Development of Open Carrier Grade-Based Platforms

By

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A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfillment of the requirements for the degree of

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ABSTRACT

The development of open Carrier Grade-Based Platforms (CGBPs) is an emerging phenomenon where the specification for the platform is defined by a consortium of Network Equipment Providers (NEPs), and third party telecommunications components suppliers, and the platform is developed internally by NEPs. Since the specification for the entire platform is open, it fosters an environment for platform development integrating off the shelf component and free open source software building blocks.

This research uses three perspectives to examine the development of open CGBPs: ecosystems (Moore, 2005), platform development (Krishnan & Gupta, 2001) and technological infrastructure (Weiss & Birnbaum, 1989). The research provides a model that captures company motivation for participating in the development of open CGBPs, company behaviour, engagement dynamics, and outcomes from participation and propositions anchored around the model.

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AdvancedTCA – Advanced Telecom Computing Architecture

AIS – Application Interface Specification

API – Application Programming Interface

BSD – Berkeley Software Distribution

CGBP – Carrier Grade Base Platform

CGL – Carrier Grade Linux

COTS – Commercial Off The Shelf

CP-TA – Communications Platforms Trade Association

QoE – Quality-of-Experience

FOSS – Free Open Source Software

GPL – General Public License

HPI – Hardware Platform Interface

IMS – Internet Protocol (IP) Multimedia Subsystem

IP – Intellectual Property

LGPL – GNU Lesser General Public License

MVA – Mountain View Alliance

NEPs – Network Equipment Providers

OSDL – Open Source Development Lab

R&D – Research and Development

RFP – Request For Proposal

SA Forum – Service Availability Forum

TDM – Time Division Multiplexing

TMT	–	Top Management Team
VSE	–	Versatile Service Engine

1 INTRODUCTION

The objective of this research is to examine the changes in roles, foundation, and leadership of companies when moving from proprietary platform development to an open carrier grade-based platform (open CGBP) development.

Open CGBP development refers to developing company specific carrier grade-based platforms employing COTS/FOSS[1] components and modular architecture while conforming to externally defined and widely accepted specifications in the telecommunications industry. Open CGBPs enable Network Equipment Providers (NEPs) to develop product and services satisfying the availability, scalability, manageability, and service response requirements of the telecommunications industry (SCOPE Initiative, 2006). Open CGBP is an emerging development area and it is in the infancy stage.

An example of an externally defined and widely accepted specification is AdvancedTCA (Advanced Telecommunications Computing Architecture). AdvancedTCA is an industry standard series of specifications for next-generation telecommunications network infrastructure equipment. An example of a company specific platform built conforming to

[1] COTS stands for Commercial Off The Shelf, which are commercially available hardware/software components that are integrated within third party products (Torchiano & Morisio, 2004). FOSS stands for Free Open Source Software, which are products released under an open source license (Alam, 2006).

an open carrier grade-based specification is Nortel's AdvancedTCA compliant VSE (Versatile Service Engine) platform.

Figure 1 illustrates the difference when moving from developing proprietary platforms to developing open CGBPs. In a proprietary platform, the company is solely responsible for designing all aspects of the platform specification and also for developing the platform. However, for an open CGBP, the keystone of the open CGBP ecosystem is responsible for the specification of the platform and the platform is built by the company. The keystone in an ecosystem acts as the hub in the network of companies and provides strategies that shape and coordinate the ecosystem (Iansiti & Levien, 2004). The SCOPE Alliance, which is an industry alliance formed by leading NEPs to accelerate the deployment of open CGBPs, acts as the keystone responsible for the health of the open CGBP. The SCOPE Alliance has a sponsor dominated hierarchical governing structure compared to merit dominated governing structures that commonly exist in open source communities (SCOPE Initiative, 2006).

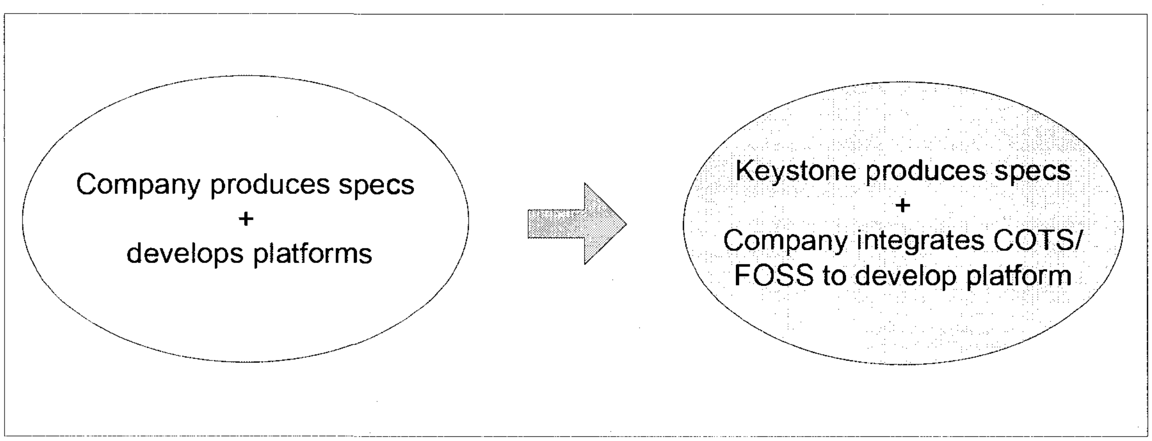

Figure 1: Developing proprietary platforms vs. developing open CGBPs

As illustrated in Figure 2, each NEP that is part of the ecosystem develops its own company specific platform in accordance to the open specification. Since all aspects of the specifications are open, NEPs utilize COTS/FOSS components in building their platforms.

AdvancedTCA is an example of an open specification ratified by the SCOPE Alliance and the VSE is a Nortel Networks' implementation of AdvancedTCA.

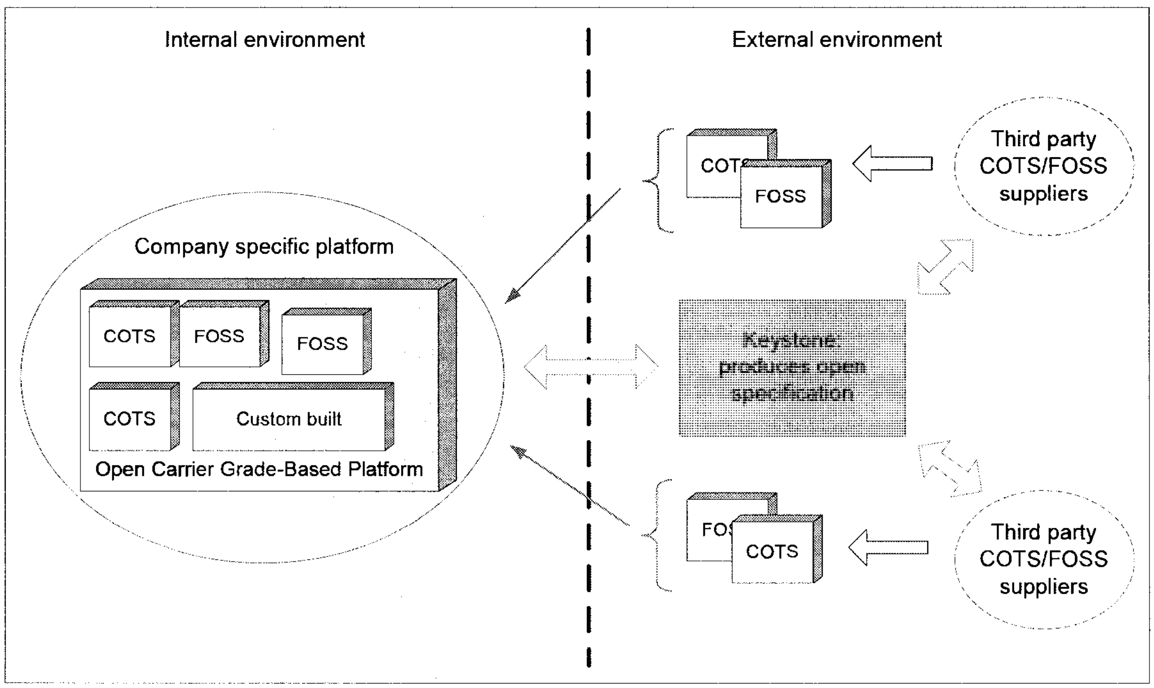

Figure 2: Development of an open CGBP

1.1 Deliverables

This research delivers two outcomes:

1. A model and propositions on the effects of open CGBPs on NEPs, third party COTS/FOSS suppliers, and service providers
2. Factors that contribute to the growth of the ecosystem anchored around open CGBPs

1.2 Relevance

This research is of interest to at least four groups. First, the top management teams of NEPs would be interested in the results of this thesis to understand the external and internal changes that occur when moving from proprietary platform development to open CGBP development. The product development managers of NEPs would be interested in understanding the importance of customer knowledge, application level development, and integration knowledge when moving to an open CGBP development.

Second, the service providers may be interested in their new role in the design of open CGBPs.

Third, the COTS and FOSS suppliers may be interested in their new role as valuable complementors in an open CGBP ecosystem as opposed to being mere suppliers.

Finally, academics will be interested in this research because it links open CGBPs with ecosystems. This thesis illustrates that open CGBP development is a new unique concept with significantly different characteristics from proprietary platform developments.

1.3 Contribution

This research contributes to the management literature in two ways:

First, this research advances our knowledge about ecosystems anchored around open CGBPs:

- This research identifies the changes in roles, foundation, and leadership that occur when moving from proprietary platform development to open CGBP development
- This research also identifies differences between developing open CGBPs and developing proprietary platforms

Second, this research incorporates the business-customer environment into platform development. To date, research on platforms has focused on engineering aspects. This thesis focuses on how internal and external elements interact with platform development.

1.4 Organization

This document is organized into six chapters. Chapter 1 is the introduction. Chapter 2 reviews the current literature. Chapter 3 illustrates the research method. Chapter 4 outlines the results of the research. Chapter 5 provides a discussion of the results. Chapter 6 provides conclusions, limitations, and suggestions for further research.

2 LITERATURE REVIEW

In the telecommunications industry, Network Equipment Providers (NEPs) supplying telecommunications equipment to service providers are under increasing pressure to deliver innovative solutions to meet service providers' demand for new services, quick response times, and the reduction in both capital and operating costs (SCOPE Initiative, 2006). Developing products utilizing open CGBPs built on open specification such as AdvancedTCA is an appealing alternative to NEPs since it helps reduce R&D investments and enables NEPs to focus on value-add products and service on top of these open CGBPs (Chacron, Bihan, Dupuy, & Bihan, 2005).

The literature review is divided into seven subsections. Section 2.1 reviews the literature on COTS/FOSS integration. Section 2.2 outlines the benefits and risks of COTS/FOSS integration, and how companies are coping with the risks. Section 2.3 reviews the literature on platforms. Section 2.4 provides a review of the literature on business ecosystems. Section 2.5 reviews the literature on open standards. Section 2.6 reviews open standards in the telecommunications industry. Finally, Section 2.7 provides the lessons learned from the literature review.

2.1 COTS/FOSS integration

Figure 3 illustrates the classical approach to COTS/FOSS integration: third party components, whether COTS or FOSS, are integrated into a product on an individual basis. The norm has been that third party components are integrated into projects based on that particular component's specifications and adherence to an individual standard.

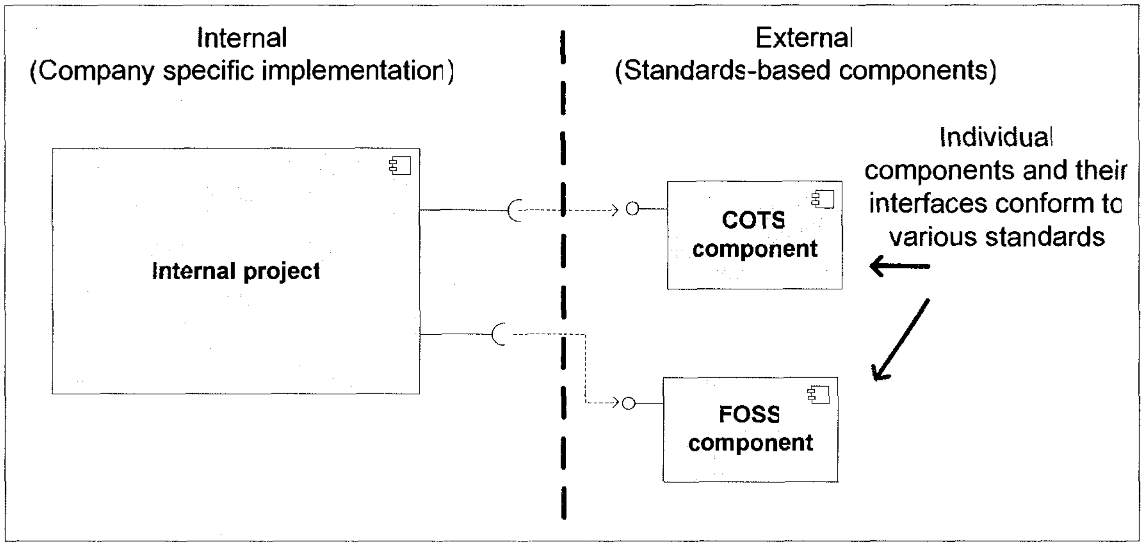

Figure 3: Individual-centric COTS/FOSS integration

Reliance on third party components such as COTS and FOSS is also dictated by the size and complexity of the project as well as the reliability of available third party components. In today's fast evolving industries, creating entire systems from scratch is no longer feasible especially given short product development schedules (Jandourek, 1996).

Primary benefits from adopting COTS and FOSS components include reduced time-to-market, decrease in development efforts, and tighter focus resulting in innovative solutions (Merilinna & Matinlassi, 2006; Li, Conradi, Slyngstad, Bunse, Torchiano, & Morisio, 2006; Keil & Tiwana, 2005). However, these benefits do not come free of risks. An integrator must be aware of upgrade management issues with third party components, the need for independent testing, Quality of Service (QoS) requirements, and any vendor lock-in issues if third party components do not adhere to any open standard (Serrano, Calzada, Sarriegui, & Ciordia, 2004; Gill, Kuhns, Levine, Schmidt, Doerr, Schantz, & Atlas, 1999).

Adoption of COTS and open source components has been in existence for several years and few studies have analyzed benefits and risks of COTS/FOSS integration. The literature also reveals approaches that companies have taken to mitigate these risks such as employing middleware services to address upgrade management issues (Minkiewicz, 2004).

2.1.1 Development and integration of COTS

Products that rely on COTS integration have been developed for over 30 years (Keil & Tiwana, 2005). Today many development projects rely extensively on COTS components. Studies show that COTS software purchases represent about 70 percent of corporate software expenditures (Keil & Tiwana, 2005). Further, a recent estimate shows that about US $200 billion is spent yearly on COTS software applications worldwide (Keil & Tiwana, 2005). The adoption of COTS has become an economic necessity in many cases because it shortens implementation timeline and reduces the unpredictability associated with building custom applications (Warboys, Snowdon, Greenwood, Seet, Robertson, Morrison, Balasubramaniam, Kirby, & Mickan, 2005).

