DEVELOPMENT PROCESS OF DATABASE APPLICATIONS FOR ARMED FORCES PURPOSES, C2IS AND THE ROLE OF THE INTERNATIONAL SECURITY ORGANIZATIONS IN THIS PROCESS

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KEY WORDS: ATCCIS (Army Tactical Command and Control Information System), C2IS (Command & Control Information Systems), C3 (Consultation, Command and Control), GIS (Geographic Information System), LRP (Land Recognized Picture), MIP (Multilateral Interoperability Program), NATO ACE ACCIS (NATO Allied Command Europe Automated Command, Control and Information System), NC3A (NATO Consulting, Command and Control Agency).

ABSTRACT:

During the last few years developing computer industry has realized one of the potential, which is the Armed Forces Applications. The nature of the Functional Applications was appropriate for the database systems. This is because the manual file organization and the flow charts were available for being computerized. Nevertheless classical database queries became insufficient in satisfying the needs of the users. The reason for this was the requirement of professional users who knew Structured Query Language (SQL) and database technology very well. Only in the standalone Geographic Information System (GIS) software it was possible to have visual analysis.

By the integration of the database applications and GIS engines, data reliability check and visual analysis opportunities were provided to the users. However there were some disadvantages of the hybrid environment. These are SQL proficiency requirements, limitations and low performance of the GIS environment in terms of digital data presentations.

Currently, command and Control Information Systems (C2IS) are serving as Decision Support Systems (DSS). Many different functional information systems such as transportation and movement, health, logistics, intelligence etc. come together under the umbrella of C2IS. These kinds of complex information systems had needed some standards for applications and dedicated database architectures. International Security Organizations (ISO) ruled these standards (such as NATO ACE ACCIS GIS trial results, ATCCIS or MIP architectures) for the member countries and users to secure the interoperability among the C2IS which were developed independently. At the end of this period, a new kind of problem arose. Existed database architectures and GIS would be compatible with the ruled standards to secure interoperability. In order to achieve this purpose instructions have been prepared in the form that is internationally agreed on for volumes of the Archives.

KURZFASSUNG:

In den letzten Jahren hat die Computerindustrie ein neues Potenzial erkannt – Anwendungen im militärischen Bereich. Die Struktur der funktionalen Anwendungensbereiche war für Datenbanksysteme geeignet. Dieses liegt vor allem daran, dass nun Zahlenwerke, Funktionen und Tabellen digitalisiert eingegeben und dargestellt werden können. Allerdings waren die klassischen Datenbankabfragen nicht geeignet für die Bedürfnisse aller Nutzer. Der Grund dafür waren die erforderlichen SQL Kenntnisse und Datenbanktechnologien von professionellen Endnutzern. Allein mit der Geographic Information System (GIS) Software ist es möglich, visuelle Abfragen und Analysen vorzunehmen.

Mit der Integration von Datenbankanwendungen und GIS-Systemen konnten dem Nutzer die Möglichkeiten für eine Überprüfung von Daten und eine visuelle Auswertung angeboten werden. Allerdings mussten einige Leistungseinbußen wegen der Verbindung dieser beiden Systeme in Kauf genommen werden. Damit sind vor allem die SQL Leistungsforderungen, sowie die Grenzen und geringerer Geschwindigkeit der GIS-Umgebung in Bezug auf die Darstellung digitalisierter Daten gemeint.

