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EVOLUTION OF MILITARY INFORMATION MANAGEMENT

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Abstract

The paper focuses on information dimension in the structure of Information and Communication Technology architecture and searches for better models to describe the structure of blue force information, especially from Enterprise Architecture (EA) approach. Enterprise Architecture has been developed better to communicate the complex structures of military capabilities. Major EA frameworks (TOGAF, DODAF, NAF) recognize the layer of information between business and technology. Nevertheless, in practice, the focus tends to turn more to the technology as has happened in several Command, Control, Communications, Computing, Information, Surveillance, and Reconnaissance (C4ISR) or Enterprise Resource Management (ERM) programs. The paper develops a tool for architects to use in measuring the maturity of information management in the current military organization and in defining the possible paths of evolution in information management available for military.

The outcome is a roadmap that describes the evolution of past and probable future for military information management and explains different drivers and constraints on roads. The roadmap is tested against experiences gained from several C4ISR, and ERM focused military transformations. The overall research approach is following the hypothetico-deductive model, and the roadmap part is applying the theory of evolution in sociotechnical systems.

Since information is essential for cognitive level sense making, decision making, and learning, Enterprise Architects should include information maturity in their roadmaps of technical and business process development. The roadmap for military information management is to help the analysing of the current situation and provide possible paths towards future stages aligned through business, information, and technical layers.

Key words: Information Science, Information Management, Enterprise Architecture, Military Transformation, C4ISR, Enterprise Resource Management

Introduction

Information and Communications Technology (ICT) has made major advances in linking the physical dimension through information to the cognitive dimension as described by John Perry et al. (2004) in their model for Information Superiority[1]. The information technology linkage between the physical and cognitive dimensions has created new ways of effect both for the red and blue force. Armed Forces recognise the benefit of sharing of information[2], collaboration[3], and coordination[4] instead of constraining and stove piping the data.

Over the past few decades, the military have been attempting to utilise information in new ways, for example, in the digitalisation of command and control[5], military supply chain management, enterprise resource management, learning management, and force production. These transformation initiatives have not been straightforward successes, failures have occurred in designing[6], implementation[7], and consolidation[8]. The reasons for these challenges are many: technology, project, security, data migration, trust, procedural, culture, among other issues. The paper approaches problems from the perspective of Enterprise Architecture frameworks such as TOGAF[9] and NAF[10].

1 Perry, Walter and Signori, David and Boon, John (2004): Exploring Information Superiority. A Methodology for Measuring the Quality of Information and Its Impact on Shared Awareness. RAND Corporation, Santa Monica CA.

2 McChrystal, Stanley, et. al. (2015): Team of teams. New rules of engagement for a complex world. Penguin Random House. New York. ISBN 978-1-59184-748-9 Pp. 118-124.

3 NIT (2013): NATO unveils Afghan Mission Network Operations Center at Kabul airport. Retrieved from http://northiowatoday.com/2013/07/15/nato-unveils-afghan-mission-network-operations-center-at-kabul-airport/.

4 Mattis, James (2013): 19 Unforgettable quotes from retiring General James 'Mad Dog' Mattis. Business Insider. Retrieved from http://www.businessinsider.com/general-maddog-mattiss-best-quotes-2013-1?IR=T&r=US&IR=T#in-this-age-i-dont-care-how-tactically-or-operationally-brilliant-you-are-if-you-cannot-create-harmonyeven-vicious-harmonyon-the-battlefield-based-on-trust-across-service-lines-across-coalition-and-national-lines-and-across-civilianmilitary-lines-you-need-to-go-home-because-your-leadership-is-obsolete-we-have-got-to-have-officers-who-can-create-harmony-across-all-those-lines-13.

5 Alberts, David & Hayes, Richard (2003): Power to the edge. Command… Control… in the information age. CCRP Publications. ISBN 1-893723-13-5.

6 DeMarco, Tom; Lister, Timothy (2003): Waltzing with bears. Managing risk on software projects. Dorset House Publishing Co, New York. ISBN 978-0-932633-60-6.

7 Mattila, Juha (2014): Lessons from developing Army Command, Control and Information System for Finnish Land Force during 2007–2009. Retrieved from http://c4isys.blogspot.sg/2014/03/lessons-from-developing-army-command.html.

8 UK MOD (2011): MOD information strategy 2011. Better informed, better defence. Retrieved from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/27388/mod_information_strat2011.pdf.

9 Open Group: The Open Group Architecture Framework, TOGAF 9.1. Retrieved from https://www.opengroup.org/togaf/.

10 NATO (2016): NATO Architecture Framework 4.0 draft. Retrieved from http://nafdocs.org/introduction/.

This study is a part of the researchers' intention to find out why so many development programmes for Command, Control, Communications, Computers, and Information (C4I) systems have faced challenges. Challenges have been studied from three architecture perspectives[11]: business view, technical view, and holistic System of systems (SoS) view. This paper focuses on a business view, with an emphasis on data and information management.

The study defines a hypothesis based on the generic evolution of management of unstructured content applied from Melissa Cook (1996)[12]. The hypothesis is tested and improved by implementing the system evolution theory mainly defined by Mokyr[13] (1998) and Andriani[14] (2012). The evolutionary paths of information management are proved with experiences from military organisations.

An architectural map of possible roads with interdependencies is created by merging the possible evolutionary paths together. The architecture map for information management may be used as a tool for strategic planning of C4I System of systems to achieve Information Superiority that military organisations have recently desired[15].

