EVOLUTION OF MILITARY INFORMATION MANAGEMENT

THE TRANSFORMATION OF MILITARY ORGANISATION OFTEN NEGLECTS THE CULTURE AND MATURITY OF ITS INFORMATION MANAGEMENT

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Summary

Information and Communications Technology (ICT) has made major advances in linking physical dimension through information to cognitive dimension as described by John Perry et al. (2004) in their model for Information Superiority. The information technology linkage between the physical and cognitive dimensions has created new ways of effect both for the red and blue force.

The paper focuses on the information dimension and searches for better models to describe the structure of blue force information, especially from the Enterprise Architecture (EA) approach. Enterprise Architecture has been developed to better communicate the complex structures of military capabilities. Major EA frameworks (TOGAF, DODAF) recognise the layer of information between business and technology, but in practice, the focus turns more to the technology as has happened in several Command, Control, Communications, Computing, Information, Surveillance, and Reconnaissance (C4ISR) and Enterprise Resource Management (ERM) programmes. The paper develops a tool for architects to use in measuring the maturity of information management in the current military organisation and in defining the possible paths of evolution in information management available for the military.
The outcome of this paper is a roadmap picturing the evolution of military information management. Enterprise Architects may use the roadmap in analysing and developing both C4ISR and ERM capabilities in military organisations. The primary research question for this paper is: What may cause so many failures in defining Enterprise Architecture at information management level and then in implementing C4ISR and ERM tools?

The paper first defines six stages for management of unstructured information from various former studies and information architecture models (Cook, 1996). The basic stages of evolution of unstructured information are defined as print, file, page, social media content, semantic content, and intelligent content.

These six stages and a generic military structure are processed through an evolutionary model derived from evolutionary theory for technical development described by Joel Mokyr (1998). The Mokyr model helps to recognise the paths of evolution, the forces that may influence the development and the ways that have been taken in achieving goals.

The outcome is a roadmap that describes the evolution of past and possible future for military information management and explains different drivers and constraints on roads. The roadmap is aligned with other similar roadmap tools Enterprise Architects are using. The roadmap is further tested against experiences gained from several C4ISR and ERM focused military transformations. The overall research approach follows the hypothetico-deductive model (Brody, 1993) and the roadmap part applies the theory of evolution in sociotechnical systems (Bertalanffy, 1969).

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.

Meanwhile, it is possible to accelerate evolution by taking shortcuts. A consistent effort to change technology, processes, and people at the same time is needed when, for example, taking force from publish-pull pages to semantic information management. It might be easier to start with structured information and then, gradually, include unstructured information.

Strong forces may also pull back already achieved development if the change has not been made to stick properly. Losing the thin trust for shared information management early in implementation may prevent individuals from sharing for a long time. Not providing the expected level of availability of the service for the knowledge base may lose the confidence of process owners.

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 analysis of the current situation and provide possible paths towards future stages aligned through business, information, and technical layers.

The research in this paper only covers the approach of evolution. The systems and business strategy approached are studied in other papers. 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. There is room for further assurance when the information sharing cultures of the military are enabling it.

**Keywords:** Information Science, Information Management, Enterprise Architecture, Military Transformation, C4IISR, 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. The Armed Forces recognise the benefit of sharing of information\(^2\), collaboration\(^3\), and coordination\(^4\) instead of constraining and stove piping the data.

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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\textsuperscript{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\textsuperscript{6}, implementation\textsuperscript{7}, and consolidation\textsuperscript{8}. The causes for these challenges are many: technology, project, security, data migration, trust, procedural, culture, among other issues. The paper approaches problems from the view of Enterprise Architecture frameworks such as TOGAF\textsuperscript{9}, MODAF\textsuperscript{10}, DODAF\textsuperscript{11}, and NAF\textsuperscript{12}.

This study is 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\textsuperscript{13}: the business view, technical view, and holistic System of Systems (SoS) view. This paper focuses on the business view, with 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)\textsuperscript{14}. The hypothesis is tested and improved by implementing the system evolution theory mainly defined

\textsuperscript{13} Desfray & Raymond 2014.
by Mokyr (1998) and Andriani (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 the C4I System of systems to achieve Information Superiority that military organisations have recently desired.