Zur Zeit dienen ‘Command & Control Informations Systeme’ (C2IS) als Führungsunterstützungssysteme (Decision Support Systems DSS). Derartige Systeme finden sich in verschiedenen funktionalen Bereichen, wie zum Beispiel Transport-, Logistik- oder Gesundheitswesen oder auch der Aufklärung und Informationsgewinnung und lassen sich als C2I-Systeme subsummieren. Derartig komplexe Informationssysteme bedurften Standards für Anwendungen und den Aufbau der Datenbanken. Internationale Sicherheitsorganisationen (ISO) gaben den Mitgliedsstaaten und Anwendern entsprechende Standards vor (wie zum Beispiel NATO ACE ACCIS GIS Versuchsreihe oder ATCCIS Aufbau), um die Interoperabilität dort sicherzustellen, wo Systeme unabhängig

voneinander entwickelt worden waren. Allerdings entstand dadurch ein neues Problem. Bereits bestehende Datenbankensysteme und GIS müssen mit den vorgegebenen Standards kompatibel sein, um Interoperabilität zu gewährleisten. Das soll unter anderem durch den internationalen vereinbarten Standard zum Umfang von Datenbanken erreicht werden.

1. INTRODUCTION

Nowadays, automation of the manual systems and file systems provided a flexibility to all sectors. Especially, independent functional applications and databases were developed with military purposes. Thus, first stage of the information system development was completed. Second stage is development of the integral (complex) information systems, such as Consultation, Command and Control Information (C3) systems. That is because, the existence of standalone information systems is not sufficient any more, for the specialists and decision mechanisms. On the global world, area of interest of military activities covers whole world territory. For this reason, it is required to handle huge amount of information very rapidly. Not only the quantity but also type of the data has changed in terms of armed forces applications. Functional Area services (FAS) were assessed independently so far, but developing IT technology allowed to combine different type of FAS together under the umbrella of Command and Control Information Systems (C2IS). On the other hand configuration of the C2IS could not be completed very easily, because of incompatible architecture of independently developed functional area services applications. Data exchange and interoperability were not maintained among these systems. At this point, International Organizations, such as NATO,UN, EU etc. played important roles for definition of the rules and standards to establish common architectures or open systems design. Especially, as the most important International Security Organization, NATO was very dominant. That is because, organizational requirements for Automated Information Systems (AIS) were very urgent, organizational structure was wide and crowded enough. The most important supportive factor was the shared budget of NATO for developing and testing new information systems. In terms of C2IS, use of interdisciplinary Core Services and FAS together created a synergy. Meanwhile, it should be mentioned that development of the C2IS is still under progress and data exchange, interoperability among independently developed C2IS is an alive problem.

2. MULTILATERAL INTEROPERABILITY PROGRAMME (MIP) TACTICAL C2IS INTEROPERABILITY REQUIREMENT

2.1 Introduction

The application of military force in the early 21st century is demanding. It covers a wide spectrum of threats and deployment scenarios that range from conventional general war through limited operations, crises response operations, asymmetric conflict, and terrorism. Unilateral capability is important to nations but most planning is made on the assumption of alliance and coalition operations in scenarios that are difficult to predict and which often arise at short notice. Thus the nature and composition of a force structure to meet military requirements will be specific to requirement and based upon a general and flexible military capability.

To achieve this, an assured capability for interoperability of information is essential. The successful execution of fast moving operations needs an accelerated decision-action cycle, increased tempo of operations, and the ability to conduct operations within combined/multinational formations. Commanders require timely and accurate information. Also, supporting command and control (C2) systems need to pass information within and across national and language boundaries. Moreover, tactical C2 information must be provided to the operational and strategic levels of command including other governmental departments. Additionally, forces must interact with non-governmental organisations, including international aid organisations.
The Multilateral Interoperability Programme (MIP) aims to deliver an assured capability for interoperability of information to support land focused joint operations[4].