Challenge and hypothesis

Why are many military C4I and ERP system implementations facing challenges? Are there possibilities at an Enterprise Architecture level to help to anticipate some of the information management related problems? These are the primary research questions in this partial study approaching the situation from an information management viewpoint. Other studies by the researchers approach the question from technical, business, cultural, and systems of systems approaches.

In Finland, the Defence Forces failed twice to implement first generation Command and Control systems, first at the operational level in 1995, and the second time at Land tactical level in early 2000. In both cases, the organisation was not

11 Desfray &Raymond 2014.

12 Cook, Melissa, A. (1996): Building Enterprise Information Architectures, Reengineering information systems. Prentice-Hall, New Jersey, ISBN 0-13-440256-1. Pp.1-40.

13 Mokyr, Joel (1998): Science, technology, and knowledge: What historians can learn from an evolutionary approach? Presented to the Conference on The Evolution of Science, Santa Fe, May 16, 1998.

14 Andriani, Pierpaolo and Carigani, Giuseppe (2012): Exaptation, innovation, and modular system. Presented to the School of Management, Cranfield University, November 9, 2012.

15 UK MOD Joint Doctrine Note 2/13: Information superiority. Retrieved from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/239342/20130813_JDN_2_13_Info_Super.pdf.

ready to share information and the technical system was intended for more stabilised and structured information exchange[16].

In Denmark, the Armed Forces have struggled in fielding their Enterprise Resource Planning (ERP) system called DeMars. First, they planned to implement it between 1999 and 2004. Evidently, they faced challenges in transforming the information flows from hierarchical line organisation to more horizontal process organisation[17].

The hypothesis of this paper is that there is an evolutionary roadmap for military unstructured information management to be found and to be used for navigation in military transformations. Enterprise Architects could use this roadmap to improve their understanding and analysis of the complex, open system of military organisation and their information management abilities. The roadmap emerges when stages of general information evolution are modeled with general system evolution frameworks. Melissa Cook[18] (1996) provides the first ideas for the stages of management of unstructured information. Richard Thorpe[19] et al. (2008) illuminate further the evolution of business knowledge. Schmidt and Cohen[20] (2013) recreate the vision for digitalisation of companies and nations. Based on these three approaches, and the short history of computing[21], the core stages of evolution of unstructured information are defined as print, file, folder, page, social media content, and semantic content - also illustrated in Figure 1.

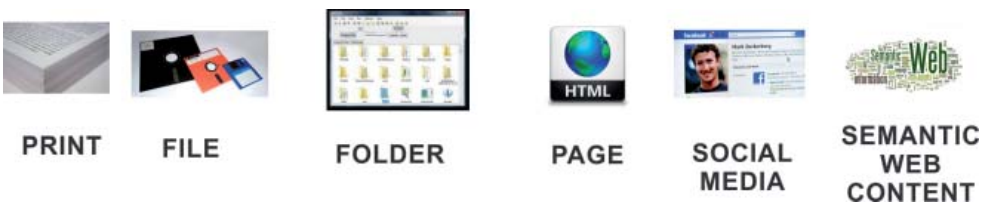

Figure 1. Assumed stages for evolution of unstructured information management

16 Mattila (2014): Lessons from developing Army Command, Control and Information System for the Finnish Land Force 2007 – 2009. Extracted 5. Nov 2016 from http://c4isys.blogspot.sg/2014/03/lessons-from-developing-army-command.html.

17 DeMars: Dansk Forsvars Management- og Ressourcestryringssystem. Retrieved from https://da.wikipedia.org/wiki/DeMars.

18 Cook, Melissa, A. (1996): Building Enterprise Information Architectures, Reengineering information systems. Prentice-Hall, New Jersey, ISBN 0-13-440256-1. Pp.1-40.

19 Thorpe, Richard; Jones, Oswald; Macpherson, Allan, and Holt, Robin (2008): The evolution of business knowledge in smaller firms. An article in Evolution of business knowledge, Edited by Harry Scarbrough. Oxford University Press. Oxford. ISBN 978-0-19-922960-4. Pp. 23-49.

20 Schmidt, Eric and Cohen, Jared (2013): The new digital age, Reshaping the future of people, nations and business. John Murray, London. ISBN 978-1-84854-621-9 Pp. 32-81.

21 Whitworth, Brian and Ahmad, Adnan (2010): The evolution of computing. In the encyclopedia of human-computer interaction. 2nd Edition. Interaction Design Foundation. Retrieved from https://www.interaction-design.org/literature/book/the-encyclopedia-of-human-computer-interaction-2nd-ed/socio-technical-system-design.

The paper focuses on military support and mission networks such as the USA's APAN[22], NIPRNET[23], and SIPRNET[24]. This article does not explain military Internet usage nor evolution of information management in governmental extranets or tactical level networks.

Method for research

The research follows the hypothetico-deductive method[25] applying the tools of systems science[26]. The interdisciplinary system science helps to understand open[27] (i.e. a system that is influenced by its environment), complex[28] (i.e. system that composes of many elements or fields that collaborate to create a functioning whole), and socio-technical[29] (i.e. interaction of social and technical factors creates conditions for successful organisational performance) systems.

Military organisation is defined in this paper as open, a complex socio-technical system that exists in the national environment and geopolitical situation. Per evolutionary paradigm, everything that exists is evolutionary and has dependencies in its history, its culture, what is happening in other fields of life and what opportunities there are available in the future. There are two major approaches for research of

22 The All Partners Access Network (APAN) is the Unclassified Information Sharing Service (UISS) for the U.S. Department of Defense (DOD).