**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 look at the question from technical, business, cultural, and systems of systems approaches.

In Finland, the Defence Forces failed twice in implementing a first generation Command and Control system, 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 ready to share information and the technical system was intended for more stabilised and structured information exchange.

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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 a hierarchical line organisation to a more horizontal process organisation.

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 modelled with general system evolution frameworks. Melissa Cook (1996) provides the first ideas for the stages of management of unstructured information. Richard Thorpe et al. (2008) illuminates further the evolution of business knowledge. Schmidt and Cohen (2013) recreate the vision for digitalisation of companies and nations. Based on these three approaches, and the short history of computing, 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](https://da.wikipedia.org/wiki/DeMars)

The paper focuses on military support and mission networks such as the USA’s APAN\textsuperscript{24}, NIPRNET\textsuperscript{25}, SIPRNET\textsuperscript{26} or NATO’s AMN\textsuperscript{27} and FMN\textsuperscript{28}. This article does not explain military internet usage nor evolution of information management in governmental extranets or tactical level networks.

Digital Information can be divided roughly into structured and unstructured information based on its organisation\textsuperscript{29}. Unstructured information does not have a pre-defined data model, nor is it organised in a pre-defined manner\textsuperscript{30}. Unstructured information requires a human being to understand it, as it is presented mainly as text, audio, or video. Structured information is organised according to the pre-determined data model, or it is annotated using an ontological taxonomy\textsuperscript{31}. It can be understood both by human and machine. This study focuses on managing the unstructured information in the above defined military information environments.

\begin{itemize}
\item \textsuperscript{24} The All Partners Access Network (APAN) is the Unclassified Information Sharing Service (UISS) for the U.S. Department of Defense (DOD).
\item \textsuperscript{25} 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.”
\item \textsuperscript{26} 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.”
\item \textsuperscript{27} Primary Command, Control, Communications, Computers, Combat Systems, Intelligence, Surveillance, and Reconnaissance (C5ISR) network in Afghanistan for all ISAF forces and operations. Consists of the ISAF SECRET network as the core with connections to national extensions from numerous Tactical Connection Nodes.
\item \textsuperscript{28} Federation Mission Network which is to be used for national application for both Allies and Partners, internally in NATO for operations, exercises, training etc., with Partners for operations, exercises, training etc. FMN as a capability is going to be delivered in conceptual form to NATO at the end of 2013 and in 2014 tested at different exercises to be operational in 2015.
\item \textsuperscript{30} See Wikipedia: https://en.wikipedia.org/wiki/Unstructured_data.
\item \textsuperscript{31} See Webopedia: http://www.webopedia.com/TERM/S/structured_data.html.
\end{itemize}
Method for Research

The research follows the hypothetico-deductive method 32 applying the tools of systems science 33. The interdisciplinary system science helps us understand the open 34 (i.e. a system that is influenced by its environment), complex 35 (i.e. system that is composed of many elements or fields that collaborate to create a functioning whole), and socio-technical 36 (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 existing 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 institutional evolution: Path Dependency 37 and Knowledge Driven Evolution 38. 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

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Joel Mokyr (1998). The Mokyr model\textsuperscript{39} helps us recognise the paths of evolution, the forces that may influence development, and the routes that have been taken in achieving goals in open, complex systems.

A system that is composed of individual subsystems that are interrelated is called System of systems (SoS)\textsuperscript{40}. The SoS may be directed, acknowledged, collaborative, or virtual\textsuperscript{41} and has an open structure, which interacts with its environment and the community that use it. The SoS has been designed to fulfill a function based on the knowledge that is available to the community and is considered useful\textsuperscript{42}. 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\textsuperscript{43}.

The SoS evolves through time, together with its society and the environment. The evolution of the SoS can be explained with Joel Mokyr’s (1998) model that is further extended by Andriani and Carigani’s (2012) modular exaptation\textsuperscript{44} to create a better understanding of compartmentalised development. Intentional knowledge creation is explained using Cattani’s (2002) model of preadaptation\textsuperscript{45}. Choo’s (1998) approach for the Knowing Organization\textsuperscript{46} is used to better understand forces affecting information processes. Christensen (2011) introduces exaptation\textsuperscript{47} as a possible path for evolution. The composed model is evaluated


\textsuperscript{40} 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.