2.2 Aim and use of MIP in the C2IS

The aim of the Multilateral Interoperability Programme (MIP) is to achieve international interoperability of Command and Control Information Systems (C2IS) at all levels from corps to the lowest appropriate level, in order to support combined and joint operations; and pursue the advancement of digitization in the international arena, including NATO.
The means to achieve this will be known as the MIP solution. This will take into account issues regarding the establishment of communication and information systems connectivity, and the establishment of a C2IS interface that fulfils common information exchange requirements.
The Programme has gone through the stages of: operational analysis, concept, feasibility, definition, development and demonstration. The present focus is on implementation and the programme has adopted a controlled iterative cycle to support incremental development. The information exchange requirements, upon which MIP is founded, encompass the spectrum of Joint and Combined Land Operations. Thus MIP meets the requirements of the Land Component Commander of Allied Joint and Combined Operations (including Article 5 and Crisis Response Operations). Systems may be wholly different from each other and need not necessarily conform to any hardware or software standard. Typically systems will be acquired through national or NATO acquisition programmes and their architecture will conform to the national or NATO policy prevailing at the time.
In a community of MIP-enabled C2 systems nations, command levels and organisations can share:
• Situational awareness (including, inter-alia, capabilities and status of friendly and enemy forces).
• Plans and Orders.
• NBC alerts and critical messages[4].

2.3 The MIP concept

The MIP specification consists of common interface and exchange mechanisms (two at present) to exchange information between co-operating but diverse C2 systems. The common interface is the Land C2 Information Exchange Data Model, LC2IEDM. It is a product of the analysis of a wide spectrum of allied information exchange requirements. It models the

information that allied land component commanders need to exchange (both vertically and horizontally). It serves as the common interface specification for the exchange of essential battle-space information. The function, implementation and the display of the host C2 application is not the concern of MIP.
System developers incorporate the MIP specification and include a single interface to it. The specification enables C2IS to C2IS information exchange and allows users to decide what information is exchanged, to whom it flows, when and over what communications medium[4].

2.4 Command and Control Information System

Command and Control Information System can be summarized as the concepts of; interoperability, coherent situational awareness, planning and information management. In fact C2IS has an inter discipliner construction. Namely, C2IS includes, GIS, Management Information System, DBMS, Web technologies, simulation systems together to form a complete "Decision Support System". All of these infrastructure helps to decision mechanisms and provides them consultancy to make a reliable decision under difficult conditions and in short period of time. Time-critical on-demand information processing in modern C2IS systems necessitates highly interconnected IT components that facilitate a media-independent, semantically homogeneous information flow among the various levels of and organizations in the command-and-control hierarchy. Furthermore, due to continually changing requirements, C2IS systems must be extremely flexible with respect to both their own internal structure and the services offered. For example, in order to support multi-lateral operations, a C2IS system must be adaptable to new (possibly evolving) command-and-control hierarchies as well as to new IT services specially tailored for specific operations. As a consequence, modern C2IS systems need to be configurable `on the fly´ and enable – at least in principle – unhindered information flow in the underlying networks. These new challenges call for a novel design paradigm: the focus is shifting from single applications toward networks of cooperating information sources (*network centric computing).*

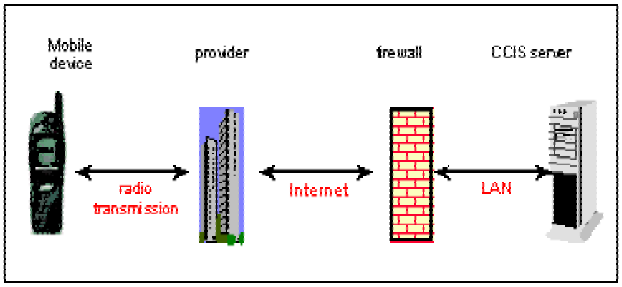

Figure 1. Architecture of Distributed C2IS

The backbone of future C2IS systems will be a network of IT services distributed in the Intranet/Internet. Via the network, IT services can be located and accessed when needed. Meta services (like yellow pages, search engines, data replication daemons, etc.) help locating services and support the integration of heterogeneous information sources. From the user's point of view, each service must be simple and fault-tolerant, and the distributed nature of the system must be transparent. As access points, the user may employ a variety of computational devices, ranging from hand-held devices like mobile phones and PDAs to fully-fledged work-stations. In order to minimize maintenance on the user side, the user interface should be as generic as possible. For instance, one could imagine a standard Web browser serving as user interface. In this way, updates and extensions of the system are contained almost entirely to the server side. Another important requirement on C2IS systems is high availability. In a distributed environment this can be achieved by means of redundancy (e.g., backup servers). Nowadays, trend is the design and implementation of a flexible core of a platform-independent, interoperable, network- centric C2IS system which allows a fast and easy integration of arbitrary IT components. In particular, architecture should be opened to Web Services. To achieve this goal, component-based distributed- object technologies like EJB, Java RMI, and CORBA, and up-to-date Web technologies should be deployed[2].