23 The Non-secure Internet Protocol (IP) Router Network (NIPRNET), but prevalently referred to as the „'Non-classified' IP Router Network," is used to exchange sensitive but unclassified information between „internal" users as well as providing users access to the Internet. It was replaced by „Sensitive but Unclassified IP Data."

24 The Secret Internet Protocol Router Network (SIPRNet) is „a system of interconnected computer networks used by the U.S. Department of Defense and the U.S. Department of State to transmit classified information (up to and including information classified SECRET) by packet switching over the TCP/IP protocols in a 'completely secure' environment".

25 Brody, Thomas (1993): The philosophy behind physics. Edited by Luis de la Pena and Peter E. Hodgson. Sprinter-Verlag, Berlin. ISBN 3-540-55914-0 Pp.84-94.

26 Flood, Robert L. & Carson, Ewart R. (1993): Dealing with complexity: An introduction to the theory and application of systems science (2nd Edition). Plenum Press, New York. ISBN 978-1441932273.

27 Bastedo, Michael N. (2004): Open systems theory. The SAGE encyclopedia of educational leadership and administration. Retrieved from http://www-personal.umich.edu/~bastedo/papers/bastedo.opensystems.pdf.

28 Bodenschatz, Eberhard (2009): Complex systems. Max-Planck-Gesellschaft. Retrieved from https://www.mpg.de/36885/cpt08_ComplexSystems-basetext.pdf.

29 Trist, Eric & Bamforth, K. (1951): Some social and psychological consequences of the long-wall method of coal getting. Human Relations, Vol 4, 1951 pp.3-38.

institutional evolution: Path Dependency[30] and Knowledge Driven Evolution[31]. The path dependency emphasises historical causality, whereas the knowledge-driven model also includes discrete possibilities for evolution. Thus, the latter approach was chosen for this research. The six stages of generic evolution of information management and a generic military structure are processed through the evolutionary model derived from evolutionary theory described originally by Joel Mokyr (1998). The Mokyr model[32] helps to recognise the paths of evolution, the forces that may influence development, and the ways that have been taken in achieving goals in open, complex systems.

A system that composes of individual subsystems that are interrelated is called System of systems (SoS)[33]. The SoS may be directed, acknowledged, collaborative, or virtual[34] and has an open structure, which interacts with its environment and the community that is using it. The SoS has been designed to fulfil a function based on the knowledge that is available to the community and is considered useful[35]. As an open system, the SoS tends to lose its coherence with time. Friction and entropy are powers that change the structure and usage of SoS at the micro level[36].

The SoS evolves over time together with its society and the environment. The evolution of the SoS can be explained using Joel Mokyr's (1998) model, which is further extended by Andriani and Carigani's (2012) modular exaptation[37] to create a better understanding of compartmentalised development. Intentional knowledge creation is explained using Cattani's (2002) model of preadaptation[38]. Choo's (1998) approach for the Knowing Organisation[39] is used to better understand the forces affecting information processes. Christensen (2011) introduces exaptation[40] as

30 David, Paul A. (1994): Why are institutions the 'carriers of history'? Path dependence and the evolution of conventions, organizations and institutions. Structural Change and Economic Dynamics 1994, Vol. 5, Issue 2, Pp. 205-220.

31 Mokyr, Joel (2002): The gifts of Athena. Historical origins of the knowledge economy. Princeton University Press, Princeton. ISBN 0-691-12013-7. Pp. 284-297.

32 Mokyr, Joel (1998): Science, technology, and knowledge: What can historians learn from an evolutionary approach? Presented to the Conference on The Evolution of Science, Santa Fe, May 16, 1998.

33 The U.S. Department of Defense (DoD) System Engineering Guide for System-of-Systems Engineering (Version 1, August 2008) defines four types of systems of systems, directed, acknowledged, collaborative, and virtual.

34 Maier, M.W (1998). „Architecting Principles for Systems-of-Systems." Systems Engineering. 1(4). Pp. 267-84.

35 Mokyr, Joel (2002): The gifts of Athena. Historical origins of the knowledge economy. Princeton University Press, Princeton. ISBN 0-691-12013-7. Pp. 284.

36 Mattila, Juha (2016): Using evolutionary theory in explaining system of systems development. Retrieved from http://c4isys.blogspot.sg/2016/04/using-evolutionary-theory-in-explaining.html.

37 Andriani, Pierpaolo and Carigani, Giuseppe (2012): Exaptation, innovation, and modular system. Presented to the School of Management, Cranfield University, November 9, 2012.

38 Cattani, Gino (2005): Preadaptation, Firm Heterogeneity, and Technological Performance. Article published in Organizational Science, Vol.16, No. 6, November-December 2005, pp. 563-580.

39 Choo, Chun Wei (1998): The knowing organization. Oxford University Press, New York.

40 Christensen, Clayton M. (2011): The Innovator's Dilemma. HarperCollins, New York.

a possible path for evolution. The composed model is evaluated against Bertalanffy's (1968) general system theory[41] as major forces affecting evolution are simplified. Finally, a practical, optimistic approach (the exploitation phase in the flow of events in Gunderson & Holling's (2002) Panarchy model[42]) is chosen to generate a model with a positive incline towards development.