People mean different things when defining COTS (Minkiewicz, 2004). This research adopts and extends the definition provided by Torchiano & Morisio (2004) as follows:

A COTS product is a software or hardware component that is not developed in the project; rather, it is acquired from a vendor and used as-is or with minor modifications.

Systems built with COTS/FOSS components can be organized into (Torchiano, 2001):

1. **Turnkey systems** – these are systems built around a commercial product such as Microsoft Office or Netscape Navigator. However, only one COTS is utilized and the final product is dominated by that COTS product.
2. **Intermediate system** – these are also systems built utilizing one COTS (Example MySQL or Oracle), but they also integrate other components in the final product. Here the central COTS dominates the final product but its integration to other components is the key.
3. **Integrated system** – these are systems built around several COTS with all of them given the same level of importance. The key here is the integration and that the fact the final product is not dominated by any single COTS.

Reliance on COTS components brings a new dimension to the product development process. In the traditional product development process, product requirements and user needs drive the evolution of the final solution. In situations where development relies on COTS, the capabilities of the COTS drive product evolution (Stavridou, 1997).

2.1.2 Development and integration of FOSS

FOSS has gained significant attention in recent years as more and more business opportunities and business models are being constructed around open source. The academic community has also kept abreast in studying the motivations behind open source software developments and commercialization practices (Liu, 2006). Many accredit the success of open source development to the vibrant open source community, commercial business model built around open source development, and the unique software development practices employed among open source development communities (Koenig, 2004; Lussier, 2004; Merilinna & Martinlassi, 2006).

Although early studies suggested that open source development makes sense only for stand alone products such as operating system software, the use of FOSS in industrial products is burgeoning (Li et al., 2006). However, despite the rising support for FOSS integration in industrial products, open source software still faces many challenges and constraints. Some of the problems include lack of documentation, testing, and field support (Li et al., 2006).

FOSS components are often used as if they were COTS where projects that employ FOSS do not need to see or modify the source code or there is lack of knowledge, skills or resources to do so (Torchiano & Morisio, 2004).

2.1.2.1 FOSS licensing

Many different types of open source licenses exist. They can be organized into three groups: highly restrictive, restrictive, and unrestrictive (Alam, 2006). Examples of highly restrictive types include the General Public License (GPL), restrictive types include the GNU Lesser General Public License (LGPL), and unrestrictive types include the Berkeley Software Distribution (BSD) license (Alam, 2006).

GPL, being highly restrictive, requires modified software to be redistributed with source code to the open source community. LGPL is normally used to license software libraries, and it provides greater flexibility for proprietary software to link or use software covered under the LGPL license without needing to open source the proprietary code. Finally, BSD, being unrestrictive, only requires retaining copyright notices in the program code, and binds no other provisions. It even allows for redistribution of open source software as proprietary code (Alam, 2006; Pearson, 2000).

2.2 Benefits and risks of COTS/FOSS integration

Both COTS and FOSS components promise faster time-to-market and increased productivity (Li et al., 2006). This section reviews the benefits and risks of integrating COTS/FOSS components.

2.2.1 Benefits

Reduced development time

An integration-centric development uses third party components instead of developing them in-house. Thus, the product development time is reduced (Erdogmus & Vandergraaf, 1999).

Increased productivity

In a system developed integrating COTS/FOSS, development effort is decreased, and thus the productivity increases. Further, early market entry, due to reduction in development time, can lead to improved market capture (Erdogmus & Vandergraaf, 1999).

Tighter focus resulting in innovative solutions

Developing systems by integrating COTS and FOSS components enables firms to focus on addressing the needs of their customers and developing the competence required to do so (Keil & Tiwana, 2005).

2.2.2 Risks

Maintenance and optimization issues

COTS software products undergo a new release every eight to nine months (Basili & Boehm, 2001). FOSS components are also constantly evolving. Thus, providing maintenance for each third party component and optimizing each of them for better performance of the overall system is a daunting task (Warboys et al., 2005). The integrator also runs the risk of newer versions of some components having backward compatibility issues and interoperability issues with other components.

COTS/FOSS adhering to different versions of a standard

When two third party components implement two different versions of the same standard problems may arise due to incompatibility issues and interoperability problems with components (Gill et al., 1999).

Vendor lock-in

COTS that do not adhere to any standard have the potential risk of a vendor lock-in, where the integrator must rely on that particular vendor for maintenance and updates (Li et al., 2006).

Maintenance issue with new versions in FOSS

Unlike a commercial third party component, open source software new releases are not field tested nor are the new versions need to be backward compatible. That means an integrator utilizing FOSS components must be aware of these issues when updating open source components (Kenwood, 2001; Merilinna & Matinlassi, 2006).

Lack of documentation for FOSS components

One of the drawbacks of open source development projects is the lack of proper documentation and support for the developed software (Merilinna & Matinlassi, 2006).

An integrator may run into the risk of lack of documentation and support from an open source project, well after committing significant resources and time.

FOSS may fail to comply with open source licensing terms

Companies need to introduce explicit checks to ensure that FOSS components that are integrated into projects indeed comply with open source licensing terms and conditions; especially since there are a number of approved open source licenses with each having its own restrictions such as the GPL, LGPL, and BSD licenses (Li et al., 2006).

2.2.3 Approaches taken to mitigate risks

Table 1 provides a summary of the practical approaches companies undertake to mitigate the risks associated with COTS/FOSS integration.

Table 1: COTS/FOSS integration risks and approaches taken to address risks

Risks	Approaches taken to address risks
Maintenance and optimization issues	Utilize middleware services
COTS/FOSS adhering to different versions of a standard	Utilize middleware services
Lack of documentation for FOSS components	Referring to bulletin boards, chat logs, mailing lists
Maintenance issue with new versions in FOSS	Freezing the used FOSS version Contribute resources to steer FOSS interface development

Utilizing middleware services

Employment of adaptive real-time middleware is illustrated in the literature as an option to address Quality of Service (QoS) in real-time systems (example: real-time CORBA) (Gill et al., 1999). Utilizing middleware services is also mentioned as the main approach to overcome vertical integration problems (Merilinna & Matinlassi, 2006).

Contribute resources to steer FOSS interface development

For open source components, contributing resources to actively steer the development of the interfaces into a more standardized direction is an option for coping with changing versions of FOSS components (Merilinna & Matinlassi, 2006). However, steering the architecture into any direction may not be an easy task. For example, one needs to be a core member of the open source project to influence the architecture on a FOSS component (Lussier, 2004).

Freezing the used FOSS version

In order to mitigate the instability in the new versions of FOSS components, some companies have frozen the adopted version in their system. For example, some embedded developers are still using Linux kernel version 2.4.2 instead of the newer versions. Although this is may not be the ideal solution, it helps prevent the bugs and fluctuations in the new versions of open source components. It is important to note that unlike a commercial component, FOSS does not get released after all the field tests. They are improved as developers use them on real products. Further freezing the used FOSS version also avoids the ripple effect of frequent releases (Merilinna & Matinlassi, 2006).

Overcoming lack of documentation in FOSS development

The literature does not identify any real solution to overcome the lack of documentation for FOSS. However, identified practices to mitigate this issue include: referring to bulletin boards, chat logs, mailing lists, and the general familiarity with the FOSS component being integrated.

All of the above mitigate some of the problems with COTS/FOSS integration. However, some issues are still unresolved. Studies of COTS/FOSS integration have not provided enough attention to the dynamic environment in which business and user requirements are rapidly changing (Warboys et al., 2005). The ability to develop system management tools to capture the dynamic aspects of COTS/FOSS components is unsolved.

2.3 Platforms and platform-based product development

The concept of platforms and platform based product development has been in existence for quite some time. However, most of the research available in the literature refers to proprietary platforms: platforms that are defined and developed internally within an organization.

2.3.1 Platform-as-a-technological-infrastructure framework

Weiss and Birnbaum (1989) define a platform as a technological infrastructure composed of:

1. A network of relationship among producers, distributors, and users;

2. An underlying dominant design; and
3. The processes and understandings involved in the invention

Figure 1 illustrates Weiss and Birnbaum's (1989) platform definition.

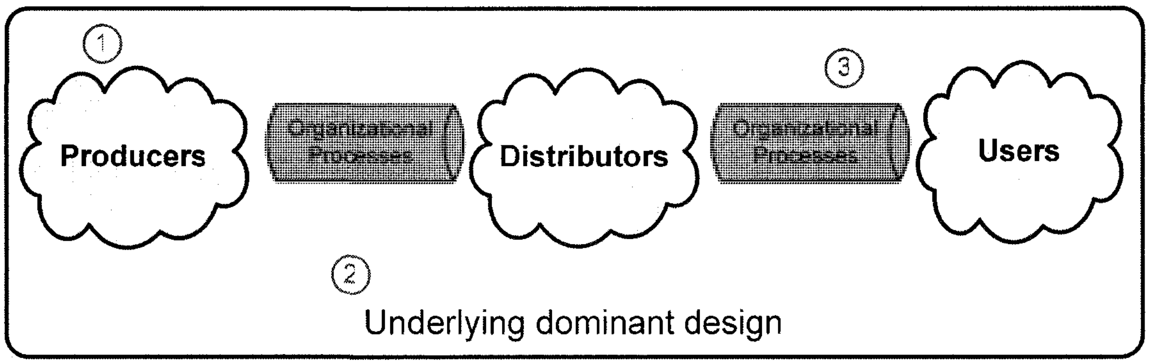

Figure 4: Platform as a technological infrastructure

Platform development is a complex, diffuse process involving a number of different people. It requires inter-organizational cooperation. For example, the customers and manufacturers define the needs for new platform characteristics. Equipment suppliers interact with manufacturers to establish the need for processing equipment to make the platforms. In order to develop platforms, users, their customers, and suppliers must interact in the process of invention.

Secondly, a dominant design provides the norms around which the platform development process is organized. For an internal/proprietary platform, the dominant design would be the agreed-upon architecture among different organizational units involved in the platform development.

Thirdly, the processes and understandings involved in the development of platforms are also important. If one agrees that the platform development is a complex, diffuse process involving a number of different people, then the organizational processes involved in managing the network must also be effective. Well organized development processes are essential for the successful development of platforms.

Weiss and Birnbaum (1989) introduce an effect called institutionalization of the technological infrastructure. This refers to the fact that well defined platform development projects constrain technological changes to a routine, cooperative process within defined boundaries. Institutionalization provides a stable process in which good estimates can be made of the rate and extensiveness of future technological change. However, the negative impact of institutionalization is that it reduces the potential for radical innovations (Weiss & Birnbaum, 1989). This means that an introduction of platform based product development, in particular a well organized and focused platform based product development, nurtures an arena for incremental innovations with predictive characteristics, but constrains radical innovations. For example, technological opportunities that may be valuable but not related closely to the established dominant design are less likely to receive attention and any progress on those opportunities may not be considered (Weiss & Birnbaum, 1989).

2.3.2 Types of platforms

Table 2 summarizes at least three types of platforms that exist today. However, this list is not exhaustive.

Table 2: Types of platforms

Platform type	Description
Internal platforms	These are platforms that are proprietary and internal to a particular firm
Internet based external platforms	Platforms that are fully transparent and open ended and are associated with the Internet infrastructure
Open CGBPs	Platforms with a mixture of both internal and external attributes: the specifications of the platforms are defined externally, but the implementation is company specific

Internet based external platforms

Internet based external platforms are a newly emerging concept associated with the Internet infrastructure (Andreessen, 2007). These platforms are transparent and open ended which means that the specifications are available to the public and anyone can interpret, implement, and deploy software components on the open Internet infrastructure in accordance to these specifications. The Internet, as a network of networks linking millions of computers with distributed software architecture has given rise to these software based external platforms. There are at least three types of these external platforms that can be identified (Andreessen, 2007):

1. Access API based external platforms
2. Plug-in API based external platforms
3. Runtime Environment based external platforms

The Access API based model is the simplest and the most common Internet based external platform available today. This is typically provided in the form of a web services

API (Application Programming Interface). Third party software components interact with the main platform via conforming to a set of well defined open APIs provided by the platform. In the Access API based model, third party components live outside the platform (Andreessen 2007). Examples of this platform include eBay, Paypal, and Google Search API.

The Plug-in API based model is where third parties build end user applications as plug-ins to the core platform. Similar to the Access API based model, here also the third party software components run outside the platform, however, it is more interlinked with the core system. This means unlike the Access API model, in the Plug-in API based model, third party software components would seem as if they are running within the core platform. Examples of Plug-in API model include Adobe Photoshop, and Facebook.com (Andreessen, 2007).

Thirdly the Runtime Environment model is where the third-party application code actually runs inside the platform. The platform provides the environment and functionalities, just like an operating system, to run applications on the network. Examples of this model include Second Life, Salesforce.com, and Ning (Andreessen, 2007).

Open CGBPs

Open CGBPs fall between internal platforms and Internet based external platforms where the specifications of the platforms are defined outside of a company in public standards groups, but the platforms are built internally within companies. The focal point of open CGBPs is that the whole platform is adherence to industry-acknowledged open standards. Since the specifications in open CGBPs are for the entire platform instead of individual components, companies can utilize already built COTS/FOSS building blocks when developing their own company specific platforms. Figure 5 illustrates that an open CGBP enables companies to lever external building blocks while focusing on proprietary value-add products and services which are of high value to their customers.