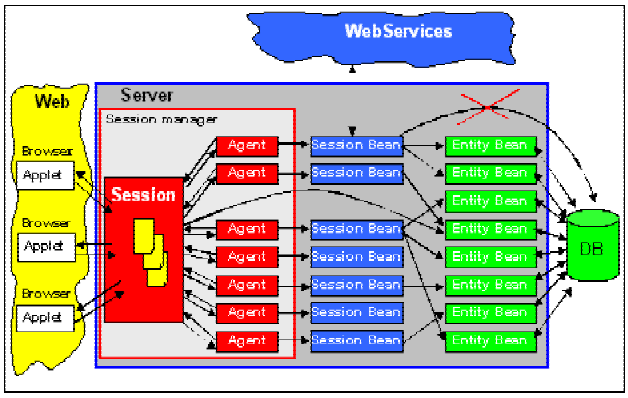

Figure 2. An example system configuration of C2IS [2].

2.5 Future Technology of C2IS

A natural way to communicate is to use natural language. In the research field of Human Language Technology (HLT) constant progress is made. This progress also leads to applications in practice. Examples are telephony systems with spoken input (e.g. information of railway connections), recognition of spoken language by dictation software or semi automatic machine translation. The progress within the area of HLT makes it possible to examine the usability of this technology in military applications and to prove this in prototypical systems. Related to Command and Control Information Systems (C2IS) the following items are of interest:

- Recognition of speech to control a C2IS. This means, that another input modality in addition to the keyboard and mouse is available.
- Natural language access in spoken or written language to C2IS databases.
- Recognition of speech and subsequent language processing as a possibility to input data into the C2IS, e.g. the automatic processing of the audit message of an observation post.
- Processing of spoken or written natural language input (e.g. radio messages or transmission, web pages) for keyword spotting or information extraction. This would deliver information relevant for use in the C2IS.

Today, the usability of HLT is restricted to narrow and well defined application areas (domains). Another requirement is that the language must be restricted as well. This means, that the vocabulary and the grammatical structures must be limited enough such that processing time becomes acceptable. The military domain and the stereotyped military command language seem to be suitable for using HLT. From the different possible uses of HLT in C2IS it was chosen during research project NATLAC (Natural Language Access) the spoken access

to C2IS databases for research. The ATCCIS database delivers the domain model. As a scenario for the prototype system the planning of a multi-national operation was used. In the first step, it was realized that the natural language front-end that will be able to answer simple spoken questions concerning this scenario, e.g., "Gehört das 9. Deutsche Bataillon zu den verfügbaren Einheiten?" ("Does the 9th GE battalion belong to the available units?"). The scenario was elaborated enough, so that more complicated language and domain problems can be modelled too in the future, e.g., complex questions or dialogues. The long-term objective of the project NATLAC is the construction of a dialogue system for a subset of spoken German referring to the scenario in the ATCCIS database [2].

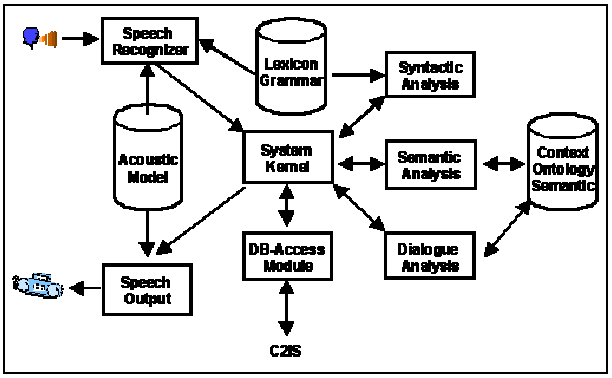

Figure 3. System configuration of HLT [2].

