice, academic research also answers and develops solutions to some of those questions. With the National Advisory Committee on Computing Qualification's (NACCQ) involvement in Enterprise Networking research both academia (particularly in the polytechnic sector)and the ICT industry gain an understanding of the issues being researched within this domain.

It would be interesting to compare New Zealand findings with both Australian and international research conducted in the same area and over the same time period to develop a comparative study for trends, directions and concentration of research topic.

It appears evident that if Enterprise Networks research can generate measurable economic and social benefits for New Zealand, then this type of research can provide new solutions and recommendations for the New Zealand marketplace (FRST, 2004)

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