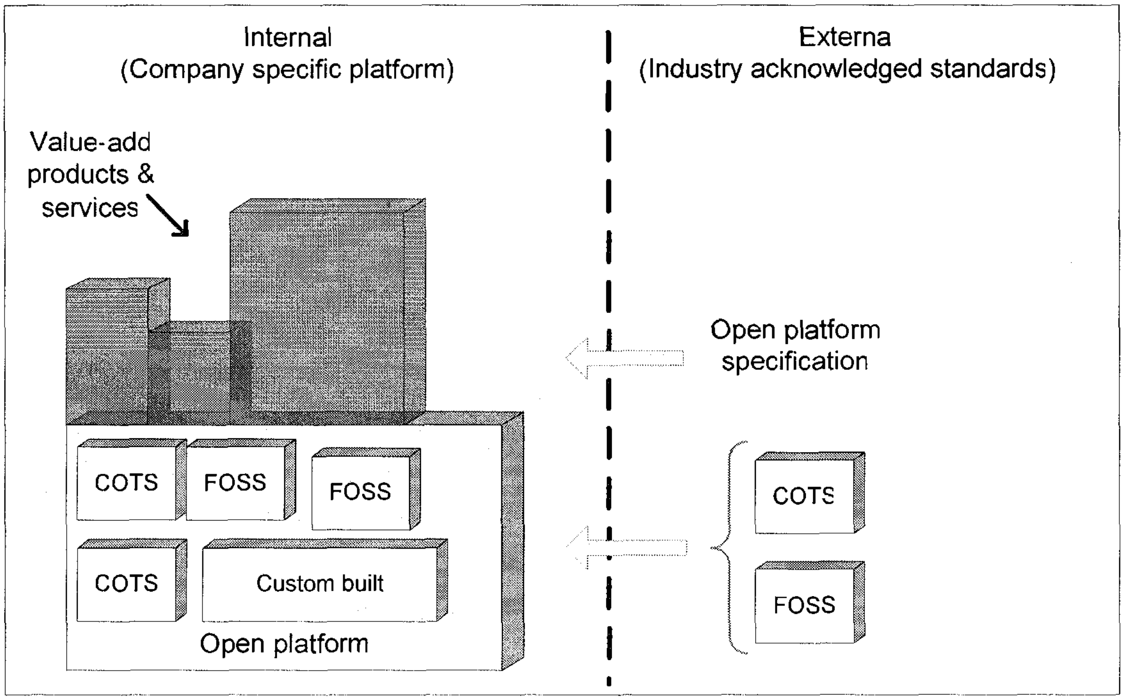

Figure 5: Open CGBP specification and implementation

Table 3 applies Weiss and Birnbaum (1989) platform-as-a-technological-infrastructure to summarize the findings from literature on internal, external, and open CGBPs.

Table 3: Comparison of platforms

	Internal platforms	Internet based external platforms	Open CGBPs
Network of relationships (producers, distributors, users)	Inter-organizational units	General public	Standard bodies, Product developers implementing the standards
Dominant design	Company specific, and internally agreed upon dominant design (Weiss & Birnbaum, 1989)	Three types exist now: API based, plug-in based, and runtime environment (Andreessen, 2007)	Primarily two dominant designs: o One at the platform level o Another at the value added products developed on top
Processes/ understandings	Product development processes	Open, transparent, and Internet based	Specification defined externally, Implementation is company specific
Effect of institutionalization	Restricted to one company and its customers, suppliers, and distributors Does not effect new entrants	All work is restricted within the Internet paradigm (Andreessen, 2007)	Number of company initiatives focused on radical initiatives are restricted within the open CGBP ecosystem

2.3.3 Benefits and risks in platform based product development

The key in a platform based product development approach is the sharing of components, modules and other resources across a range of products (Halman et al., 2003). Halman et al. (2003) identifies three primary aspects of platform development:

1. Modular architecture
2. Interfaces that define the interaction points of the modules
3. The standards (the specifications to which the modules conform)

The literature shows that there are many long-term advantages to developing platforms and platform based products. Some of the benefits include (Halman et al., 2003; Muffatto, 1999; Simpson, Marion, Weck, Holtta-Otto, Kokkolaras, & Shooter, 2006; Krishnan & Gupta, 2001):

- Reduced development and manufacturing costs
- Reduced development time
- Reduced overall complexity - the ability to manage the complexity of providing greater product variety from a platform based product development
- Greater degree of reuse (i.e., more time and effort spent in design and development)
- Better learning across projects that are built on the same platform
- Improved ability to update products
- Increased efficiency in product development and commercialization

Some of the concerns about platform based development include (Halman et al., 2003; Muffatto, 1999; Simpson et al., 2006; Krishnan & Gupta, 2001):

- Platform based development tends to be more strategic and is a long term investment
- Need to renew the platforms time-to-time as customer demands changes
- May result in over design of low-end variant products
- Product planning decisions such as product positioning and introduction sequence are strongly impacted

2.3.4 Platform's effect on product positioning

Krishnan and Gupta (2001) argue that platforms affect product positioning decisions. They argue that in a platform based-product development environment, a company would have different options in constructing the platform to optimally place products on top of it and to garner maximum profits. It is important to understand that the components constituting the platform are to be shared among high-end and low-end products. Platforms may end up being over designed for low-end products, or under designed for high-end products. Depending on market diversity and economies of scale of non-platform based development, a company may or may not employ platform based product development. Table 4 provides a summary of the findings by Krishnan and Gupta (2001).

Table 4: Choices for platform based product development (Krishnan & Gupta, 2001)

Market diversity

Non-platform economies of scale	Low	Medium	High
Low	Standardized product	Product family with or without a platform	Niche product
Medium	Standardized product	**Platform based product family**	Niche product
High	Standardized product	Standardized product	Standardized product

Table 4 indicates that if non platform economies of scale are high, then it would always be wise to offer one standardized product to all market segments. They call this the standardized product approach. Non platform economies of scale may result if the platform based approach leads to wasteful inclusion of non-shared components on the platform (over-design cost). When market diversity is high and non platform economies of scale are low or medium, a firm may choose to only serve the high-end customers with a niche product (single product). Table 4 indicates that Krishnan and Gupta (2001) conclude that only when scale economies are medium or low and when market diversity is also medium, it would be profitable for a company to invest in platform based product development. When market diversity is low, it is optimum for the firm to aggregate consumer segments and offer a standardized product. When market diversity is too high it may not be profitable to share components between two niches, which would leave the firm serving only the high-end consumer market.

2.3.5 Platforms and COTS/FOSS integration

The classical or the individual-centric integration of COTS/FOSS has few shortcomings when it comes to capturing the dynamic aspect of environment changes and third party components. Figure 6 illustrates the long-term difficulties when utilizing COTS/FOSS building blocks in a project such as managing components' evolution, interactivity among components, and changing customer demands (Gill et al., 1999; Warboys et al., 2005). COTS software products undergo a new release every eight to nine months (Baisili & Boehm, 2001). As business requirement and customer needs change, the companies that develop products integrating COTS/FOSS components must be able to cope with the changing demands (Gill et al., 1999). Thus, utilizing long-lived general-purpose COTS/FOSS components creates a challenging problem.

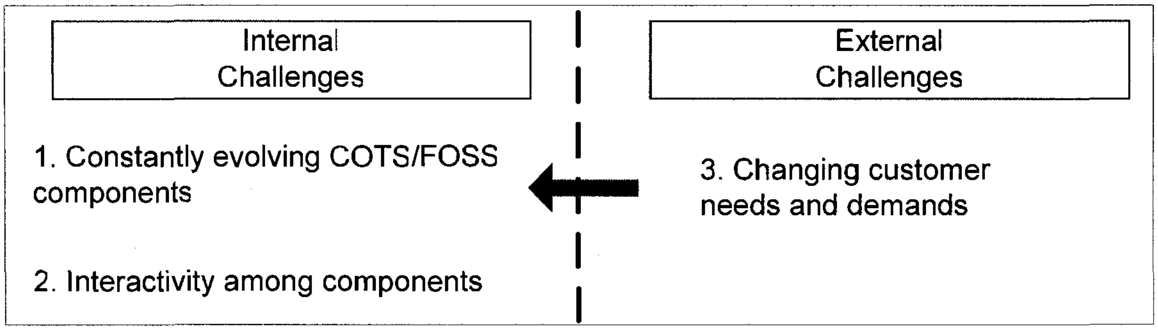

Figure 6: Development difficulties when utilizing COTS/FOSS building blocks

In individual-centric integrations, developers are either disregarding or inadequately dealing with dynamic environment changes (Warboys et al., 2005). However, it must be recognized and exploited and not ignored.

2.4 Literature review on business ecosystems

Problems faced by technology companies in commercialization of their technologies can be categorized into three key areas: managing interdependencies, accelerating adoption, and creating and appropriating value (Bailetti, 2008). Traditionally these key problems have been addressed by studying the economy and economic organizations as markets and hierarchies. Markets facilitate transactions for goods. Hierarchies facilitate control over activities that produce goods (Moore, 2005).

Today continuous innovation and co-evolution of innovation are critical. Individual company's innovations and discoveries must be joined by complementary advances by other firms in order for customers to benefit. These complementary advances or co-evolution of innovation has become a necessity since no single firm has all the skills, specialized knowledge, and managerial resources necessary for the whole system. Moore (2005) argues that a third organizational form, a business ecosystem approach, tackles both coordination of innovation in goods and the activities that produce them as well as the co-evolution of innovation across multiple companies. Ecosystem organizational form enables inter-firm coordination and helps firms align dreams, plans, and product road maps (Bailetti, 2008).

A business ecosystem is defined by James F. Moore (2005) as "an intentional communities of economic actors whose individual business activities share in some large measure the fate of the whole community." It can also be seen as interdependent niches that in turn are occupied by organizations. Figure 7 illustrates the fundamental structure of a business ecosystem.

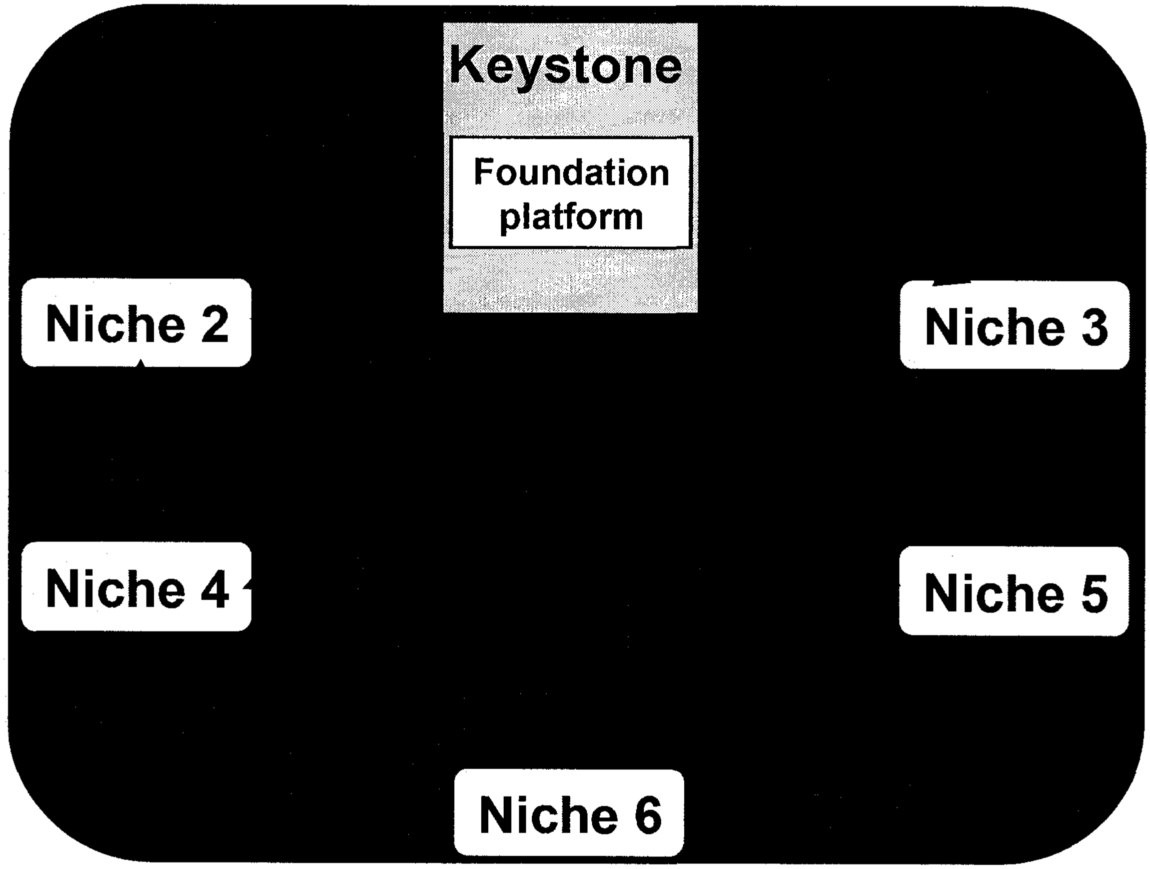

Figure 7: Business ecosystem structure

At its core, a business ecosystem has at least one keystone, a foundation platform, and a network of niches of complementors resulting in a complex adaptive multi-contributor system. The keystone in an ecosystem acts as the hub in the network and keystone strategies shape and coordinate the ecosystem (Iansiti & Levien, 2004). The foundation platform anchors the ecosystem community and provides a broad template to which members of the community can identify potential contributions. The foundation platform consists of: i) technologies; ii) architectures, designs and assets used to build market offers; iii) components, products and services; iv) contracts; and v) processes (Bailetti, 2008). All niches derive value from foundation platform, however, some more than others. As illustrated in Figure 7, a company may be part of one or more niches, or outside all niches (e.g., 'X' in figure).

Companies and individuals share in some large measure the fate of the ecosystem. Over time, members of the ecosystem tend to align their investments with directions set by central companies or keystones. Companies find mutually supportive roles and capabilities and move towards a shared vision. In an ecosystem, companies can also compete by building competitive differentiators utilizing the foundation platform. This leads to creating new niches and opening new markets (Moore, 2005). For example, the Eclipse ecosystem has spun off a multitude of niche markets from its core foundation platform (Smith & Milinkovich, 2007). Various products and services developed on top of the core Eclipse platform ranges from general Integrated Development Environments (IDEs) to geophysical processing and modeling in the oil and gas industry (Kyle, 2007).

2.4.1 Modular architecture

Business ecosystems are built on modularity. A modularized architecture with properly defined and well-documented interfaces provides a clear plan for what sort of firms will provide which element. An ecosystem can be conceived as providing a solution stack - modular contributions building one upon the other.

2.4.2 Business ecosystems and anti-trust laws

Traditional economic theories do not incorporate business ecosystems. There are no conceptual templates from traditional economic theories to detect, inspect, and assess business ecosystems. However, understanding of ecosystems and ecosystem organizational forms are improving (Moore, 2005).

Moore (2005) points out that antitrust law today runs the risk of analyzing ecosystems primarily as markets that have become collusive, rather than hierarchies that have been opened up. Antitrust cases that lack the understanding of this level of inter-firm collaboration towards pro-competitive, innovation-furthering public goods may inadvertently impair business ecosystems. It is debatable whether or not existing anti-competitive concepts such as excessive market power and abuse of power can be applied to business ecosystems or whether new models of power and abuse need to be drafted. This stems from a greater degree of variance in ecosystem organizational forms compared to traditional market and hierarchical organizational forms. For example, in an ecosystem, power can be defined at three levels: in spaces, in ecosystem leadership (keystone), and/or in particular niche markets. A company can have 100% share in a niche market within an ecosystem and may have the power to overcharge customers or drive out competitors; yet, it may only have a small share in its industry as conventionally defined (Moore, 2005).

2.5 Literature review on standards

2.5.1 Standards defined

There are many different standards that exist (Baskin, Krechmer, & Sherif, 1998). Standards in general represent a set of common agreements for communications (Krechmer, 2006). Openness in an open compatibility standard means that the specifications are available for anyone to build systems conformant to that standard. An open compatibility standard can be defined as:

> transparent specifications of data and behaviour that form the basis of interoperability, where interoperability refers to the ability of different components to communicate information in "equivalent ways" resulting in "equivalent user outcomes" (Dalziel, 2003).