In the constructed evolutionary model, there are three main paths for System of systems to evolve:

1. Preadaptation is driven by the need to develop new SoS'. It includes research, experimenting, and acquiring new knowledge with other means. Several optional solutions may be produced and explored to find the best fit. Gained knowledge and prototypes are used to design new SoS' to fulfil the requirements of the new function.

2. Adaptation happens when the SoS is co-opted gradually for different usage without necessarily understanding why it fits to the new function.

3. Exaptation occurs when component C from another system is co-opted as part of SoS' in making it more efficient or fitting to the purpose.

There are driving and resisting forces that affect the evolution of function and SoS. This optimistic model simplifies them into two opposing forces: Resistance and Drive. The optimism is the decline in the picture in Figure 2. The model assumes that there is a generic drive to improve and develop the performance of the community, systems it is using, and knowledge it possesses.

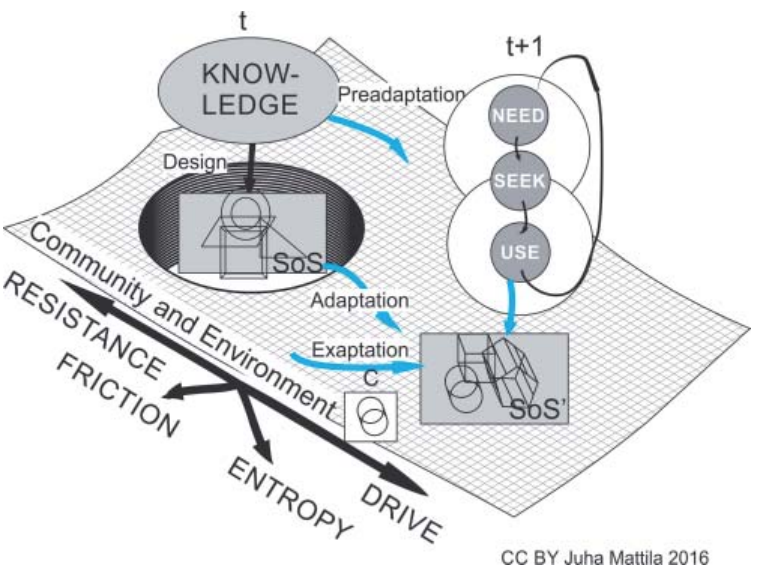

Figure 2. An optimistic model to explain evolution of System of systems

41 Bertalanffy, Ludwig von (1968): General system theory. Revised edition. George Braziller, Inc. New York.

42 Gunderson, Lance H.; Holling, C.S. (2002): Panarchy. Understanding Transformations in Human and Natural Systems. Island Press, Washington.

Knowledge is imperative for preadaptation and exaptation. For knowledge creation, there is a process of information need, seek, and usage. Both the environment and community are affecting this process from cognitive, affective, and situational dimensions[43].

Description of evolution for the military information management

The means of storing defines the information management in a military environment. Firstly, information was printed on paper and bound to create books or documents which were stored on the shelves of a library or archives. The management of information used bibliographies to publish information on information and physical items (i.e. books or documents) to assist with distribution. Manual flows of paper supported the management processes.

With automated data processing systems, information was captured in digital format, arranged in files, stored in folders, and managed by distributing files through email. The management used physical access to systems, encryption, and restrictions in access to folders. The processes were defined by the functions that were using information systems[44].

The following sections explain the evolutionary stages in the management of unstructured information in a military environment according to their medium.

Print

Since the printing innovation by Gutenberg, the unit for managing information has mainly been a page, document, or a book. Sharing of information is based on distributing letters, memorandums, minutes-of-meetings, and paper documents.

The military has adapted print media from other areas of society and utilised it to manage troops, deliver orders and collect reports. Printed paper is still used for managing many official military documents. The EU Military Staff prefers to manage top secret information on paper because of its physical constraints and manageability[45].

43 Choo, Chun Wei (1998): The knowing organization. Oxford University Press, New York.

44 Mukherji, Ananda (2002) „The evolution of information systems: their impact on organizations and structures", Management Decision, Vol. 40, Issue: 5, pp.497–507.

45 See EU classification guidance for TRES SECRET UE. https://euobserver.com/secret-ue/117634.

File

When personal computing was adapted in military official information management, the paper was converted to file and book to the folder. First, they were stored on data mediums like tape, floppy disks, compact discs, and memory sticks, among other things. Sharing information is based on delivering these mediums that contain files and folders. The military is tackling the issue of non-connected systems by transferring information between systems via manual data mediums (like USB sticks or DVD)[46]. The personal level and manual information management are exposed to risks of data leaks. In the largest military data leak in 2010, almost 400 000 classified logs from the Iraq War were published by WikiLeaks[47].

In the Finnish Defence Forces, the first file sharing content management was used during the 1980s when personal computers were introduced as general data processing entities. One of the first command posts used Nokia manufactured PCs and floppy disks back in 1985[48].

Storage

Furthermore, these files and folders were stored on hard disks and accessed via file management structures (for example FAT, NFS) - first on single PC's and then increasingly networked storages. The military was quick to adapt the developing civilian information technology.

More recent ways of managing and distributing files are cloud based. Besides the legacy storage area networks, the storage may also be organised in a converged architecture, where storage and computing resources are integrated as one computing package[49]. The other end for cloud computing storage is to use hyper-converged infrastructure, where a number of standard attached storages are virtualised using software defined storage[50].

