International Journal of Engineering Science Invention
ISSN (Online): 2319 – 6734, ISSN (Print): 2319 – 6726
www.ijesi.org ||Volume 6 Issue 11|| November 2017 || PP. 04-07

Telecommunications using Systems Engineering Methodology

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Abstract: *The discipline of systems engineering and system thinking concept began mid-century as a result of military planning, and was later adopted and expanded by defence and aerospace industries (Checkland, 1979). Systems engineering practices and processes used today therefore evolved to facilitate military and aerospace applications, although the usefulness of the discipline extends far beyond its original purpose. Industries reliant on systems engineering structures frameworks and their practitionersgas and oil, telecommunications, large construction projects, and transport and logistics systems. Professions using systems engineering disciplines include project and asset management, and utility management. Despite being used for over a half century, systems engineering concepts just recently have emerged as a discipline in its own right. This is partly due to the roots of systems' practices relating to defence and aerospace industries and requiring different applications in other industries, for example, telecommunications which is the focus of this case study. Hence, the case study compares these two domains (aerospace and defence and telecommunications) to elicit similarities and differences to give a broader picture about new systems applications. In addition, the architectural aspect of communications networks is considered.*

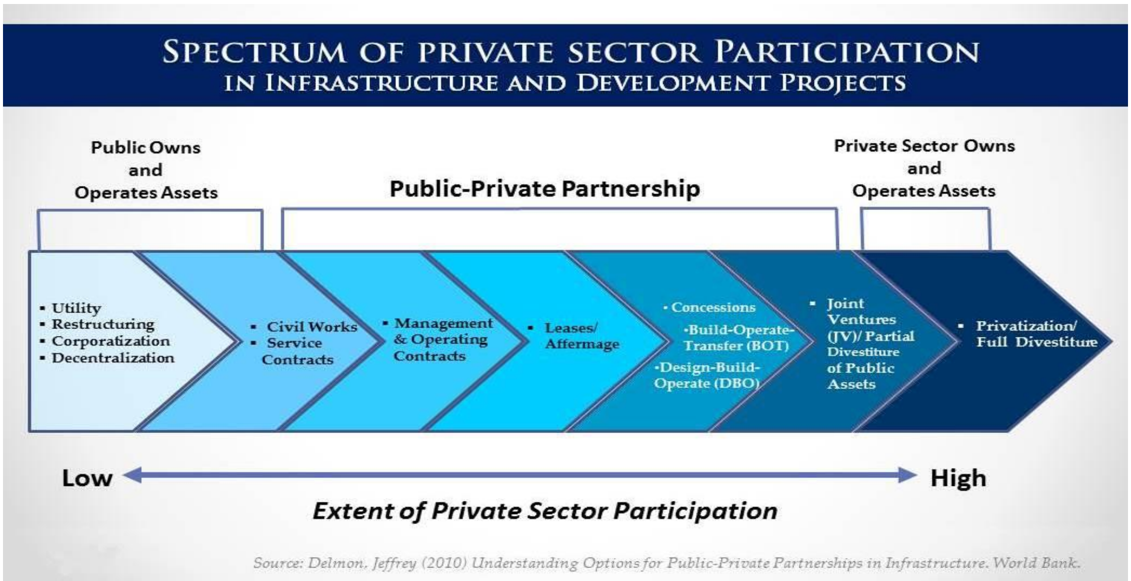
Date of Submission: 23-10-2017 Date of acceptance: 04-11-2017

I. Introduction

Evaluation

The case study considers systems engineering mapping in the early stages of a telecommunications development project. These particular systems process activities are then compared with traditional defence-based methodologies.

There are common elements between the approaches of system engineering for aerospace/defence and telecommunications, although they are applied differently according to the type and conditions of each project. The INCOSE Systems Engineering Handbook (2000), notes a number of differences between defence and private sector applications, such as telecommunications, as shown in figure 1.



Source: Delmon, Jeffry(2010) Understanding Options for Public Partnerships in Infrastructure, World Book.

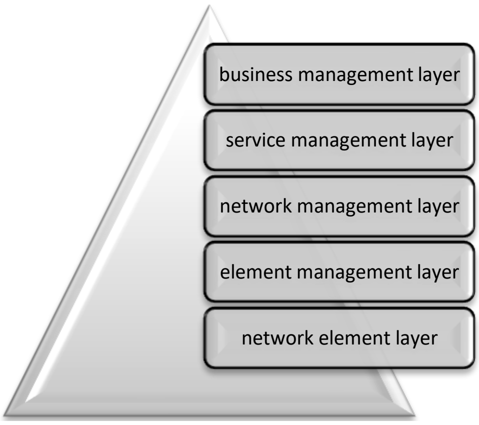
Figure 1 *Differences in systems approaches, public and private projects*

In public military systems the goal is system reliability and functionality, whilst in private commercial systems, useful and attractive features (aesthetics) play a greater role after functionality. The private sector system or product also has a price target, that is cost structure, set by the competition (Mital et al. 2009).

Of importance in systems engineering planning are design constraints (INCOSE, 2000). These include regulatory constraints, including submissions, test results and time involved for approvals to be granted. In telecommunications, there are also private sector permits to be considered when hardware or software licensing is considered. Further, cost concerns for development time involve market dynamics which require flexibility and positioning in the market to adapt to new technology. It could be argued that defence goasl are clear for their project systems, whilst in the private sector, goals are unclear and often it is the competition that is the benchmark for acceptability.