In general, interoperability means the ability to swap different vendor components as long as the components are conformant to the same standard. For the purpose of this research the general term "standard" refers to an open compatibility standard. Perens (no date) defines six principles and practice of open standards:

- Availability – open standards are available for all to read and implement without any restrictions
- Maximize end-user choice – open standards do not lock customers to a particular vendor or group

- No royalty – refers to open standards being free for all to implement. Certification fees for compliance are excluded
- Extension or subset – refers to the ability to extend or provide a subset form of an open standard
- Predatory practices – refers to the fact that open standards could employ license to prevent any "embrace-and-extend" tactics. This would require reference information on any extension of the standards to be made public

There are many reasons to seek a standard. Baskin et al. (1998) identifies three main reasons for standard development:

1. To expand market
2. To share risks in an emergent field
3. To gain legitimacy

To expand market, refers to situations where only through standards a company can increase its market share. The second scenario is where in an emerging field it may be too risky for a company to develop products on its own. Firms share knowledge selectively to stimulate the market in order to discern unforeseen applications (Baskin et al., 1998). Finally standards could also be a competitive strategy for new entrants to gain legitimacy when competing among dominant players.

Standards are a vital part of the ever changing telecommunications industry. Lack of standards results in many companies making large investments in poor product choices (Lawlis, Mark, Thomas, & Courtheyn, 2001).

2.6 Open standards in the telecommunications industry

Open standards are vital for interoperability among components in the telecomm industry and there are many active open standards development in hardware, operating systems, and middleware layers of telecommunications equipment. Recent efforts are focused towards developing open standards for an entire platform (e.g., open CGBPs). This section provides an overview of various standards and standard organizations working towards these open CGBPs in the telecommunications industry.

2.6.1 PICMG and AdvancedTCA specification

PICMG – the PCI Industrial Group – is a standard organization with over 450 companies developing hardware based open specifications (About PICMG, 2007). Founded in 1994, PICMG's objective is to provide equipment vendors a common specification in order to increase availability and to reduce costs and time to market. To date, PICMG has produced many open hardware specifications including CompactPCI, AdvancedMC, and AdvancedTCA.

The PICMG specifications had inadequate requirements for service availability, scalability and had limited interoperability among different vendor equipment.

AdvancedTCA offers all parties significant benefits (Chacron et al., 2005) through a wider standardization effort and with a common goal from industry players.

AdvancedTCA, Advanced Telecom Computing Architecture (also known as ATCA), is a series of open standard specifications for next-generation telecommunications network infrastructure equipment (PICMG AdvancedTCA, 2003). AdvancedTCA is targeted to be a common hardware platform for building carrier-grade products in a multi-vendor compatible environment. AdvancedTCA satisfies high reliability, availability, scalability and increased functionality with potential cost savings due to several choices in hardware vendors (AdvancedTCA HW Profile, 2007; Chacron et al., 2005). The hardware platform specification consists of a chassis (card shelf), card specifications, power supplies, chassis management modules, cooling, back plane, and transition modules (PICMG AdvancedTCA, 2003). The modularity of AdvancedTCA is provided by the choices and selection of plug-in boards based on specific application requirements (Chacron et al., 2005; Liu, 2003).

2.6.2 SCOPE Alliance

The SCOPE Alliance is an industry alliance formed among leading NEPs to accelerate the deployment of open CGBPs (SCOPE Initiative, 2006). In January 2006, Alcatel, Ericsson, Motorola, NEC, Nokia and Siemens formed the SCOPE Alliance with a mission to enable and promote vibrant open CGBPs encompassing COTS and FOSS building blocks (SCOPE Initiative, 2006). The participation of many other industry players and other standard bodies has strengthened the SCOPE Alliance.

The SCOPE Alliance complements the work of other industry initiatives such as PICMG, Service Availability (SA) Forum, and Open Source Development Lab (OSDL) by identifying gaps and providing additional specifications when needed. Gaps are areas that lack clarity or missing required feature sets within a given platform that could potentially lead to different interpretations and implementations of the same standard (SCOPE Initiative, 2006). The SCOPE Alliance establishes profiles, with additional specifications and promotes the use of COTS and free open source software building blocks. Profiles are subsets of existing open specifications from industry groups such as PICMG, and OSDL that provide technical requirements regarding the interfaces and building blocks spotted by any gaps (SCOPE Initiative, 2006).

2.6.3 OSDL and Carrier Grade Linux specification

The AdvancedTCA standard only covers the hardware plane. A broader open CGBP vision encompasses similar efforts along the vertical chain, including operating system and middleware specifications. As such, the Carrier Grade Linux (CGL) working group at Open Source Development Lab (OSDL) is engaged in developing Linux specifications to meet carrier grade needs of the telecommunications industry (Haddad, 2006). It defines requirements intended to improve applicability of Linux to environments with greater service availability, reliability, and scalability needs. The CGL working group is composed of industry representatives from hardware vendors, Linux distribution suppliers, and NEPs (Linux Foundation, 2007). The SCOPE Alliance also complements OSDL by identifying gaps and provides additional specifications via its Linux profile specification.

2.6.4 SA Forum – Middleware standards

The Service Availability (SA) Forum develops and publishes high availability and management software specifications and it promotes and facilitates their adoption in the industry (Haddad, 2006). It is a consortium of hardware vendors, IT companies, NEPs, and independent software vendors. Two important specifications from the SA Forum include the Hardware Platform Interface (HPI) specification which separates hardware from management middleware, and Application Interface Specification (AIS) which provides standardized interface definition between SA Forum high available middleware and service applications (Carrier Grade Middleware Profile, 2007).

2.6.5 Mountain View Alliance

The Mountain View Alliance (MVA) is another industry consortium similar to SCOPE Alliance. MVA aims at accelerating the adoption of open CGBPs (MVA Overview, 2005). However, unlike the SCOPE Alliance, MVA focuses on the marketing and coordinating efforts among industry groups and its member organizations. It organizes collective marketing activities such as trade shows, press events, and articulates value propositions as a promotional effort towards increasing open CGBP adoption and COTS/FOSS use in the telecommunications industry (MVA Overview, 2005).

2.6.6 CP-TA

Communications Platforms Trade Association (CP-TA) is an organization of communications platform and COTS providers that focuses on verifying and certifying third party components for compliancy against industry standards (Haddad, 2006). CP-TA develops testing requirements and test methodologies based upon SCOPE profiles and other specifications from PICMG, the SA Forum and Carrier Grade Linux. It certifies products for interoperability and other compliant specifications (Haddad, 2006).

Figure 8 illustrates the collaboration among all these standards groups in the telecommunications industry working towards developing open CGBPs.

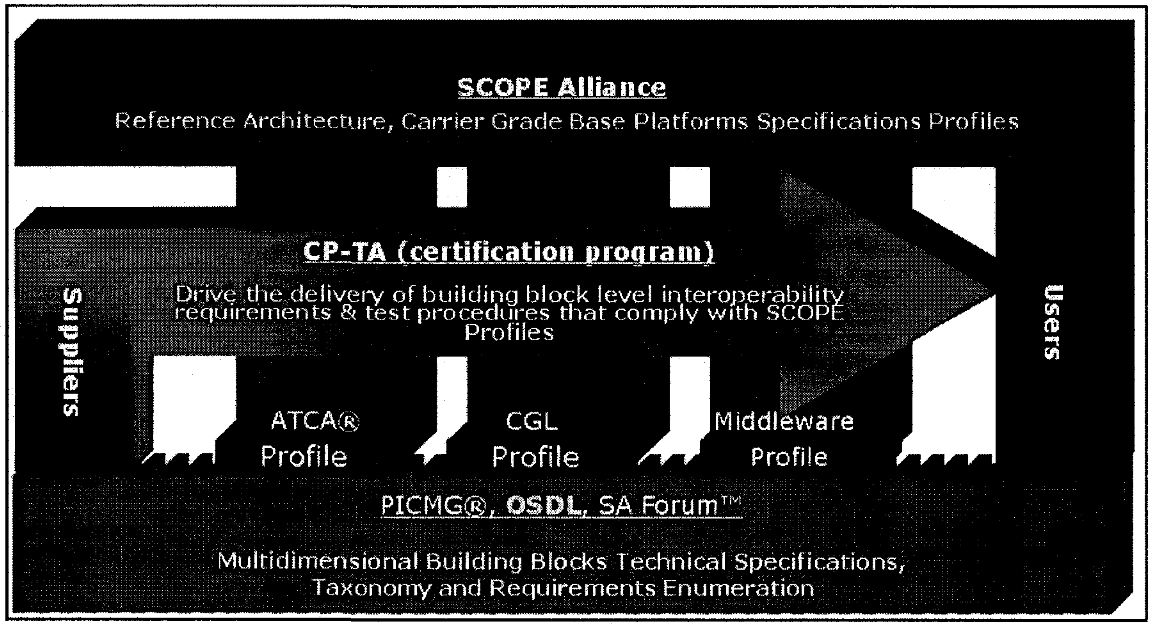

Figure 8: Collaboration among standards groups (Figure source: Haddad, 2006)

2.7 Lessons learned from literature review

This subsection summarizes the key lessons learned from the literature review.

Academic literature on open CGBPs does not exist

Open CGBPs are in the infancy stage. There is no academic literature that focuses on describing their general characteristics or comparing open CGBPs to proprietary platforms.

An ecosystem organizational form way of thinking is essential to the success in today's economy

The focus of competition has progressed from competing in terms of efficiency and effectiveness to continuous innovation. A business ecosystem with an effective keystone, underlying foundation platform, and niche markets provide a suitable environment for inter-firm relationships and to co-evolve innovation.

COTS/FOSS integration has become central to the success of open CGBPs

Classical or individual-centric COTS/FOSS integration lacks the ability to manage update management issues and optimization of components as business needs evolve. System development needs to cope with anticipated changes such as the release of new COTS/FOSS versions in a dynamic environment, and must be able to cope with the behaviour which may arise from the interaction between the system components (Warboys et al., 2005). On the other hand, the ability of open CGBPs and the ecosystems anchored around them to capture both the COTS/FOSS components' initial static configurations and the reconfiguration of the components on an ongoing basis has made COTS/FOSS components highly valuable to NEPs.

An open CGBP can be better understood as a technological framework composed of network of relationships, underlying dominant design, and processes around which it is organized

The network of relationships refers to the necessary interactions required among NEPs, COTS/FOSS suppliers, and service providers. Dominant design, the open specifications produced by the keystone, provides the norms around which the platform development process is organized. Finally the processes refer to the development methodologies and the work breakdown structures employed in developing the platform.

The institutionalization of open specifications reduces the potential for radical technological change in platform development

Through their work on platforms as technological infrastructure framework, Weiss and Birnbaum (1989) have illustrated that as platform development emerges in a sector, it provides an institutionalized framework for technological inventions which constraints technological changes to a routine, cooperative process within defined boundaries. This they call the institutional effect. Institutionalization provides a stable process for incremental innovation where good estimates can be made of the rate and extensiveness of future technological change. It also increases the rate of new product introduction. However, the caveat here is that, institutionalization constraints the potential for any radical technological innovations since the development of platforms implies a specialized and narrow focused technological development.

Open CGBPs affect ecosystem positioning decisions

In a platform-based product development environment, platform are either over designed for low-end products (resulting in over designed cost) or under designed for high-end products (resulting in low quality) (Krishnan & Gupta, 2001). The optimal placement of open CGBP specification created by the keystone in an ecosystem is always a challenging task.

3 RESEARCH METHOD

This chapter describes the research method. Section 3.1 identifies the steps used to produce the deliverables. Subsequent sections describe the steps carried out in this research.

3.1 Research steps

The steps undertaken in the research were:

1. Examined relevant literature and produced lessons learned
2. Identified the SCOPE Alliance and open CGBP projects
3. Developed an initial model using literature review and SCOPE Alliance domain
4. Carried out an interview with a VSE project architect
5. Developed a questionnaire incorporating the model and obtained feed back from Nortel VP
6. Incorporated feedback, refined model, and redistributed the questionnaire
7. Final model and outcomes were derived from all feedback
8. Made observations and recommendations based on results obtained

3.2 Examined relevant literatures

The research examined the extant literature on COTS/FOSS integration and its benefits and risks. Literature on platform development and platform based product development were examined. Platforms and COTS/FOSS integration was reviewed. Literature on business ecosystems and telecommunications standards was also studied. From the literature review it was identified that there was a gap in linking COTS/FOSS integration and open CGBPs. A gap was also identified in understanding the existence of an ecosystem around open CGBPs.

3.3 Identified the SCOPE Alliance and open CGBP projects

The SCOPE Alliance space was examined. How NEPs and third party COTS/FOSS suppliers were collaborating in developing open CGBPs were studied. Various telecommunications development projects utilizing open CGBP were examined. Although a few list of development projects were identified from company websites and examining white papers, Nortel Networks' Versatile Service Engine (VSE) project was found to be detailed and accessible for investigation. The list of development projects identified is provided below.

Nortel Network's Versatile Service Engine (VSE)

Versatile Service Engine (VSE) is an open CGBP built on the AdvancedTCA specifications to meet the processing needs of today's wireless, wireline, and cable applications (Nortel Product Brief, 2007). This AdvancedTCA compliant platform enables Nortel to integrate standards based COTS and FOSS components, reducing the development efforts and leaving Nortel to focus on the value added products built on top of the platform. It utilizes Nortel Carrier Grade Linux (NCGL) operating system - open-source Linux with Nortel carrier-grade features added to it.

Some of the Nortel products built on this VSE platform include:

- Call Session Controller (CSC)
- Home Subscriber Server (HSS)
- Mobile Switching Center Server (MSC)
- Home Location Register (HLR)
- Packet Mobile Switching Center (P-MSC)

NEC's AdvancedTCA based xGSNs

NEC, a leading Network Equipment Provider headquartered in Japan, has developed many xGSN mobile packet core nodes based on AdvancedTCA specifications. xGSN nodes are composed of a Serving GPRS Support Node (SGSN) and Gateway GPRS Support Node (GGSN) (Brown, 2004). A GPRS Support Node (GSN) is a network node that provides mobility management, session management and transport for Internet Protocol packet services in a GSM network. GGSNs are wireless routers that provides primary interface between a carrier's radio and packet networks (Springham, 2003).

NEC's xGSN packet core nodes are based on Intel AdavancedTCA buliding blocks running carrier-grade Linux from MontaVista Software. The middleware and applications are NEC specific (NEC 3G Mobile, 2008). NEC has deployed its xGSN nodes to many service providers since 2003 including Japanese carrier NTT DoCoMo (Brown, 2004).