46 See: http://whatis.techtarget.com/reference/Fast-Guide-to-Storage-Technologies.

47 On October 22, 2010, WikiLeaks released almost 400,000 logs from the Iraq War, spanning a period of 6 years from Jan 1st 2004 to Dec 31st 2009. Each log represents a 'SIG ACT' or Significant Action recorded from the field level during the war. WikiLeaks has made these classified logs available to the public on the Internet, and provided a summary of the logs including, among other data, sensitive details such as the location of operations, numbers of deaths and personnel involved in field operations. This represents the largest military data leak (or spillage) in history. See: http://www.titus.com/titus-blog/2010/10/wikileaks-what-can-we-learn-about-protecting-and-sharing-information/#more-273.

48 Peltonen, Erkki and Honkasalo, Kari (2006): From punch card to information network. Original in Finnish: Reikäkortista tietoverkkoon. Puolustusvoimien tietotekniikkalaitoksen historiikki. Puolustusvoimien Tietotekniikkalaitos, Espoo.

49 See: https://en.wikipedia.org/wiki/Converged_infrastructure.

50 See: https://en.wikipedia.org/wiki/Hyper-converged_infrastructure.

In the Finnish Defence Forces, the first email service (Vaxmail) was provided to a deployed force in 1994. The Defence Forces' broad email and file sharing service (Esikuntajarjestelma -95) was implemented in 1995. It also included collaborative consumption pages for private point of sales[51].

Web page

Publishing information on pages has existed since newspapers. A digital page was introduced in 1980. The military has been challenged with this publish and pull method of content management, since the culture of "need to know" requires predefined access rights. The MS SharePoint has become one of the most used platforms for both files and web pages (UK, U.S, NATO). There are also other platforms in use such as IBM WebSphere (FIN, GER) and Open Source based (FRA, U.S). Most of the operational planning is done via portals and orders are both prepared and shared as pages.

In the Finnish Defence Forces, the first Domino portal was published in 1995 and WebSphere Portal in 2007[52].

Social media

Sharing information via social media means has exploded in private life where Wikipedia, Facebook, and Twitter have gained popularity. The military has been following this trend in the Internet environment. In 2007, the first military accounts started appearing in social media. In 2009, US started its first plans for exploiting social media[53].

The whole change from the one-way publish-pull policy of the first Web towards a more interacting and collaborating web is called Web 2.0[54]. The military use enterprise social media tools as part of their content management platforms e.g. SharePoint and WebSphere.

In the Finnish Defence Forces, the first force wide collaboration toolset was published in 2010, which included voice, video, chat, whiteboard, and meeting management[55].

51 Peltonen, Erkki and Honkasalo, Kari (2006): From punch card to information network. Original in Finnish: Reikäkortista tietoverkkoon. Puolustusvoimien tietotekniikkalaitoksen historiikki. Puolustusvoimien Tietotekniikkalaitos, Espoo.

52 Peltonen, Erkki and Honkasalo, Kari (2006): From punch card to information network. Original in Finnish: Reikäkortista tietoverkkoon. Puolustusvoimien tietotekniikkalaitoksen historiikki. Puolustusvoimien Tietotekniikkalaitos, Espoo.

53 See: http://www.defence.gov.au/PathwayToChange/Docs/SocialMedia/3.%20Analysis%20and%20insights.pdf.

54 See: https://en.wikipedia.org/wiki/Web_2.0.

55 Lagus, Antti (2010): Architecture for communications in Defence Forces. Original in Finnish: Puolustusvoimien viestintaratkaisun arkkitehtuuri. Verkostopuolustus 2010, Spring. Puolustusvoimien Johtamisjärjestelmäkeskus, Jyvaskyla. ISSN-L1798-6672.

Semantic web information

The next generation of markup Web is called semantic, or sometimes Web 3.0[56]. It means that information is not referred to as a page, but the basic unit is a sentence or word that defines the subject, predicate, and object. This language makes most unstructured data readable by both humans and machines. Most of the military Open Source Intelligence systems have been using semantic structures in categorising events extracted from data flows on the Internet since 2005.

In the Finnish Defence Forces, the first Battle Management System based on the semantic knowledge model was introduced in 2010, and by 2015 it was rolled out for the training of conscript troops[57].

Intelligent web information

As a probable future extension of managing "unstructured" information, research has been done under the title of Web Intelligence or Web wisdom. It consists mainly of using artificial intelligence as a meta-component with all information. Each piece of information thus possesses some application to enable diverse ways of processing data[58].

The critical issue for information is to recognise the context where it is required. By using historic patterns of causality between context and the purpose, an approximation for the purpose of the information can be determined for a given context[59]. Multifactor authentication with inherence factors is one example of the application of this approach.

Evolutionary path

The direct evolutionary path is created as a continuum of these stages in information management, as illustrated in Figure 3.

56 See: https://en.wikipedia.org/wiki/Semantic_Web.

57 Mattila, Juha (2010): Development of land forces C4I for the end state of 2016. Original in Finnish: Maavoimien johtamisjärjestelmän kehittäminen 2016 puolustusvoimia varten. Viestimies no 1/2010.