3 GIS & C2IS

3.1 Definition and role of GIS

With a narrow identification; GIS is computer software that links geographic information (where things are) with descriptive information (what things are). Unlike a flat paper map, where "what you see is what you get," a GIS can present many layers of different information. To use a paper map, all you do is unfold it. Spread out before you is a representation of cities and roads, mountains and rivers, railroads, and political boundaries. The cities are represented by little dots or circles, the roads by black lines, the mountain peaks by tiny triangles, and the lakes by small blue areas similar to the real lakes. A digital map is not much more difficult to use than a paper map. As on the paper map, there are dots or points that represent features on the map such as cities, lines that represent features such as roads, and small areas that represent features such as lakes[3].

Briefly GIS, takes together information layers relevant to a definite geographic extend to give the user a better understanding about that region. What kind layers of information you collect depend on your purpose. Especially for the military purposes, aim of the user may be; reconnaissance, Unit/troop tracking, intelligence, operation, C2IS, logistic, battle damage assessment etc. In order to use a GIS:

- Software,
- Data,
- People,
- Training are necessary.

GIS Target Architecture of NC3A covers:

- Use of open standards,
- Elimination of proprietary file formats from Core GIS services,
- Specification of standardised interfaces between the Core GIS services and functional services with emphasis on:
  - Flexibility
  - Openness
  - Interoperability

3.2 Specifications and use of GIS in C2IS

GIS is one of the basic building stone of C2IS. According to the rising trend, GIS works as an integral part of the C2IS. There are some standards for functional area services database architectures such as ATCCIS and nowadays MIP (Multilateral Interoperability Programme), in terms of military symbology ; Mil Std-2525/APP-6(A) etc. Favorite software alternative for database is LC2IEDM Oracle Database. In terms of GIS architecture, NATO ACE ACCIS (NATO Allied Command Europe Automated Command, Control and Information System) geospatial information support for the functional are services. Namely web based tools for situational awareness and all of the functional area services such as LRP(Land Recognized Picture), ERP (Event Recognized Picture) tools etc. use digital geospatial information as map base. GIS also provides geographic analysis opportunity for planning process. Thematic military overlays can also be prepared via GIS.

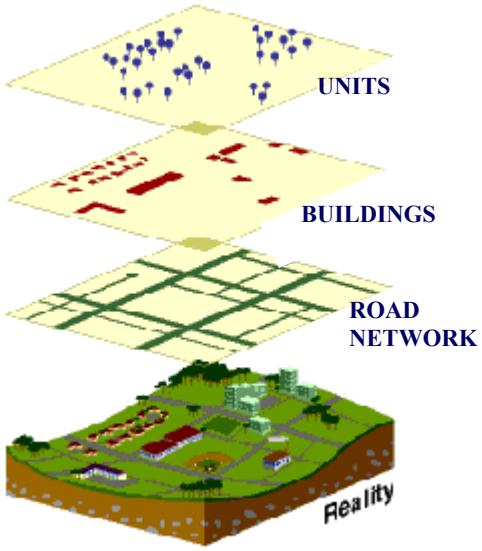

Figure 4. Example for GIS Layers of Information.