\textsuperscript{44} Andriani, Pierpaolo and Carigani, Giuseppe (2012): Exaptation, innovation, and modular system. Presented to the School of Management, Cranfield University, November 9, 2012.


against Bertalanffy’s (1968) general system theory⁴⁸, as major forces affecting evolution are simplified. Finally, a practical, optimistic approach (exploitation phase in the flow of events in Gunderson & Holling’s (2002) Panarchy model⁴⁹) 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, or acquiring new knowledge by 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 community, systems it is using, and knowledge it possesses.

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 dimensions⁵⁰.

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

Description of Evolution for the Military Information Management

The means of storing defines information management in a military environment. The first information was printed on paper and bound to create books or documents which were stored on 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 via 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\textsuperscript{51}.

In the information environment\textsuperscript{52}, the human creation of information was mainly by writing or drawing at first, but then the content was amended with pictures and videos and now the tendency is towards more audio and video based communication. On the other hand, a human being is gradually substituted by machines which sense their environment and create both structured and unstructured information of a vast magnitude i.e. big data\textsuperscript{53}. The volume, velocity, and variety of this new data have gone beyond the ability of legacy computers to process. The management of big data cannot be based anymore on files and folders\textsuperscript{54}.

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

**Print**

Since the invention of printing by Gutenberg, the unit for managing information has been mainly 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 in managing many official military documents. The EU Military Staff prefers to manage top secret information on paper because of its physical constraints and manageability\textsuperscript{55}.

\textsuperscript{52} The aggregate of individuals, organisations, or systems that collect, process, or disseminate information; also included is the information itself. See also information system. Dictionary of Military and Associated Terms.
\textsuperscript{55} See EU classification guidance for TRES SECRET UE. https://euobserver.com/secret-ue/117634.
When personal computing was adapted in military official information management, the paper was converted to file and book to folder. First, they were stored in data mediums like tape, floppy disks, compact discs, and memory sticks among others. Sharing information is based on delivering these mediums containing 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). The personal level and manual information management is 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.

In the Finnish Defence Forces, the first file sharing content management became utilised in 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.

Furthermore, these files and folders were stored on hard disks and accessed via file management structures (for example FAT, NFS) - first in single PCs and then increasingly networked storages. The distribution of files between storages

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57 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.
was first done by File Transfer Protocol, FTP or via Email (mainly SMTP). The military was quick to adapt the developing civilian information technology.

The more current ways of managing and distributing files are cloud based. Besides the legacy storage area networks, storage may also be organised in a converged architecture, where storage and computing resources are integrated as one computing package. 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.

The cloud-stored files are accessed via different means. Most common file sharing platforms are, for example, MS SharePoint, OneDrive, Dropbox, Bit Torrent, and Netflix.

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

Web Page

Publishing information on pages has been there since newspapers. A digital page was introduced in 1980. The method is composed of hypertext (HTML) structured page, Uniform Resource Locator (URL) to provide an address to

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64 See: https://en.wikipedia.org/wiki/HTML.
HTML page, Hypertext Transfer Protocol\textsuperscript{66} to provide a session between page and viewer, and a web browser\textsuperscript{67} to present the content of the digital page to a viewer.

The military is challenged by this publish and pull method of content management since the culture of “need to know” requires predefined particular 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) or 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\textsuperscript{68}.

### 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 on social media. In 2009, the US started the first plans for exploiting social media\textsuperscript{69}.

The whole change from the one-way publish-pull policy of the first Web toward more interacting and collaborating web is called Web 2.0\textsuperscript{70}. Web 2.0 is defined by social networking, video sharing, web applications and collaborative consumption. The military use enterprise social media tools as part of their content management platforms e.g. SharePoint and WebSphere.

\textsuperscript{67} See: https://en.wikipedia.org/wiki/Web_browser.
\textsuperscript{70} See: https://en.wikipedia.org/wiki/Web_2.0.
In the Finnish Defence Forces, the first force wide collaboration toolset was published in 2010 and included voice, video, chat, whiteboard, and meeting management\textsuperscript{71}.