58 For more on Web Intelligence Consortium (WIC) see: http://wi-consortium.org/.

59 Chang, Carl K. (2013): Situational Software Engineering. Key note presentation in WIC conference October 29, 2013.

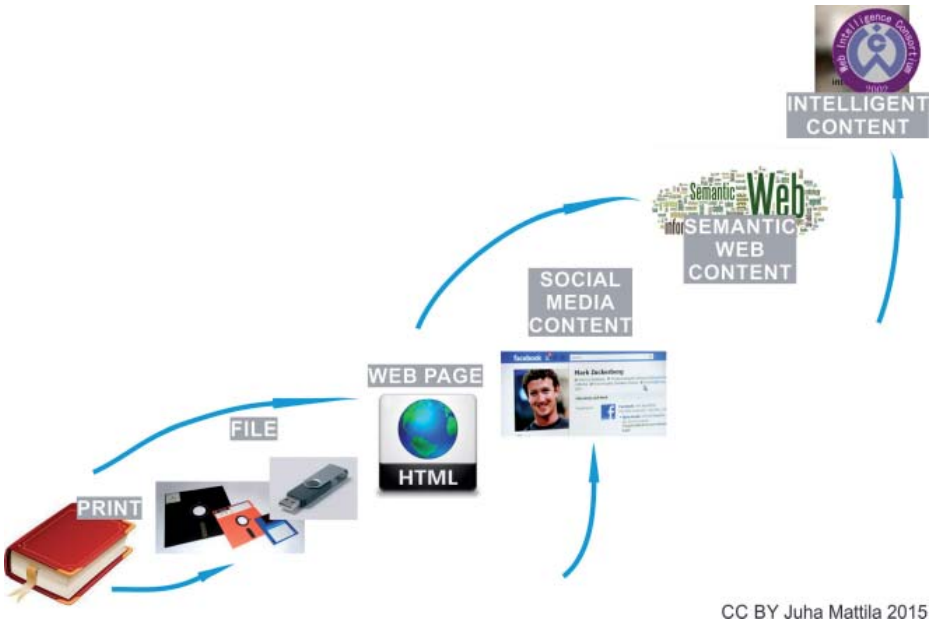

Figure 3. Evolutionary path for military information management

Some of the stages have causality with their history. Print, File, and Page are almost linear in evolution. Semantic content is derived from Page. Personal ways to post information defined Social Media. Intelligent content is extrapolated from machine learning and structured information management. All of them are preadapted first in the civilian sector and then adapted to military purposes. The Finnish Defence Forces have journeyed[60] through all stages but the last. Within the Services of the U.S. Armed Forces, all the stages of information management are present at same time. The future may be driven outside of the military since major civilian ICT companies are investing more in research and development than the defence industry together[61].

60 Mattila, Juha (2016): Architecture for Information Management Transformation; Part G of Introduction to ICT rationalisation programme of the Finnish Defence Forces from Enterprise Architecture viewpoints. Retrieved from http://c4isys.blogspot.sg/2016/03/architecture-for-information-management.html.

61 James, Andrew, S (2013): Emerging technologies and military capability. S. Rajaratnam School of international Studies. Retrieved from https://www.rsis.edu.sg/wp-content/uploads/2014/07/PB131101_Emerging_Technologies_and_Military_Capability.pdf.

The map of possible roads for evolution of military information management

Military organisations have followed the general evolutionary path (print – file – page – social media content – semantic – intelligent content) in developing their management of unstructured information. The general path includes two definite leaps that require more effort: 1) from files to pages; and 2) from unstructured content to more structured content. There have also been more discrete shortcuts together with downgrades defined by cultural and doctrinal powers of the force as illustrated in Figure 4.

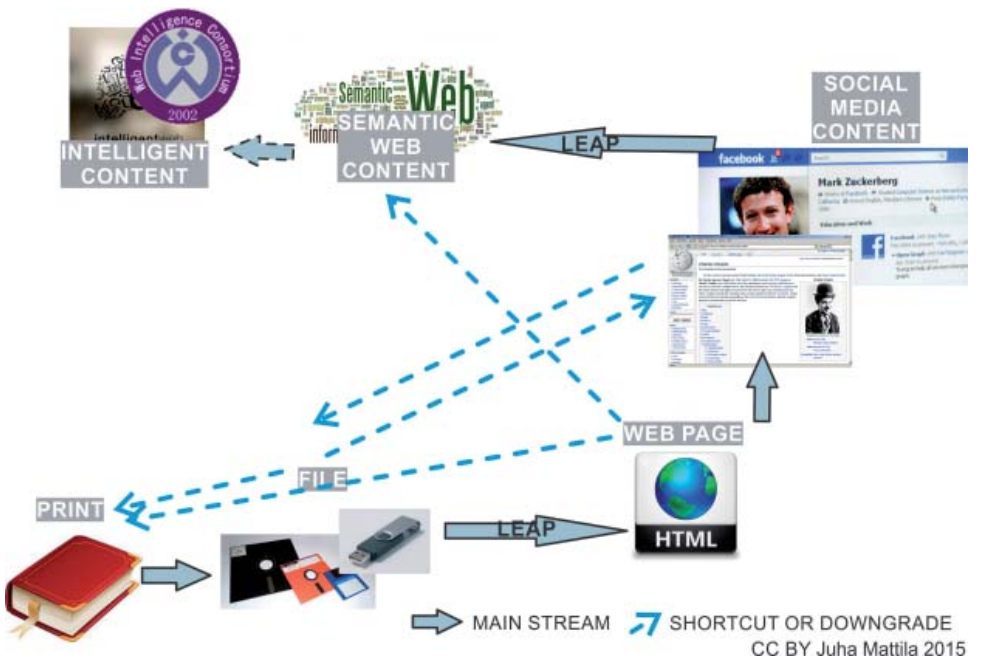

Figure 4. Roadmap for military information management

There are two leaps in the evolutionary path that may present challenges for information management culture. The first is a long cultural leap from individually possessed files in personal folders to publishing knowledge in pages. From an individual viewpoint, one had a feeling of control over one's information in managing personal folders and based on personal decisions to send it to others via means such as email or access to shared folders. Then, suddenly, one is required to publish one's information to everyone via a web page with no apparent control

over who has access, reads the content and – worst of all – uses the information[62]. The military culture with "push to share", "need to know", "learning by instruction" and "confidentiality foremost" values[63] is keeping forces from transforming towards the "need to share" culture[64]. Nevertheless, in the Irish Armed Forces, the Supreme Commander comments on a blog written by a private soldier about lessons learned in the UNIFIL operation[65] - an example of a major culture transformation.