Figure 5. Example military overlay in GIS environment of C2IS

4 STANDARDS, STATED BY NATO

4.1 Automated Information Systems (AIS) Developed by NATO

Over recent years the Strategic Commands' (SC) operational Command and Control (C2) Information Systems (C2IS) services have developed along independent paths and to their own schedules. This has resulted in two main systems: the Automated Command and Control Information System of Allied Command Europe (ACE ACCIS) and the Maritime Command and Control Information System (MCCIS) of Allied Command Atlantic (ACLANT). In addition, a plethora of operational C2IS services have been fielded throughout NATO, generally without reference to the achievement of wider systems coherence or interoperability; many of these now fall in the category of legacy systems requiring replacement.
In order to promote interoperabilty, portability, scalability and cost effectiveness across the whole life cycle of AIS and to comply with the relevant Defence Capabilities Initiative (DCI) action items and the NATO Consultation, Command and Control Organisation (NC3O) Goals and Objectives, the two SC's have agreed to achieve architectural convergence and management harmonisation with respect to all AIS services.

4.1.1 NC3O Objectives: The objectives of the NC3O are identified below:

- To integrate and improve the capabilities currently provided by the AIS services within ACE and ACLANT and to NATO HQ, in order to achieve effective and interoperable consultation, command and control, and general administrative functions suitable for flexible direction and execution of day-to-day operations within and beyond NATO's Area of Responsibility (AOR).
- To merge MIS and C2IS to progressively attain an integrated Bi-SC AIS.
- To facilitate the design and subsequent operation of systems that provide improved information flow across hierarchical boundaries, including operational forces, e.g. CJTF-requirements, and that maximise interoperability with national systems.

4.1.2 Evolution Steps : Evolution of the programme was maintained step by step :

- Establishment of the common configuration among system users, including common software and hardware.
- In order to maintain interoperability among different user groups, establishment of the Military Message Handling System (MMHS) or NATO Messaging System Handling Project (NMS).
- Through a combination of evolution steps it will expand the geographic scope of CCIS and provide for information exchange with a number of national sites concerned with NATO planning and consultation. Next step will be implemented as a Bi-SC effort in order to facilitate the convergence of ACE ACCIS and MCCIS to a Bi-SC AIS Core Capability by year 2004.
- The last step has been planned to integrate the Functional Area Services (FAS) across the homogeneous application platform built by the Bi-SC Automated Information System (AIS.) These FASs, supported by common core products, provide specific applications to one or more mission areas (e.g., OPS, LOG, and Personnel.) These are normally provided by a database server and software applications, which run on either the end-user desktop, or on a separate application server, and render the requisite data to the end-users and facilitate data transactions such as display and modification. This step will be enabled by a specific set of FAS CPs, which are currently being developed.

The Figure 6, provides a high-level system view that depicts the Bi-SC AIS Services Paradigm adopted for the Bi-SC AIS Architectural Framework. It comprises:

- the WAN;
- a Core Capability containing common services (e.g. core services and system management services);
- Specific C2 (e.g. Land C2) and Administrative (e.g. Financial) services, which are accessed by users via the enabling functionality provided by the Core Capability.

The Wide Area Network is the data network infrastructure that interconnects the Bi-SC AIS nodes. Its boundary lies within the WAN gateway facilities (currently access routers). The WAN is in the network domain, along with other communications services such as video tele-conferencing and telephony. It is therefore not part of the Core Capability although it is essential to interconnecting AIS nodes.
The Bi-SC AIS Core Capability is the foundation on which the Bi-SC AIS will be built. As such it will provide the common services to support the SCs end users' core business. The achievement of the Bi-SC AIS Core Capability will be the first Bi-SC AIS convergence milestone and will be the result of the harmonisation and standardisation of the Core Capability services of the two SCs: i.e. ACE-ACCIS core components and the ACLANT MCCIS Architectural Convergence Initiative (MACI) core components. This will include the common implementation of other essential capabilities (e.g. message handling, document management, etc.).