Alcatel's AdvancedTCA-compliant SGSN

In 2005, Alcatel introduced its first AdvancedTCA-compliant SGSN (Serving GPRS Node), a mobile core network element responsible for data communication continuity in different cells of the mobile network (Alcatel Press, 2005). Alcatel has also implemented its 5020 Softswitch for fixed networks on the AdvancedTCA platform. Leveraging a common hardware platform built on AdvancedTCA across its entire portfolio of network solutions, allows Alcatel to reduce total cost of ownership for fixed and mobile operators (Alcatel Press, 2005).

Flash Network's NettGain and Harmony platforms

Flash Networks, a leading mobile Internet quality-of-experience (QoE) solutions provider has developed and deployed two AdvancedTCA based platforms in the mobile Internet market: NettGain and Harmony. Flash's AdvancedTCA based QoE platforms lower capital and operating expenses while providing greater scalability, reliability, and service availability to its customers (Flash Press, 2007). NettGain and Harmony enhance subscriber QoE and accelerate mobile content loading by applying best-in-class services on mobile data traffic (Flash Press, 2007).

Motorola's NetPlane Software Suite

The NetPlane Software Suite is an open solution that has been designed to offer advanced integrating framework for building highly available communication applications (Perla, 2005). The services provided by NetPlane are hardware independent, and are built in accordance to Service Availability Forums' AIS and HPI specifications.

Tektronix's GeoProbe

The GeoProbe platform is another open CGBP monitoring solution built on AdvancedTCA specifications. Some of its components also employ carrier grade Linux along with Tektronix's own real-time operating system (Solutions White Paper, 2006). It provides monitoring services for GSM, GPRS, UMTS, and VoIP networks. The GeoProbe platform is Tektronix Unified Assurance solution which provides network management for both legacy and next-generation networks.

3.4 Developed an initial model

Based on the literature review and the review of the SCOPE Alliance and projects, a conceptual model and propositions were developed to address the effects of open CGBPs on NEPs, service providers, and COTS/FOSS suppliers. The model was developed to capture the effects on NEPs, COTS/FOSS suppliers, and service providers as NEPs move from proprietary platform development to open CGBP development.

3.5 Interview with a VSE architect

Although a few lists of development projects were identified, Nortel's Versatile Service Engine (VSE) project was found to be detailed and accessible for investigation. An interview was carried out with a VSE project architect. The results of the interview are summarized in Appendix A. The interview captured in-depth the COTS/FOSS integration aspect of open CGBPs. The model was refined based on the interview findings.

3.6 Developed a questionnaire and obtained feedback

A questionnaire was developed incorporating the updated model and propositions. Appendix B includes the questionnaire. The questionnaire was sent to Nortel VP and Chief Architect familiar with the VSE project. He was asked to provide feedback on the completeness of the model and the propositions. For each proposition, the questionnaire also asked to add comments and to make suggestions if the participant does not agree with the proposition. The questionnaire also included thought provoking open ended questions such as the participant's knowledge about the next stage of developments for open CGBPs and best ways to grow the ecosystems anchored around open CGBPs.

3.7 Incorporated feedback and redistributed the questionnaire

Feedback obtained from Nortel VP was very valuable and effective. His inputs were incorporated into the questionnaire and the model and propositions were refined. The updated questionnaire was then distributed to two other senior managers from Nortel's top management team involved with the VSE project. The questionnaire was distributed via email. After a week from the initial distribution, a reminder email was sent to notify them of the importance of their participation and encouraged them to send responses to the questionnaire.

3.8 Final model and outcomes were derived

The final model and propositions were derived incorporating all the feedbacks received. The propositions were categorized into four main areas: company motivation for participation in open CGBP ecosystem, behaviour of participation, engagement dynamics, and outcomes of participation.

3.9 Made observations and recommendations

Based on the results obtained from the research, observations were made on the effects of open CGBPs on NEPs, third party COTS/FOSS suppliers, and service providers. Observations were also made on how to effectively grow the ecosystem anchored around open CGBPs.

4 RESULTS

This chapter presents the results of the study. Section 4.1 explains how the model and propositions were developed in the research. It outlines the evolution of the model and how it was refined and shaped after feedback was received. Section 4.2 provides the final model and the propositions anchored around the model. Section 4.3 categorizes the propositions into company motivation, company behaviour, engagement dynamics, and outcomes from participation. Section 4.4 outlines issues identified with open CGBP development. Section 4.5 summarizes the results on the next stage of open CGBPs.

4.1 Evolution of the model and propositions

4.1.1 Initial model and propositions

Figure 9 depicts the initial model constructed from lessons learned from literature review, SCOPE Alliance and projects. As shown on the diagram, the model identified seven areas that were affected by the use of open CGBPs. They are summarized in Table 5. Table 6 outlines the propositions that were derived from this initial model.

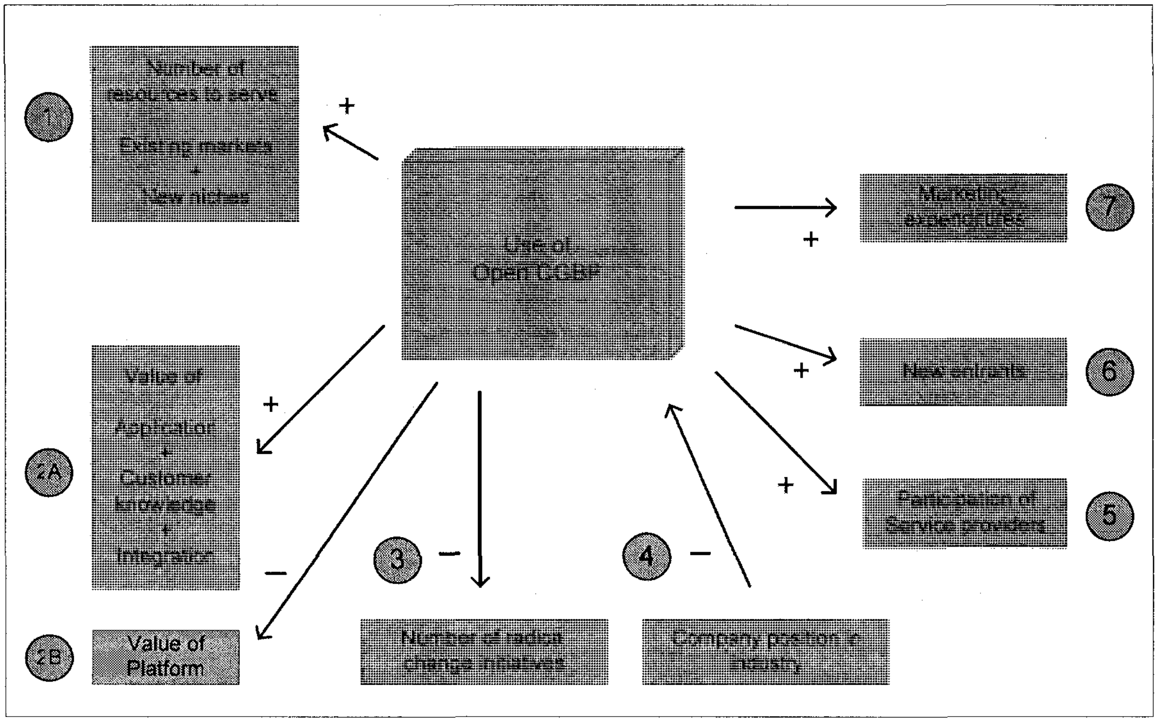

Figure 9: Initial model constructed

Table 5: Impact of open CGBP identified in the initial model

Effects of open CGBP on various aspects of NEPs, COTS/FOSS suppliers, and service providers	
1	Number of resources available for a company to continue to cater existing markets, and to capture new niches
2	More emphasis towards applications, customer knowledge, and integration when using open CGBP and less towards platform's Intellectual Property (IP)
3	The effect on radical change initiatives when using open CGBP
4	Company's market position and the impact on endorsement of open CGBP
5	Increased participation of service providers when using open CGBP
6	The opportunities for new entrants and the effect on barriers to entry when using open CGBP
7	The effect on marketing expenditures such as branding and differentiating of company's products built on open CGBP

Table 6: Propositions from initial model

	Propositions derived from the initial model
1	Use of open CGBP increases company's resources to serve existing markets and to capture new niches
2	Use of open CGBP shifts value from being in the platform to being in applications, customer knowledge, and integration of external components
3	Use of open CGBP decreases the number of company initiatives focused on radical change
4	Use of open CGBP is negatively related to the company's position in the industry
5	Use of open CGBP increases the number of service providers that participate in platform development
6	Use of open CGBP increases the number of new entrants into the market
7	Use of open CGBP increases spending on marketing and branding applications

4.1.2 Model refined after the interview with a VSE architect

The model and propositions were refined after an in-person interview with a VSE project architect from Nortel Networks. Figure 10 shows the updated model and Table 7 summarizes the updated propositions.

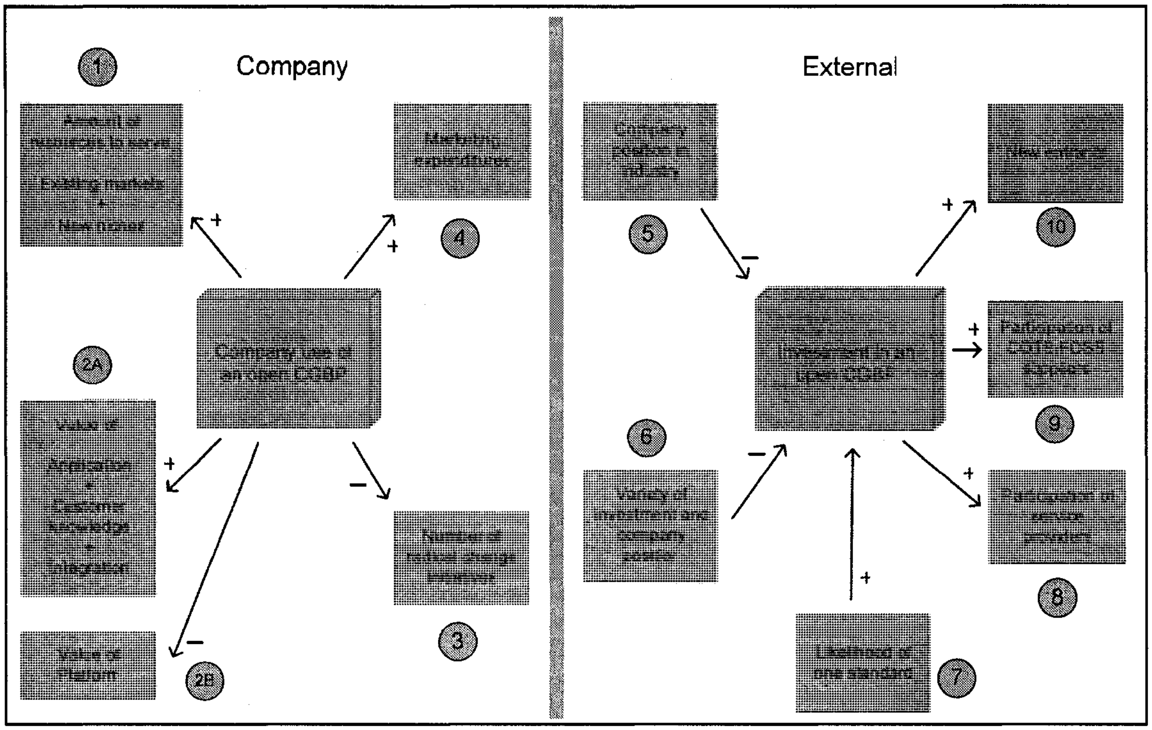

Figure 10: First iteration of model refinement

Table 7: Updated propositions after the first iteration

	Propositions derived from the initial model
1	Use of open CGBP increases company's resources to serve existing markets and to capture new niches
2	Use of open CGBP shifts value from being in the platform to being in applications, customer knowledge, and integration of external components
3	Use of open CGBP decreases the number of company initiatives focused on radical change
4	Use of an open platform increases marketing spending
5	Amount contributed towards the development of an open platform is negatively related to a company's position in the industry
6	Variety of contribution towards the development of an open platform is negatively related to a company's position in the industry
7	Investment in an open platform is positively related to the likelihood of emergence of a single platform over the long term

8	Service providers' participation in an open platform development is significantly greater than the service providers' participation in a proprietary platform development
9	Third party COTS/FOSS suppliers' participation in an open platform development is significantly greater than their participation in a proprietary platform development
10	Open platform increases the number of new entrants into the market

4.2 Final model and propositions

Figure 11 illustrates the final model that incorporates responses to the questionnaire.

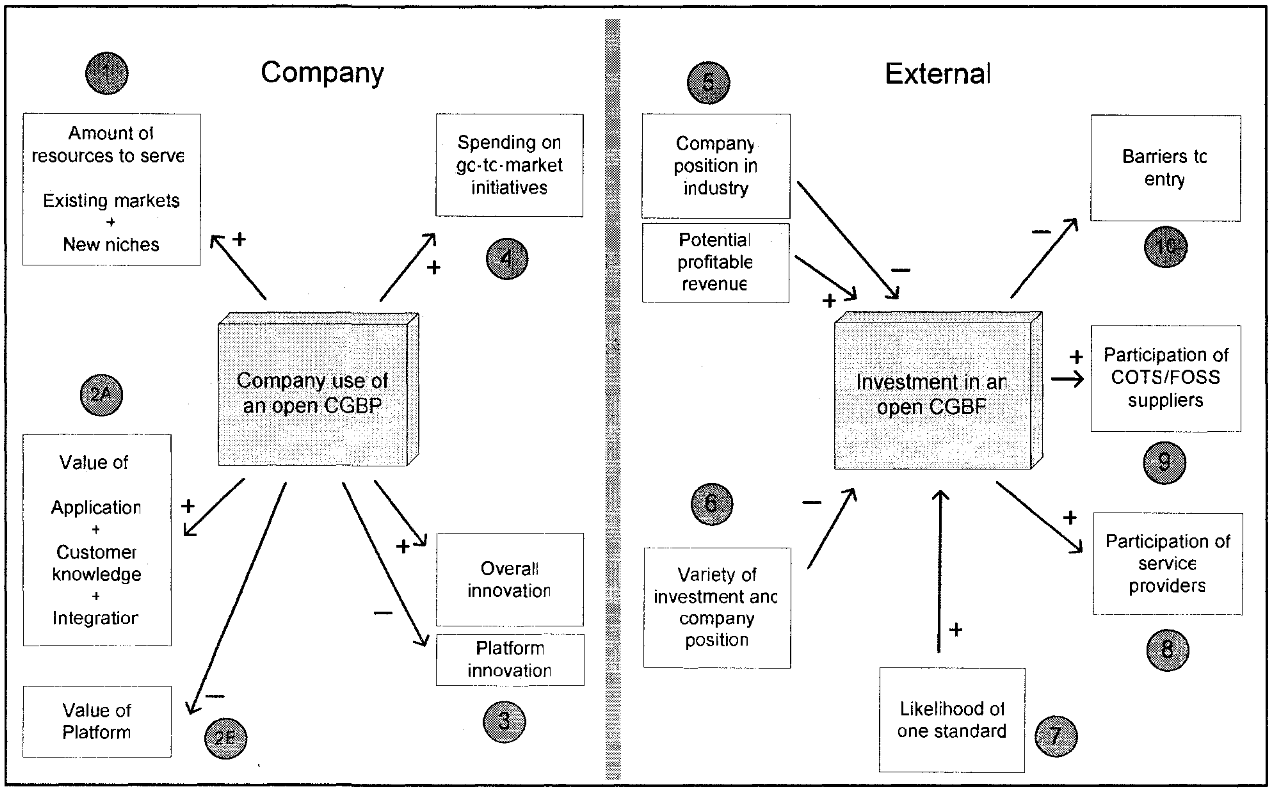

Figure 11: Use of open CGBP and its impact

Figure 11 illustrates a model of how a company's usage of an open CGBP, its investment in an open CGBP, and the existence of an ecosystem affect various aspects of NEPs, COTS/FOSS suppliers, and service providers. Ten aspects are identified:

1. Amount of resources available for a company to continue to cater existing markets, and to capture new market niches

2. Value of applications, customer knowledge, and integration value of the platform's IP

3. Number of platform innovations vs. overall innovation initiatives

4. Time-to-market expenditures

5. Investment in an open CGBP compared to the company's position in the industry and potential profitable revenue

6. Variety of investment in an open CGBP and the company's position in the industry

7. The likelihood that a single platform will be able to serve the entire market in the long run

8. Participation of service providers in platform development

9. Participation of third party COTS/FOSS suppliers in platform development

10. Barriers to entry

4.2.1 Propositions

When a company is solely responsible for the platform, it contributes a significant amount of resources towards advancing and maintaining the platform. However, when a company uses an open CGBP, a significant amount of resources are no longer tied to internal platform development. The company has more resources to invest towards satisfying customer needs. With open CGBP, the company can allocate more resources towards developing applications for niche markets and to orchestrate external resources to focus on satisfying the needs of external markets. This leads to the following proposition:

Proposition 1: Use of an open CGBP increases company's resources to serve existing markets and to capture new market niches.