The case study mentions defence program elements of system engineering which could be successfully transferred to the private sector. In the early exploratory stages of systems development there are particular defence/aerospace practices which can add value to the commercial application, given relevance and validity. Thus, further transfer of knowledge between industries is required to develop systems engineering as a profession.

A further matter is changing styles of telecommunications management, which, because of the merging technologies of communications and data transfer, wireless applications and proliferating systems design, has necessitated several managerial layers to control interconnections of the evolving ICT industry. Change management is inherent in this telecommunications management network, where the technical management (network element) deals with the software and hardware of the system and the others deal with policies, procedures, services, facilities, data and personnel.



Source INCOSE Systems Engineering Handbook 2011, s.
Figure 2 *Telecommunications management network*

In traditional aerospace and defence approaches, a strong presence in the non-engineering manager levels are not as apparent; thus telecommunications differs with its needs for change management and control management in an industry which has its own architecture, methodology and protocols.

Building blocks

Whilst traditional building blocks form a hierarchical model for the aerospace/defence functions (system, segments, subsystems and components), a telecommunications structure differs as the top elements of the model do not represent aggregates of the lower items. The telecommunication model can be envisioned as consisting of nodes, lines and terminals: a node being a multi-line entry and terminals are the end equipment for each line. In every node layers of protocols control the transmission of communications and data back and forth.

Characteristics of systems engineering design

In this study, protocols for systems engineering are derived from the International Standards Organisation. The model for national standards is prefixed with ISO, and has a seven-part Reference Model for communications or ICT, which facilitates global connectivity between all countries. In this model, each layer has its own functionality and protocols which now differ substantially from the initial defence/aerospace models of a half-century past. (INCOSE, 2000). Varying functions are defined in each layer to facilitate particular modes of communication, so that high rates of technology change on some levels require frequent upgrades and protocol changes, which are reflected in national standards. To build a new network, such as the Australian national network, requires selective use of protocols and models from each layer, hence, Australian design can be totally different from other countries provided that standards for each particular layer are obeyed.

Identify and resolve complexity

Complexity in telecommunications takes several external forms: technology change, the international protocols, national government action in either aerospace or telecommunications industries. Internally, the large number of stakeholders and the interactions between subsystems underlie the complexity of the system, which must be designed for maximum flexibility. Arguably, the most effeicient technology will be the latest, but competition in the ICT industry leads to proliferations of applications which add significantly to problems with connectivity, operability, and system overload. Further, customer support for the myriad of machines and technologies that are in use and on the market leads to underuse and waste. Complexity in telecommunications at all levels seems destined to grow.

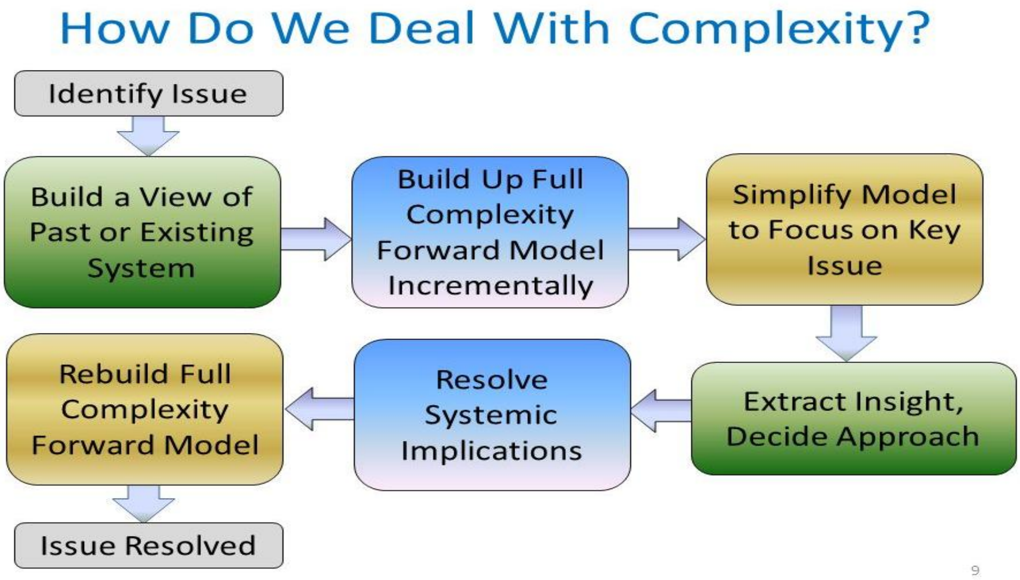


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Figure 3 *who to deal with complexity*

Evaluate systems engineering application

In this case study, systems engineering's processes and practices are used initially to launch another network, product or service. Rarely is the growing complexity of the applications manifest at every level considered, apart from obtaining more resources. Systems engineering must remain within national and international protocols; however, engineering ingenuity and flexibility is required simply to integrate new services and products into existing constraints, including physical constraints of materials and bandwidths, and industry constraints of regulations and competition.

II. Conclusion

The lessons learnt from this case study are concerning. There are major differences in development processes between defence and telecommunications systems, and in the evolution of both sectors. There are issues for systems engineers when operating in the different organisational environments of public and private enterprises, with their hierarchical and network structures and the high level of competition in telecommunications which forms differing constraints of cost and aesthetics. In each domain there may be various drivers which affect commercial development processes and then influence the role of SEs in tailoring and development new systems.

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Shougi Suliman Abosuliman Telecommunications using Systems Engineering Methodology." International Journal of Engineering Science Invention(IJESI), vol. 6, no. 11, 2017, pp. 04-07.