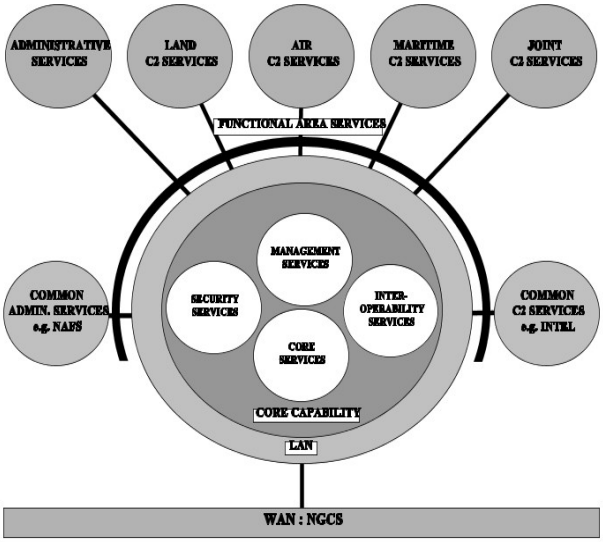

Figure 6. Bi-SC AIS High Level System View

The Functional Area Services, supported by common core products, provide specific applications to specialist end-users. These are normally provided by a database server and software applications, which run on either the end-user desktop, or on a separate application server, and render the requisite data to the end-users and facilitate data transactions such as display and modification.

4.1.3 Functional Requirements: The Bi-SC AIS configuration is required to provide the AIS services, through a combination of hardware and software components.

Core Services will be installed at every Bi-SC AIS node and will be required to support all mission areas/organisational elements with general-purpose services. They will provide common applications for all users and the enabling technologies such as web-browsing, collaborative tools etc.

Interoperability Services will provide information exchange capabilities, facilitate the co-operative efforts of the different command nodes and enhance the ability of the SCs to interoperate with nations and external organisations.

Security Services will provide confidentiality, integrity, availability, authentication, access-control, non-repudiation and accountability services across the entire system.

Management Services will provide for integrated system management and support for both node and Local Area Network (LAN) assets and relevant WAN assets.

Functional Area Services (FAS) will provide business-dedicated applications, databases, and in some cases special interfaces to external systems through secure gateways. These Services will be required to support a specific mission area/organisational element and collaborative processes between different mission areas/organisational elements.

Network Services will provide the variety of communication services required by Static and Deployable HQs and Augmentation Forces. These will be provided by one integrated WAN plus LANs.[1]

5 CONLUSIONS

GIS is a computer application, combining digital geospatial information with descriptive information. GIS holds thematic information on the dedicated layers. At the beginning of the evolution process, GIS was used as a standalone tool. Huge size digital geospatial information warehousing was a problem. Network centric GIS architecture was developed via technological improvements on network, GIS application software and computer sciences. Nowadays, according to lessons learned and results of scientific research, the most favorite configuration is "WEB based GIS architecture with RDBMS based spatial data storage". One of the most important GIS application area is armed forces applications. Strategic trends in armed forces information systems forced the specialists to use integrated systems, for instance C2IS. C2IS are composed of "Functional Area Services" such as Land C2 Services, Air C2 Services, Joint C2 Services etc. additionally "Core Capability" such as Management Services, Security Services etc. and as the last component LAN or Wide Area Network. In fact, each C2 system can be assessed as a hybrid system which is composed of Automated Information Systems, such as Land Recognized Picture Information System or Logistics Information System etc. and GIS component.

In order to secure; interoperability, coherent situational awareness, planning and information management, C2IS have been implemented. Mean while, so far each country in the NATO has developed her own C2IS independently. But, nowadays, trend is the design and implementation of a flexible core of a platform-independent, interoperable, network- centric C2IS system which allows a fast and easy integration of arbitrary IT components. In particular, architecture should be opened to Web Services. Some significant applications of Web services has already been implemented, for instance Common Operational Picture (COP) viewer.

Interoperability is the basic issue among the standalone C2IS and indirectly GIS. In order to secure; interoperability, connectivity and common information exchange ability, NATO has developed some standard architectures, such as ACE ACCIS, ATCCIS, AIS and lately MIP. According to these standard architectures, most probably web based new C2IS and GIS are going to be implemented in the near future.

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