When platform requirements are specified internally, a significant amount of IP is captured. This is not the case with open CGBPs. Open CGBPs are available for all. Hence, customers would not wish to pay much more for something that is abundantly available. Companies make money only on the value-add applications that customers care about, not the embedded platform that is common (Eisenmann et al., 2007). The value of the IP of a company using an open CGBP will have to shift from being in the platform to being in applications, customer knowledge, and integration. When companies are faced with commoditization – in this case the platform is being commoditized – they have no other choice but to invest in creating innovative new products (Krishnan & Zhu, 2006). This leads to the following proposition and its two sub propositions:

Proposition 2: Use of an open CGBP shifts value that an NEP creates from being in the platform to being in the applications, customer knowledge, and the knowledge on how to integrate external components.

> Proposition 2A: Use of open CGBP increases the value of an NEP's applications, customer knowledge and integration capability.

> Proposition 2B: Use of open CGBP decreases the value of an NEP's platform.

Open CGBP provides more opportunity for an NEP to introduce new products anchored around the platform. However, new innovation initiatives on the platform itself will be limited. Well defined infrastructures constrain technological changes to a routine, cooperative process within defined boundaries (Weiss & Birnbaum, 1989). Platform institutionalization provides a stable process in which good estimates can be made of the rate and extensiveness of future technological change. Since an open CGBP is defined and shaped by many stakeholders, there is a critical mass that needs to be convinced for radical changes to take effect. Open CGBPs have standardized practices and processes that nurtures an arena for incremental innovations with predictive characteristics and greatly reduces likelihood for radical innovations. For example, technological opportunities that may be valuable but not related closely to the established dominant design of an open CGBP specification are less likely to receive attention and any progress on those opportunities may be limited. This leads to:

Proposition 3: Use of an open CGBP increases the number of company initiatives focused on using the platform and decreases the number of company initiative to innovate on the platform.

With all NEPs developing products on the same platform, NEPs must refocus investment into go-to-market initiatives as they attempt to differentiate their end products and the value they add to customers. Advertising is seen as a key attack strategy when competing in a common platform environment (Eisenmann et al., 2007). Go-to-market initiatives such as partnering strategies, outsourcing strategies, and sales strategies will also increase. This leads to the following proposition:

Proposition 4: Use of an open CGBP increases spending on go-to-market initiatives such as partnering, outsourcing, sales, and marketing.

An NEP's investment in an open CGBP depends on its position in the industry. A market leader may be less interested in using an open CGBP since it will destroy the company's

IP invested in a proprietary platform and hence the company's competitive advantage. A company that is not a market leader or a new entrant into the industry would be heavily involved in establishing and using open CGBPs as a way to bypass building expensive proprietary platforms and reduce the leader's competitive position in the industry.

On the other hand, an NEP's investment in an open CGBP can also be compared to the cost and complexity to develop the platform versus predicted revenue. This leads to:

Proposition 5: Amount of contribution towards the development of an open CGBP is negatively related to an NEP's position in the industry and is positively related to potential profitable revenue.

With open CGBPs, a company can participate, contribute, and reap benefits at various levels. Companies can use the platform to create products and services for which customers worldwide are willing to pay, reduce time to cash, decrease development and commercialization costs, and harness innovation worldwide. In a business ecosystem, there exists a keystones who co-envision and co-manage co-evolution among members (Moore, 2005). As illustrated in Figure 12, a company in an open CGBP ecosystem can invest towards leadership roles in keystone governance, developing open CGBPs assets, and/or managing particular niche markets. However, the company's level of investment is negatively related to the company's position in the industry. For example, a company that is not a market leader or a new entrant in the industry would be heavily involved in all aspects of the business ecosystem; whereas, market leader may just decide to be a mere observer. Thus, the following proposition is derived:

Proposition 6: Variety of contribution towards the development of an open CGBP is negatively related to a company's position in the industry.

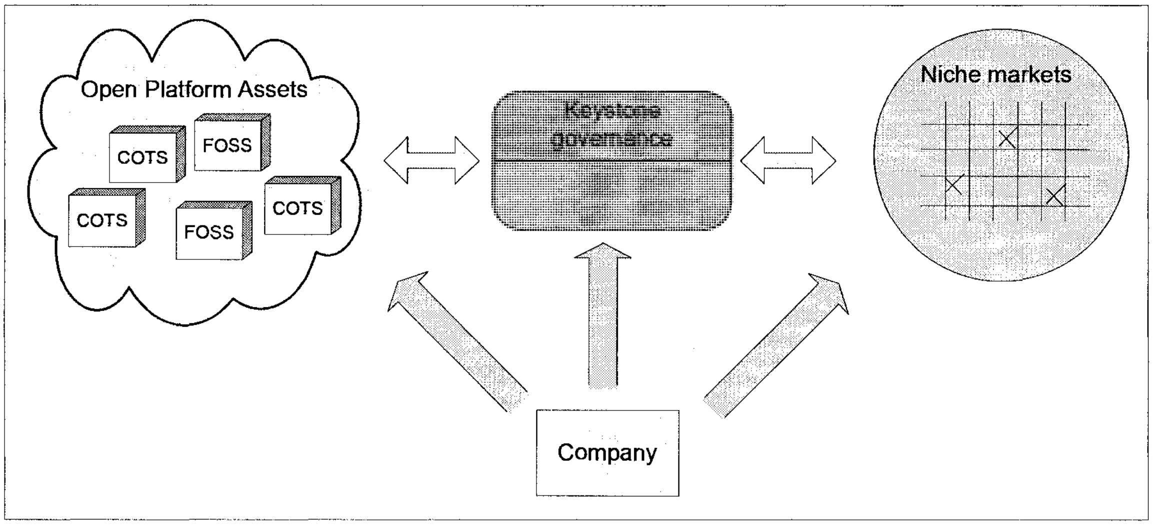

Figure 12: Various levels of company participation in an open CGBP ecosystem

NEPs' investment in an open CGBP depends on the likelihood that a single platform will emerge in the long run. Development of an open CGBP is more appealing for NEPs when the entire market is likely to be served by a single platform over the long term. Eisenmann (2007) argue that if a winner-take-all outcome is favoured when multiple rivals are developing competing platforms, the winner has a chance of earning monopolist's profits whereas the rest of the firms are forced to total write-offs. This is disconcerting to most top management teams of NEPs as many are risk averse and would result in rivals combining forces to develop open CGBPs (Eisenmann, 2007). This leads to:

Proposition 7: Investment in an open CGBP is positively related to the likelihood of emergence of a single platform over the long term.

Service providers, NEPs primary customers, will react positively towards an open CGBP initiative. Open CGBPs decrease vendor lock-ins. Service providers could potentially have seamless mixing of best-of-breed products from different NEPs and yet still conform to a uniform set of management and maintenance procedures (Liu, 2003). The business ecosystem anchored around an open CGBP enables a much transparent and effective customer feedback mechanism (Moore, 2005). At its core, a business ecosystem is a network of niches of complementary contributions that are independently developed and integrated in a modular transparent architecture. The modular design provides a much transparent and direct link between service providers and NEPs revealing service providers what modules perform what functions (Moore, 2005). Thus, service providers are made aware of many key components and have the ability to make design choices. Further, the modular architecture of an open CGBP reduces service providers' cost of operation, cost of interaction, and risk while increasing trust on products built on open CGBPs. The key stones of open CGBPs encourage the participation of all stake holders (SCOPE Initiative, 2006). This will lead to an increased service providers' participation as proposed in:

Proposition 8: Service providers' participation in an open CGBP development is significantly greater than the service providers' participation in a proprietary platform development.

An open CGBP and the ecosystem surrounding it facilitate a suitable environment for third party suppliers to provide inputs into open CGBP development. In an ecosystem model, suppliers move from being mere suppliers to valuable complementors – they align their vision with the keystone and other members in building the foundation platform. Unlike in a proprietary platform development where most of the specifications are closed, open CGBP specifications developed by the SCOPE Alliance encourages participation of COTS/FOSS suppliers (SCOPE Initiative, 2006). There are also many incentives for suppliers to involve in with the definition of specifications such as the ability to steer the direction of specs definition and evolution. This leads to:

Proposition 9: Third party COTS/FOSS suppliers' participation in an open CGBP development is significantly greater than their participation in a proprietary platform development.

The development of an open CGBP reduces barriers to entry. New entrants with little system design expertise in telecommunications can lever open CGBPs to quickly turn out adequate products (Liu, 2003). As clearly stated by Moore (2005), the openness in business ecosystems means that modules are properly defined with well-documented interfaces, and business contracts are not restrictive. With an ecosystem anchored around open CGBPs, network of niches of the ecosystem are open to new entrants:

Proposition 10: Open CGBP decreases the barriers to entry for new entrants into the market.

4.3 Categorization of propositions

Propositions can be organized based on (i) the factors that motivate NEPs to participate in the development of open CGBPs, (ii) behaviour of participation, (iii) engagement dynamics, and (iv) outcomes from participation. Table 8 organizes the 10 propositions into these four groups.

Table 8: Categorization of propositions

	Factor	Proposition(s)
Company motivation	Reduce cost, speed to market	Proposition 1
	Change business focus, new position in value chain	Proposition 2
Company behaviour	Technical commoditization	Proposition 2B
	Refocus innovation	Proposition 3
	Refocus investment	Proposition 4
Engagement dynamics	Control strategy	Propositions: 5 & 6
	Partner strategy	Proposition 7
Outcomes from participation	Increases addressable market	Proposition 1
	Increases value diversity	Propositions: 8 & 9
	Increases product volume	Proposition 10

4.4 Issues identified with development of open CGBPs

Table 9 outlines the issues and problems identified from examining the VSE project and the approaches taken to address these issues.

Table 9: Issues faced in developing open CGBP

Issues/problems faced in developing VSE	Approaches taken to mitigate issues
COTS suppliers are not caught up to AdavancedTCA specifications	Not all the components are bought from outside
Lack of software integration capabilities from third party vendors	Some integration software is currently handled by VSE. Hope is to get support from third party vendors in the near future
Some specifications of AdvancedTCA are not complete	VSE project fills in the gap: o Give more specs to suppliers (RFPs) when buying external hardware components o Try not to make extra specifications to derail from AdvancedTCA o Make sure suppliers are not making components specifically for VSE

4.5 Results on the next stage of open CGBPs

The questionnaire sent out to the respondents included a question on where do they see the next stage of development of open CGBPs. Currently open CGBP specifications such as AdvancedTCA are defined in standards groups (SCOPE Alliance, PICMG, etc) and platforms are built internally integrating COTS/FOSS components such as the VSE project. The questionnaire specifically inquired whether this development approach likely to continue. The results from the responses are summarized below in Figure 13. Results show that in the past NEPs where integrating only at the chip level. Current open CGBP development approach enables platform based integration of third party building blocks. In the future, there is anticipation for outsourcing the entire platform. However, research from studying the VSE project demonstrates that it may be sometimes before that level of integration is possible.

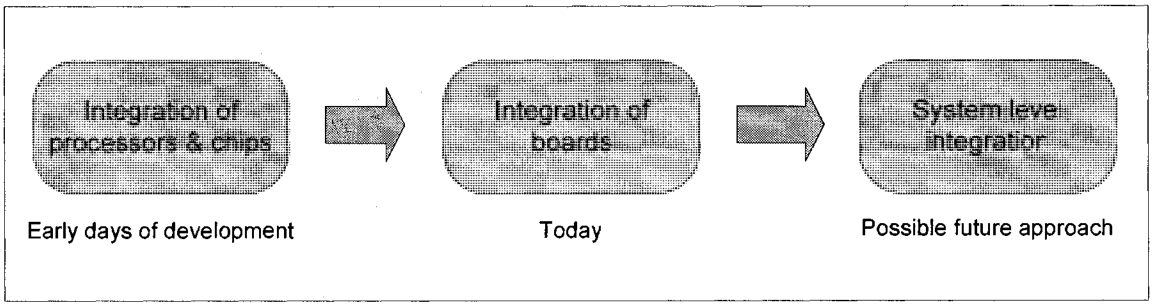

Figure 13: Next stage of open CGBP development

5 DISCUSSION OF RESULTS

This chapter discusses the model and propositions developed in Chapter 4. It applies:

- the business ecosystem perspective advanced by Moore (2005) to understand the industry collaboration among NEPs, third party COTS/FOSS suppliers, and service providers that are involved in open CGBPs
- product development perspective advanced by Krishnan and Gupta (2001) to understand platform positioning and COTS/FOSS integration in open CGBPs
- technological-infrastructure perspective advanced by Weiss and Birnbaum (1989) to understand platform level changes and radical innovations.