**Semantic Web Information**

The next generation of markup Web is called semantic or sometimes Web 3.0\textsuperscript{72}. 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. The semantic web uses Resource Description Framework (RDF)\textsuperscript{73} to describe information, taxonomies, and interchangeability features. The Web Ontology Language (OWL) describes ontologies and data syntax is described in Extensible Markup Language (XML). Queries are done via SPARQL\textsuperscript{74}.

Most of the military Open Source Intelligence systems have been using semantic structures for categorising events extracted from data flows on the internet since 2005. Some of the information integration and big data applications in military Enterprise Resource Management have been using semantic models to exchange data\textsuperscript{75}. In the Finnish Defence Forces, the first Battle Management System based on semantic knowledge model was introduced in 2010 and by 2015 it was rolled out for the training of conscript troops\textsuperscript{76}.


\textsuperscript{74} See: http://wiki.opensemanticframework.org/index.php/Main_Page.

\textsuperscript{75} Wisnowski, Denis (2011): Semantic technology in the DoD Business Mission Area. See https://www.youtube.com/watch?v=OzW3Gc_yA9A.

Intelligent Web Information

As a possible 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 different ways of processing data.\(^{77}\)

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.\(^{78}\) 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 illustrated in Figure 3.

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\(^{79}\) through all stages but the last. Within the Services of 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

\(^{77}\) For more on Web Intelligence Consortium (WIC) see: http://wi-consortium.org/.


civilian ICT companies are investing more in research and development than the defence industry together\textsuperscript{80}.

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figure3.png}
\caption{Evolutionary path for military information management}
\end{figure}

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.

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 a personal decision to send it to others via means like email or access to shared folder. Then suddenly, one is required to publish one’s information to everyone via a web page with no apparent control of who has access, reads the content and - worst of all - uses the information. The military culture with “push to share”, “need to know”, “learning by instruction” and “confidentiality foremost” values is keeping forces from transforming towards

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“need to share” culture\textsuperscript{83}. 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\textsuperscript{84} - an example of a major culture transformation within Armed Forces.

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\textsuperscript{85}. The leap is imperative to enable artificial intelligence, machine learning, and improve man-machine collaboration. It has taken two years for the Internet to have 4 million domains using schema.org\textsuperscript{86} markup language\textsuperscript{87}. The U.S DoD has been attempting to build horizontal integration of their enterprise data since 2008 by using standard ontologies\textsuperscript{88}. It took the Land Forces of Finland about three years to produce a suitable semantic knowledge model at basic physical and lower abstract levels\textsuperscript{89}.

There is a possibility to accelerate evolution by using shortcuts and passing by some stages. The Land Command of Finnish Defence Forces jumped from file defined directly to the semantically defined battle management system. It required a consistent effort to change the technology, ontology of information, processes, and behaviour of people at the same time\textsuperscript{90}.

\textsuperscript{84} 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.
\textsuperscript{86} See: http://schema.org/.
There is also a change towards keeping the culture of information management from developing, since new technology is providing ways to get rid of old bottlenecks and friction. Search engines, active directory\textsuperscript{91}, and access to cloud-based file management\textsuperscript{92} 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 warfighters\textsuperscript{93}. The access to sensitive information was constrained for a single defence analyst\textsuperscript{94}.

The outcome is a roadmap in Figure 4 that describes the evolution of past and possible future for military information management and explains different drivers and constraints on roads. The roadmap is aligned with other roadmap tools Enterprise Architects are using. 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 in communicating the current situation of the 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 end state as illustrated in Figure 5. For a novice architect, the basic Architecture Development Model (ADM)\textsuperscript{95} seems to provide a top-down blueprint for the future design of the

\textsuperscript{91} See: https://en.wikipedia.org/wiki/Active_Directory.
\textsuperscript{92} For example, via MS SharePoint or IBM Domino.
enterprise. Implementing a new business logic enabled by advanced information management and supported by the newest technology surely provides the 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.

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

In 1995, the Defence Forces of Finland fielded its first digitised command, control, and communications (C3) procedures supported by a Graphical Information System, named 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

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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.

![Figure 6. an example of information management architecture analysis](image)

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.

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\textsuperscript{97}.

**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 is only covers the approach of evolution in information management. The systems and business strategy approached are studied in other 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 a few business cases that authors have been exposed to. There is room for further assurance when the information sharing cultures of the military are enabling it.


Byrne, Barry (2010): 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.