Secondly, there is an extended information structure leap from the huge amount of shared unstructured data (text, pictures, videos, personal sensor data) via enterprise social and other media towards structuring everything in two additional dimensions: metadata and logic[66]. The leap is imperative for enabling artificial intelligence, machine learning, and improved man-machine collaboration. It has taken two years for the Internet to have 4 million domains using schema.org[67] markup language[68]. The U.S DoD has been attempting to build horizontal integration of their enterprise data since 2008 by using standard ontologies[69]. It took the Land Forces of Finland about three years to produce a suitable semantic knowledge model at basic physical and lower abstract levels[70].

There is a possibility to accelerate evolution by utilising shortcuts and passing over some stages. The Land Command of the Finnish Defence Forces jumped directly from file defined to the semantically defined battle management system. It required a consistent effort to change technology, ontology of information, processes, and behaviour of people at the same time[71].

There is also a change to keeping the culture of information management from developing, since new technology is providing ways to get rid of old bottlenecks

62 O'Reilly, Tim (2005): What is web 2.0? See: http://www.oreilly.com/pub/a/web2/archive/what-is-web-20.html. (Accessed on September 14, 2016).

63 Muth, Jorg (2011): Command culture. Officer education in the U.S. Army and the German Armed Forces 1901-1940, and the consequences for World War II. University of Texas Press, Denton. ISBN 978-1-57441-533-9. Pp. 181-200.

64 McChrystal, Stanley, et. al. (2015): Team of teams. New rules of engagement for a complex world. Penguin Random House. New York. ISBN 978-1-59184-748-9 Pp. 118-124.

65 Byrne, Barry (2016): IKON, a case study of a multi award winning knowledge management programme in a 9000+ organization. A keynote presentation in ECKM 2016,2 September, Belfast, Northern Ireland.

66 Szeredi, Peter; Lukacsy, Gergely; Benko, Tamas (2014): The semantic web explained. Cambridge University Press. Pp. 52-73.

67 See: http://schema.org/.

68 Guha, Ramanathan V. (2013): Light at the end of tunnel. Keynote in ISWC 2013, 21-25 October, Sydney, Australia. See: http://iswc2013.semanticweb.org/content/keynote-ramanathan-v-guha.html.

69 CJCSI 3340.02B (2013): Joint enterprise integration of warfighter intelligence. See: http://www.dtic.mil/cjcs_directives/cdata/unlimit/3340_02.pdf.

70 Mattila, Juha (2012): Summary of the contract. Original in Finnish: Urakan päätössanat. Viestimies 4/2012.

71 Mattila, Juha (2012): Summary of the contract. Original in Finnish: Urakan päätössanat. Viestimies 4/2012.

and friction. Search engines, active directory[72], and access to cloud-based file management[73] have extended the file based content management within military enterprises hugely.

The 2010 leak of Iraq War Logs downgraded the U.S. Armed Forces and NATO's attempts to share information more freely amongst staff officers and war fighters[74]. The access to sensitive information was constrained for a single defence analyst[75].

The outcome is a roadmap in Figure 4 that describes the evolution of past and probable future for military information management and explains different drivers and constraints on roads. The roadmap is aligned with other roadmap tools used by Enterprise Architects. The roadmap is further tested against experiences gained from several C4ISR and ERM focused military transformations explained in the following chapters.

Examples of the usage of roadmap

The Enterprise Architect may use a simple illustration for communicating the current situation of technology, information, business, and culture of the military organisation. With the same map, the architect may communicate the possible future states and probable challenges on the journey towards the end state as illustrated in Figure 5. For a novice architect, the basic Architecture Development Model (ADM)[76] seems to provide a top-down blueprint for the future design of the enterprise. Implementing a new business logic enabled by advanced information management and supported by the newest technology surely provides best outcome. Real life leaves the architect with a major investment in technology, but information management behaviour together with change-resistant organisational culture prevent any attempts for further development at business level.

72 See: https://en.wikipedia.org/wiki/Active_Directory.

73 For example, via MS SharePoint or IBM Domino.

74 Farley, Robert (2010): Over the Horizon: WikiLeaks and the Information Battlefield. World Politics Review, October 27, 2010. See: http://www.worldpoliticsreview.com/articles/6842/over-the-horizon-wikileaks-and-the-information-battlefield.

75 Reuters (2013): Iraq war logs in Bradley Manning case 'hit us in the face': US officer. August 01. See: http://www.ndtv.com/world-news/iraq-war-logs-in-bradley-manning-case-hit-us-in-the-face-us-officer-530119.

76 Harrison, Rachel (2013): TOGAF 9 foundation study guide. 3rd edition. Van Haren Publishing, Zaltbommel. ISBN 978-90-8753-741-8. Pp. 87-114.