This chapter is organized into 6 sections. Section 5.1 discusses the ecosystem perspective. Section 5.2 discusses the product development perspective. Section 5.3 discusses the technology-infrastructure perspective. Section 5.4 summarizes the impact on product positioning and platform functionalities. Section 5.5 summarizes the impact on opportunities for radical innovations. Finally, Section 5.6 provides observations on how to grow the ecosystem anchored around an open CGBP.

5.1 Ecosystem perspective

Moore (2005) argues that a business ecosystem organizational form is necessary to coordinate and co-evolve innovation across multiple companies. At its core a business ecosystem has a keystone, a foundation platform, and a network of niches of complementors resulting in a complex adaptive multi-contributor system (Moore, 2005):

- Keystone in an ecosystem acts as the hub in the network and keystone's strategies shape and coordinate the ecosystem
- The foundation platform consists of: i) technologies; ii) architectures, designs and assets used to build market offers; iii) components, products and services; iv) contracts; and v) processes
- Each niche addresses a distinct need and operates as a self organizing action group within the vision of the ecosystem

The business ecosystem anchored around the development of open CGBP is illustrated in Figure 14. The links illustrate that all niches derive value from the Foundation Platform governed by the keystone, however, some more than others as shown by the strength of links. Similarly strength of link between two niches varies.

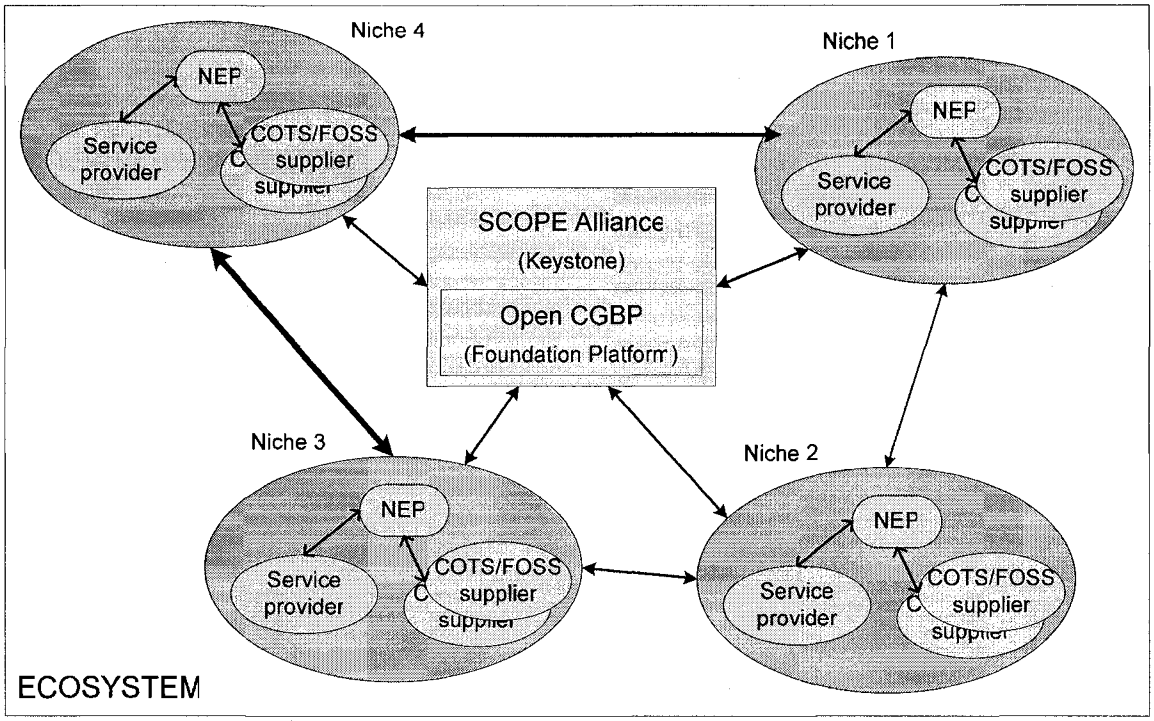

Figure 14: Ecosystem anchored around an open CGBP

Each company in the ecosystem will see other organizations and individuals as carrying out roles. Table 10 summarizes the roles of the companies/consortia as NEPs move from developing proprietary platforms to developing open CGBPs.

Table 10: Roles undertaken by comapneis in the ecosystem

Companies/ participants	Roles undertaken by companies in the ecosystem
SCOPE Alliance	o Acts as the keystone of the ecosystem o Mission is to enable and promote vibrant open CGBPs encompassing COTS and FOSS building blocks o Is an industry alliance initially formed among leading NEPs o Currently has a larger member base including COTS/FOSS suppliers and other industry standards groups: it is a consortium of consortia. o SCOPE complements the work of other industry consortia by identifying gaps and providing additional specifications when needed
NEPs	Participate in the ecosystem at various levels: o Leadership roles in keystone governance (e.g. Alcatel-Lucent, Ericsson, NEC, Nokia Siemens Networks, and Nortel Networks are SCOPE board members) o Managing particular niche markets o Observer/user of open CGBPs
COTS/FOSS suppliers	Have become active complementors in the open CGBP ecosystem from being mere suppliers. They also participate in leadership role in keystone governance (ex. Huawei, and Motorola are SCOPE board members)
Service providers	Service providers are the users of products developed by NEPs

5.2 Product development perspective

Krishnan and Gupta (2001) have developed a framework to identify different situations under which a platform based approach, standardized approach, or a niche product approach could be utilized depending on market diversity and non-platform scale economies. Table 11 illustrates their research findings. Krishnan and Gupta (2001) conclude that a platform based development is optimal only when the market diversity is medium and when the non-platform economies of scale are not high.

Table 11: Krishnan and Gupta's framework for platform based product development

Non-platform economies of scale	Market diversity: Low	Market diversity: Medium	Market diversity: High
Low	Standardized product	Product family with or without a platform	Niche product
Medium	Standardized product	**Platform based product family**	Niche product
High	Standardized product	Standardized product	Standardized product

This research applies the same logic to understand why telecommunications companies are developing open CGBPs integrating COTS/FOSS components.

In looking at the use of AdvancedTCA based platforms, the feedback received from respondents show that NEPs are not developing all their products based on AdvancedTCA platforms. For example, AdvancedTCA platform is employed in all radio controllers, wireless edge infrastructures, and IP Multimedia Subsystem (IMS) network nodes. Yet AdvancedTCA is not employed in building products with large variety of processing and functional needs or in situations where mass production of dedicated hardware is efficient and cost effective. For example, Respondent 1 pointed out that

NEPs are still using dedicated hardware for Time Division Multiplexing (TDM) switching, and speech processing. This shows that NEPs are utilizing open CGBPs only in situations where volume is low and cost/complexity is high. This agrees in certain degrees to Krishnan and Gupta's argument for platform based product development.

Further since Krishnan and Gupta's (2001) work is on internal platforms, non-platform economies of scale contribute significantly when selecting a platform based product development approach. However, in open CGBPs platform economies of scale are considerably high since the platform cost is shared among NEPs (increased number of COTS/FOSS suppliers competing for the same open CGBP space). Thus, it has the potential to offset any non-platform economies of scale.

5.3 Technological infrastructure perspective

In applying Weiss and Birnbaum's (1989) platform-as-a-technological-infrastructure perspective, this research recognizes a lack of participation on behalf of service providers in shaping open CGBP specifications and development. Weiss and Birnbaum (1989) argue that a network of relationship among suppliers, producers, and users is vital towards a successful development of platforms. Although suppliers, the third party COTS providers and open source community are actively involved, the review of SCOPE Alliance and open CGBP projects show that service providers are not actively involved in standards groups. Lack of participation of service providers may not lead to a viable growth of open CGBPs.

5.4 Impact on product positioning and platform functionalities

In their work on platform based product development, Krishnan and Gupta (2001) argue that since components constituting the platform need to be used in both high- and low-end products, they must often be over-designed. The feedback received from respondents also reveals similar results. With open CGBPs, NEPs have only shifted the value added and product differentiating functionalities on top of platforms, leaving platforms heavy on general purpose computing utilities.

Equation 1 shows the differentiating and non-differentiating components of a product. ΔF_1 denotes the general non-differentiating components, such as computing utilities, that customers do not wish to pay for. Whereas, ΔF_2 denotes differentiating value-add applications and services NEPs provide to their customers.

Equation 1: Components contributing to a product

$$\Delta F = \Delta F_1 + \Delta F_2$$

ΔF_1 – non-differentiated product components

ΔF_2 – value-add product components

Thus, NEPs are interested in porting ΔF_1 into open CGBPs. Since open CGBPs are shared among many NEPs and as all the NEPs are interested in porting non-differentiating components into the platforms, open CGBPs end up developed as most generic as possible. In accordance with Krishnan and Gupta's (2001) findings, this leads to over-design of any low end products built on top of these platforms.

5.5 Impact on opportunities for radical innovations

5.5.1 Effect of institutionalization on internal platforms

In their work on platform-as-a-technological-infrastructure framework, Weiss and Birnbaum (1989) introduced the concept of institutionalization which constraints radical innovations from emerging within the ecosystem surrounding the firm that has developed and nurtures the platform. In an internal/proprietary platform development environment, this ecosystem is composed of the firm's suppliers, users, distributors and customers. However, the existence of platform and the institutionalization effect only limits radical innovations within this ecosystem. It does not limit another company, totally outside of this ecosystem, from developing radical innovative technologies. This is also similar to many of Christensen's work on the theory of disruptive innovations (Christensen and Raynor, 2003). With many explicit illustrative examples, Christensen and Raynor have shown that at many instances while incumbent firms are locked in a technological infrastructure that only focuses on catering to the needs of high-end demanding customers, disruptive technologies (radical innovations) are introduced at the low-end market by new entrants. This is due to the fact that an external firm is not affected by the institutionalization effect surrounding the ecosystem in which the firm developing and nurturing the platform and its suppliers, users, distributors, and customers are connected.

Figure 15 illustrates the technological infrastructure and the surrounding ecosystem in an internal/proprietary platform development.

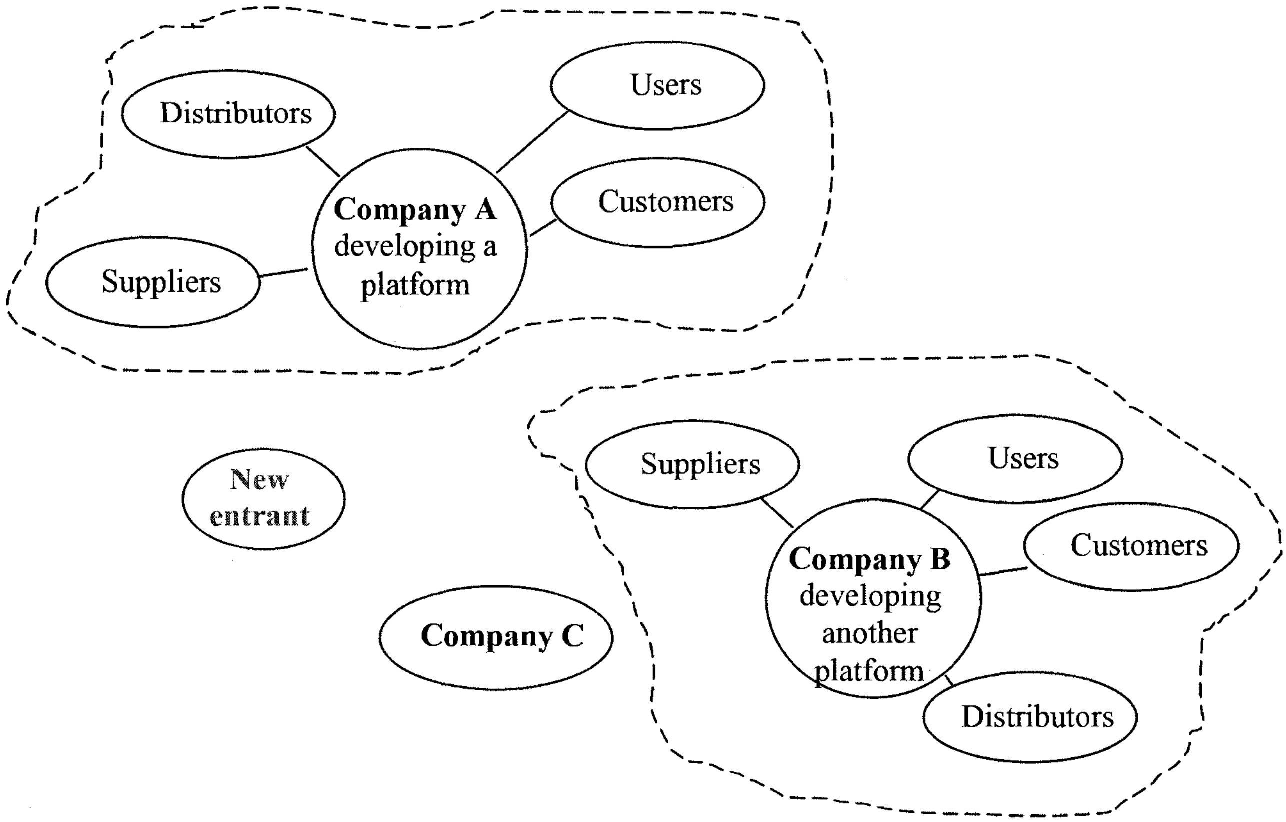

Figure 15: Institutionalization effect in internal platform development

Here the new entrant and company C are not affected by any institutionalization effects that bind company A or company B. Therefore, no institutionalization effects prevent new entrant or company C from introducing radical innovative technologies.

5.5.2 Effect of institutionalization on Internet based external platforms

This institutionalization effect can also be seen on Internet based external platforms; however, it produces a different result. Since much research is needed on Internet based external platforms and the effect of the Internet on them, this research only makes inferences based on very few available literature findings. As it was shown in the literature review, there are at least three types of Internet based external platforms: access API based, plug-in API based, and runtime environment based. Further, they are all constrained within the Internet infrastructure. As these three types of platforms solidify with (1) a network of relationship among suppliers, users, distributors, and customers; (2) specific development processes and understandings; and (3) dominant designs, the institutionalization effect would further restrain any radical changes around them.

Thus applying Weiss and Birnbaum's (1989) platform-as-a-technological-infrastructure perspective, Figure 16 illustrates that a radical innovation here could only emerge outside of existing three platforms; however, unlike the internal/proprietary case, here the radical innovation is still constrained within the Internet.

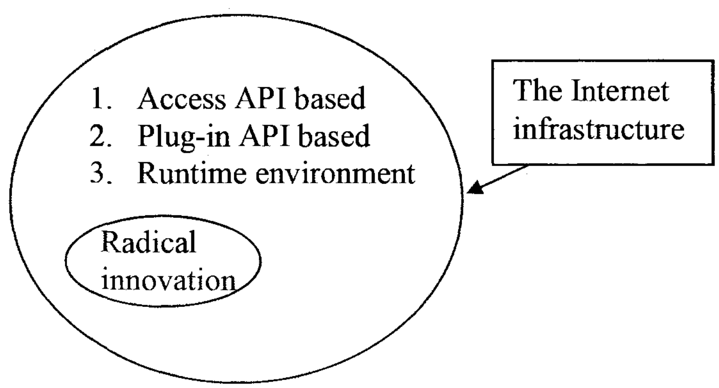

Figure 16: Institutionalization effect in Internet based external platform development

5.5.3 Effect of institutionalization on open CGBPs

Finally the effect of institutionalization on open CGBPs is discussed here. As identified in Proposition 3, institutionalization does limit NEPs' innovation initiatives on open CGBP itself. Since an open CGBP is defined and shaped by many stakeholders, there is a critical mass that needs to be convinced for innovation initiatives to take effect on the platform. However, as illustrated in the internal and Internet based external platform circumstances, this institutionalization effect only applies within the ecosystem. Any company not utilizing a said open CGBP is free to make any level of innovative initiative on their platform.

Thus in summary the institutionalization effect also limits extensiveness of innovation initiatives on open CGBPs and results in shifting the position of new innovations higher along the vertical domain into applications developed on top of open CGBPs.

5.6 How to grow the ecosystem anchored around an open CGBP

The health of an ecosystem is more important that its size (Moore, 2005). The literature on business ecosystem outlines many ways in which an ecosystem can be sustained and grown. Bailetti (2008) identifies ecosystem health as a function of:

- Profits members generate
- Rate of product and services introduced
- Number of new niches created
- Number of members contributing to evolve foundation platform
- Heterogeneity of members, products and services, and interactions

- Ability to withstand shocks and adapt to changes

Since open CGBP development is still in its infancy, data is not available to measure these attributes. In order to sustain and grow the ecosystem anchored around open CGBP, all the participants of the ecosystem must first understand the existence of the ecosystem and their roles in the ecosystem. It is also important to understand the ecosystems are different from clusters, networks, associations and alliances (Bailetti, 2008). Shared vision of the companies in the ecosystem must be reflected in the SCOPE keystone, and the process to identify/change leaders in keystone must be transparent. The health of the ecosystem is strengthened by the diversity of members who compete and collaborate and by the more number of diverse niches.

6 CONCLUSIONS, LIMITATIONS, AND FUTURE RESEARCH

6.1 Conclusions

This research developed a model and propositions on the effects of open CGBP development on NEPs, COTS/FOSS suppliers, and service providers. The model captured the internal and external environments that affect the usage and investment in open CGBPs.

This research categorized the developed propositions into four groups: (i) the company motivation to participate in the development of open CGBPs, (ii) behaviour of participation, (iii) engagement dynamics, and (iv) outcomes from participation.

The business ecosystem perspective helped understand the changes in roles, foundation, and leadership of companies as NEPs move from proprietary platform development to open CGBP development. The product development perspective helped understand the value capture in open CGBPs and the level of COTS/FOSS integration in open CGBPs. The technology infrastructure perspective helped understand the level of innovation in open CGBPs and the need for service providers' participation.

Due to the infancy nature of open CGBPs, only a handful of individuals have a deep understanding of the development open CGBPs, level of integration of COTS/FOSS components, and the inter-organization level of collaboration within an ecosystem framework.

6.2 Limitations

The model and propositions were developed only using the analysis of the SCOPE Alliance domain the VSE project. Thus they are not tested and cannot be generalized.

Due to the downturn of the economy, it was difficult to convince more executives to collaborate.

6.3 Opportunities for future research

This study provides at least two opportunities for future research:

1. Test propositions

2. A research study is suggested to examine how open CGBP effects internal development changes such as:
    - The requirement for new work breakdown structures
    - New metrics to measure product development effectiveness and efficiency
    - Changes in the development processes
    - Different skill set on the part of developer

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APPENDICES

Appendix A: Summary of interview carried out with a VSE project architect

	Nortel Network's VSE Platform
Project Summary	Versatile Service Engine (VSE) is an open CGBP built on the AdvancedTCA specifications
Open specifications used	AdvancedTCA, AIS, HPI specifications from SA Forum
Driving factors	To avoid vendor lock-in Reduced cost o Better costs for components due to higher competition among COTS suppliers Innovative products o Many third party vendors working on the same thing Better capabilities and functionality fit
Internal development changes	One team dedicated to the development of the VSE platform. This team acts as a supplier to the rest of the teams developing applications on top of the VSE platform
Product positioning	VSE is kept as a general computing platform More application specific functionality is pushed into products on top of VSE
Forecast for radical innovations	In early integrations were at the chip level, now NEPs are integrating boards, and in the future NEPs may end up integrating at the system level. For example, buying a complete open CGBP from vendors. More focus is on applications and services on top of platforms
Issues/problems faced	COTS suppliers are not caught up to AdvancedTCA specifications Lack of software integration capabilities from third party vendors o Integration software currently handled by Nortel o Hopes to get support from third party vendors Some specifications of AdvancedTCA are not complete o Nortel needs to fill in the gap o Nortel gives more specs to suppliers (RFPs) when buying external hardware components o Nortel tries not to make extra specifications derail from AdvancedTCA o Do not want suppliers making manufacturing components specifically for Nortel

Appendix B: Sample questionnaire sent out to the participants

OPEN CARRIER GRADE-BASED PLATFORM

My name is Jeevithan Muttulingam (jeevithan@ieee.org) and I am a graduate student in the TIM program at Carleton University. I am completing a thesis supervised by Prof. Tony Bailetti (bailetti@sce.carleton.ca). I would very much appreciate you taking 10-15 minutes to provide comments on the propositions and the model shown on page 2 and answers to the questions on page 4.

Figure 1 represents my thinking about:

- How an open Carrier Grade-Based Platform (CGBP) affects various aspects of a Network Equipment Provider (NEP)
- How investment in an open CGBP affects aspects of NEPs', service providers', and COTS/FOSS suppliers' involvement

I seek your feedback on whether or not the model is accurate and complete. For each proposition, please let me know the changes that I should incorporate or any other comments you may have on the space provided. Pages 5-7 provide supporting rational for each proposition.

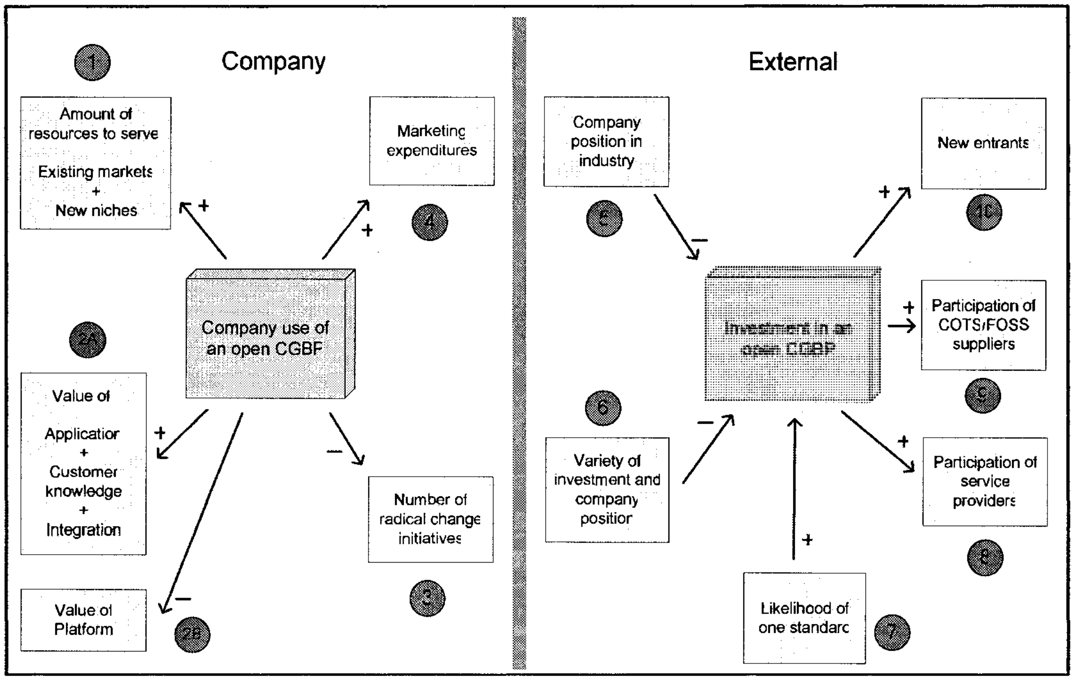

Figure 1: Usage and investment towards an open CGBP and its effects

Propositions	Changes and comments
1: Use of an open CGBP increases an NEP's resources to serve existing markets and to capture new market niches	
2: Use of an open CGBP shifts value from being in the platform to being in the applications, customer knowledge, and the knowledge on how to integrate external components	
2A: Use of open CGBP increases the value of applications, customer knowledge and integration	
2B: Use of open CGBP decreases the value of platform	
3: Use of an open CGBP decreases the number of company initiatives focused on radical change	

4: Use of an open CGBP increases marketing spending	
5: Amount contributed towards the development of an open CGBP is negatively related to an NEP's position in the industry	
6: Variety of contribution towards the development of an open CGBP is negatively related to an NEP's position in the industry	
7: Investment in an open CGBP is positively related to the likelihood of emergence of a single platform over the long term	
8: Service providers' participation in an open CGBP development is significantly greater than their participation in a proprietary platform development	
9: Third party COTS/FOSS suppliers' participation in an open CGBP development is significantly greater than their participation in a proprietary platform development	
10: Open CGBP increases the number of new entrants (NEPs) into the market	

QUESTIONNAIRE

1) Is the model shown in Figure 1 complete? What changes would you suggest I incorporate into the model? Are there any important aspects that are missing?

2) Currently open CGBP specifications such as AdvancedTCA are defined in standards groups (SCOPE Alliance, PICMG, etc) and platforms are built internally integrating COTS/FOSS components. For example Nortel's Versatile Service Engine (VSE) is a company specific open CGBP built on the AdvancedTCA specs. Is this development approach likely to continue? Where do you see the next stage for open CGBPs?

3) In your opinion what are some best practices to grow the health of the ecosystem anchored around open CGBPs?

RATIONALE FOR PROPOSITIONS

Proposition 1: Use of an open CGBP increases an NEP's resources to serve existing markets and to capture new market niches.

When an NEP is solely responsible for the platform, it contributes a significant amount of resources towards advancing and maintaining the platform. However, when it uses an open CGBP, a significant amount of resources is no longer tied to internal platform development which is now available to invest towards satisfying customer needs and to expand into new niche markets.

Proposition 2: Use of an open CGBP shifts value from being in the platform to being in the applications, customer knowledge, and the knowledge on how to integrate external components.

> Proposition 2A: Use of open CGBP increases the value of applications, customer knowledge and integration.
>
> Proposition 2B: Use of open CGBP decreases the value of platform.

When a platform is built internally, it captures a significant amount of IP. This is not the case with open CGBPs. With open CGBPs, NEPs make money only on the value-add applications that customers care about. Thus, the value of the IP of an NEP using an open CGBP will have to shift from being in the platform to being in applications, customer knowledge, and integration. When companies are faced with commoditization – in this case the platform is being commoditized – they have no other choice but to invest in creating innovative new products.

Proposition 3: Use of an open CGBP decreases the number of company initiatives focused on radical change.

Well defined infrastructures constraint technological changes to a routine, cooperative process within defined boundaries. Since an open CGBP is defined and shaped by many stakeholders, there is a critical mass that needs to be convinced for radical changes to take effect. Open CGBPs have standardized practices and processes that nurtures an arena for incremental innovations with predictive characteristics and greatly reduces likelihood for radical innovations. For example, technological opportunities that may be valuable but not related closely to the established design specifications are less likely to receive attention and any progress on those opportunities may not be considered. This may result in companies decreasing their investment in radical change initiatives.

Proposition 4: Use of an open CGBP increases marketing spending.

With all NEPs developing products on the same platform, companies are forced to differentiate their end products and the values they serve to customers. Branding and other marketing strategies become paramount resulting in increased marketing spending. Heavy advertisement is a key attack strategy when competing in a common platform environment.

Proposition 5: Amount contributed towards the development of an open CGBP is negatively related to an NEP's position in the industry.

An NEP's investment in an open CGBP depends on its position in the industry. A market leader may be less interested in using an open CGBP since it will destroy its IP invested in proprietary platform and hence its competitive advantage. An NEP that is not a market leader or a new entrant into the industry would be heavily involved in establishing and using open CGBPs as a way to bypass building expensive proprietary platforms and to reduce the leader's competitive position in the industry.

Proposition 6: Variety of contribution towards the development of an open CGBP is negatively related to an NEP's position in the industry.

With open CGBPs, an NEP can participate, contribute, and reap benefits at various levels. An NEP participating with an open CGBP development can invest towards leadership roles in industry standard groups (SCOPE Alliance, etc), develop open CGBPs assets, and/or manage particular niche markets. However, an NEP's level of investment is inversely related to its position in the industry. For example, an NEP that is not a market leader or a new entrant in the industry would be heavily involved in all aspects of an open CGBP development; whereas, a market leader may just opt out to be a mere observer.

Proposition 7: Investment in an open CGBP is positively related to the likelihood of emergence of a single platform over the long term.

Development of an open CGBP is more appealing for NEPs when the entire market is likely to be served by a single platform over the long term. If a winner-take-all outcome is favoured when multiple rivals are developing competing platforms, the winner has a chance of earning monopolist's profits whereas the rest of the firms are forced to total write-offs. This is disconcerting to most top management teams of NEPs as many are risk averse and would result in rivals combining forces to develop open CGBPs.

Proposition 8: Service providers' participation in an open CGBP development is significantly greater than their participation in a proprietary platform development.

Service providers, NEPs primary customers, will react positively towards an open CGBP initiative. Open CGBPs decrease vendor lock-ins. Service providers could potentially have seamless mixing of best-of-breed products from different NEPs and yet still conform to a uniform set of management and maintenance procedures. The modular and open aspect of open CGBPs provide a clear picture for service providers to understand key components and the ability to make design-level inputs. The modular architecture of open CGBPs also reduces service providers' cost of operation, cost of interaction, and risk while increasing trust on products built on top of open CGBPs.

Proposition 9: Third party COTS/FOSS suppliers' participation in an open CGBP development is significantly greater than their participation in a proprietary platform development.

An open CGBP facilitates a suitable environment for third party suppliers to provide inputs into open CGBP development. There are many incentives for suppliers to involve in with the definition of specifications such as the ability to steer the direction of specs definition and evolution

Proposition 10: Open CGBP increases the number of new entrants (NEPs) into the market.

Incumbent NEPs have heavily invested in proprietary platforms which are seen as high barrier to entry for new entrants into the same market. However, the development of open CGBPs reduces barriers to entry. New entrants with little system design expertise in telecommunications can lever open CGBPs to quickly turn out adequate products.