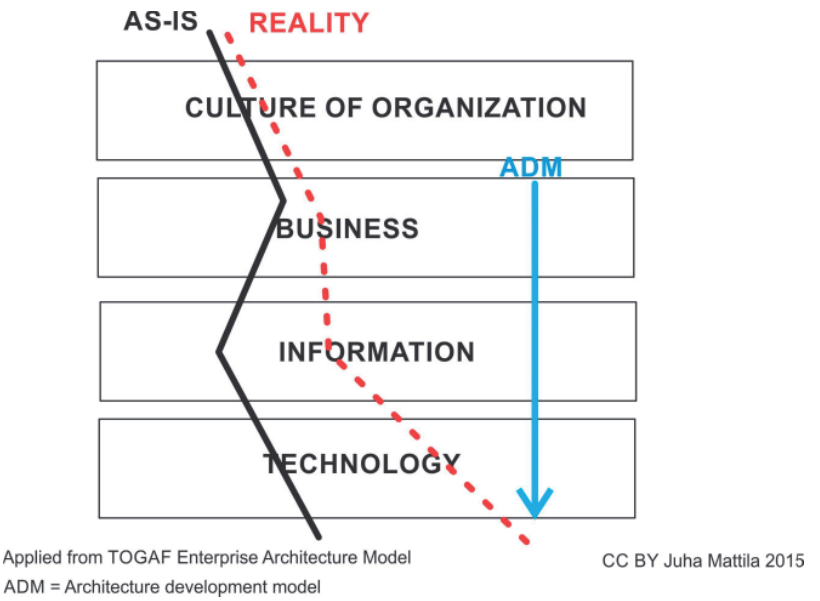

Figure 5. Simple scenario for challenges in development of enterprise capabilities

In 1995, the Defence Forces of Finland fielded their first digitized command, control, and communications (C3) procedures supported by a Graphical Information System, called OPJO. It was based on the most advanced technology of the time, but the organisation never abandoned their file and paper-based information management and 'manually' driven command post procedures. Thus, the C3-system withered while Powerpoint and email based information sharing blossomed[77].

With the information management roadmap, an enterprise architect may be able to illustrate the current situation. The roadmap provides options for a strategy to improve the capabilities, but also provide ways to show the realism of the different paths in Figure 6. The strategy may choose a far edge of technology with intelligent content, but most probably individuals are at the generic social level of using social media, and organisational culture may have difficulties in adapting to need-to-share policy and Web pages.

The more evolutionary strategy might adapt smaller steps and set goals to transform from files to web pages and allow the culture of the organisation to develop more iteratively, as illustrated in Figure 6.

77 Mattila, Juha (2014): Lessons from developing Army Command, Control and Information System for Finnish Land Force during 2007 – 2009. Retrieved from http://c4isys.blogspot.sg/2014/03/lessons-from-developing-army-command.html.

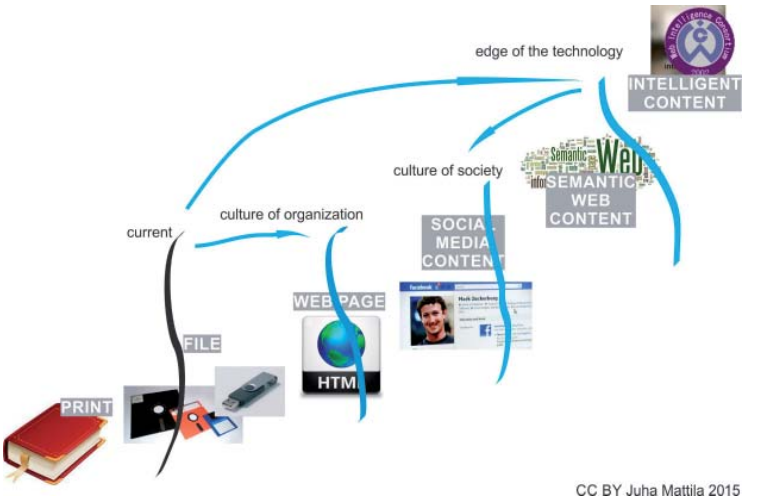

Figure 6. An example of information management architecture analysis

Since information is essential for cognitive level sense making, decision making, and organisational learning, Enterprise Architects should include information management in their roadmaps of technical and business process development. The roadmap for military information management is to help the analyses of the current situation and provide possible paths towards future stages aligned through business, information, and technical layers, taking into consideration the cultural forces as systems science and thinking promotes[78].

Conclusion

The paper uses the hypothetico-deductive approach in creating a linear model for the evolution of information management typical for military organisations. The model is tested within a framework for generic systems evolution and improved into a roadmap. The roadmap for information management explains chosen military cases for both success and failure.

The research proves that there is a roadmap that the evolution of military information management has been following. The roadmap may help Enterprise Architects in their quest to help to define information strategies and understand the forces that effect the transformation of socio-technical systems.

The research in this paper only covers the approach of evolution in information management. The systems and business strategy approached are studied in other

78 INCOSE (2015): Systems engineering handbook. A guide for system life cycle processes and activities. 4th edition. John Wiley & Sons Inc. New York. ISBN 978-1-118-99940-0 Pp. 17-20.

papers provided by the authors. This article does not illustrate the integrated roadmap of business, information, and technology, which can be found in further papers by the writers.

The research is based mainly on qualitative data in proving the roadmap. The data is collected from the few business cases that the authors have been exposed to. There is room for further assurance when the information sharing cultures of the military allow it.

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