Smart, Visual, Collaborative – Intelligence in 2020

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***Abstract* — Most armies are currently in a transformation process to meet the needs that arise from the nature of present and future types of conflicts. One crucial aspect in any military operation is having the right information at the right time. But, information and data is being produced at an ever increasing pace. Moreover, data is often spread across departments or even across organization without any direct links. The demand for information thus is often only poorly met. A key to find a solution is to rethink the way data and also knowledge is handled. In this context this paper proposes a framework that builds upon three pillars deemed crucial for the future: the smartness of data, the visual appeal of its presentation, and the collaborative nature of working with it.**

***Keywords* — Data Exploration, Knowledge Management, Workflows, Transformation**

I. Introduction

The German *Bundeswehr* is in an imminent balancing act between what is essential for the security and what is financially possible. Saving decisions have made a restructuration necessary. The elimination of the compulsory military service is only the perceived tip of the iceberg. This restructuration includes the reorientation of the intelligence gathering and reconnaissance activities and will revolutionize organization, structure and technical equipment.

According to the *Weißbuch 2006* [1], the security context is extensive: from territory, population and allies' protection, via mastering of regional conflict, till combat of terror and weapons of mass destruction and support of the free world trade. Recent operations show this is not only for the books.

The core problem is found in many organizations. On the one hand it is required to achieve the current level of operation or even more with less money, while on the other hand being confronted with more conflicts, a wider task field, more international operations in multi-national associations with police-like activities and additionally cyber defense.

In light of these challenges this paper proposes an architectural template for building future intelligence principles that relies on three paradigms: smart, visual and collaborative. These paradigms will be motivated and explained in the following, and also sketched how with technologies available today a matching architecture is achievable.

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II. Boundary Conditions

The Network Centric Operations will build a decisive pillar of modern armies [2]. Strategic and tactical intelligence gathering and reconnaissance converge if highly mobile operational troops draw directly on information and resources from the home headquarters. "Traffic Monitoring", "Target Identification" and "Target Monitoring" will be the goals of intelligence solutions in all levels, as shown in Fig. 1.

Fig. 1. Activity Fields of Future Intelligence Solutions

Cooperation with other national and international organizations will be clearly stronger in future operation scenarios, at least in order to reduce cost through synergy.

III. Resulting Requirements

From the experience, the outlined goals and boundary conditions, requirements for intelligence gathering and reconnaissance and for the way up there emerge. Through cost and time pressure, armies can not afford failing big projects any more. "Time-to-market", time between plan and first operational version of a system has to decrease dramatically.

At the same time, the staffing level will be in the future even tighter, and inefficiently used man power a taboo. Future solutions have to be fully integrated and give prominence to the users and their needs.

This effects the organization of procurement orders. Solutions must be accomplished in phases in order to be operational in short time after the first phase. The obtained experience flows in short feedback cycles into the next phases. Solutions have to be prioritized in order to achieve the goals efficiently with the tight budget.

IV. Future Information Gathering and Reconnaissance

The fundamental mission of the intelligence gathering and reconnaissance remains the same: certain users have to be provided with adapted information of the current situation. Through the highly dynamic environment of many armies, the requirements on quality and speed of results are indeed very high and will still increase through the next decade.

In the context of network centric operations, units in operation have to be supported in almost real time by strategic teams in the headquarters, i.e. remote. Warfare reconnaissance and action mesh faster and faster. For instance in police-like tasks (e.g. identify, find, and track targets and suspects) it is necessary to evaluate the obtained material (e.g. intercepted GSM conversations) almost in real time in order to decide on a adequate action. At the same time, the quantity of available information to be evaluated increases: there are more sensors, e.g in UAV's or man-packed. Information of (more or less reliable) partners and third parties (UN, auxiliary organizations, police units, local units) has to be integrated. Also public accessible information has to be mapped in a current situation report ("Open Source Intelligence") [3], for instance information from Twitter about humanitarian acts, often including time and GPS stamp.

Fig. 1 depicts one of the imminent characteristics of today's reconnaissance missions and systems. As seen in the upper row several activity fields of reconnaissance missions are common and need to be supported. In order to support them a core set of different capabilities are necessary. Some of them are shown on the left hand side. Those capabilities on the one hand are independent from each other in the sense that no capability needs any other to be applied. On the other side, for each activity they are combinable to serve its specific needs and demands. Reconnaissance of the future depends on such capabilities being combinable in an easy yet effective way.

Intelligence solutions in the future have to be smart, visual and collaborative in order to put the clients – according to their needs and in real time – in the condition to make sound decisions with fully situation awareness despite the increasing information flow.

Smart

The main goal in the system design for intelligence gathering and reconnaissance should be to offer an optimal user experience, i.e. to give the maximal support to the users in completing their tasks. Optimal user experience is twofold: on one hand, high degree integration of all system components based on the concept "Smart Architecture, Smart Data"; and on the other hand a high usability of the system.

The overall architecture of the intelligence tools (Smart Architecture) allows the seamless interaction between different components, even from different providers. Friction losses at the interfaces are avoided, the interaction between tools is best possible so that the operator can toggle between meta-data analysis and content analysis, between IP data and GSM data, between social network analysis and time-space analysis, without loosing previous analysis results.

At the same time, the architecture allows the inclusion as well as the integration of the most different information sources, due to a smart data alignment. Equal entities in different data sources are combined in the data pool, for instance documents from one person from different sources (GSM calls or e-mail) or biometrical information from a searched person and corresponding photos. Techniques of distributed artificial intelligence ("Semantic Technologies") are used here.

Fig. 2 provides an example of a typical intelligence architecture as can be found in many modern systems. It shows that systems rely on two different types of information that needs to be first integrated and then aligned and correlated. On the left hand side there are different sensor systems, each delivering structured and unstructured data in high volumes and almost real-time. At the bottom, there are many data sources which store background knowledge that piled up during many years of operation. This knowledge is often at different location, in different formats and sometimes uses different terminology to express the same. Its main characteristic is heterogeneity.

Two techniques seem to be promising to align real-time sensor information with background knowledge: An event driven architecture [4] and service orientation. Each step in the chain of evaluation operates on a stream of events coming from diverse source systems and on aggregated data. To be flexible and adaptable to a fast-paced outside world, a smart

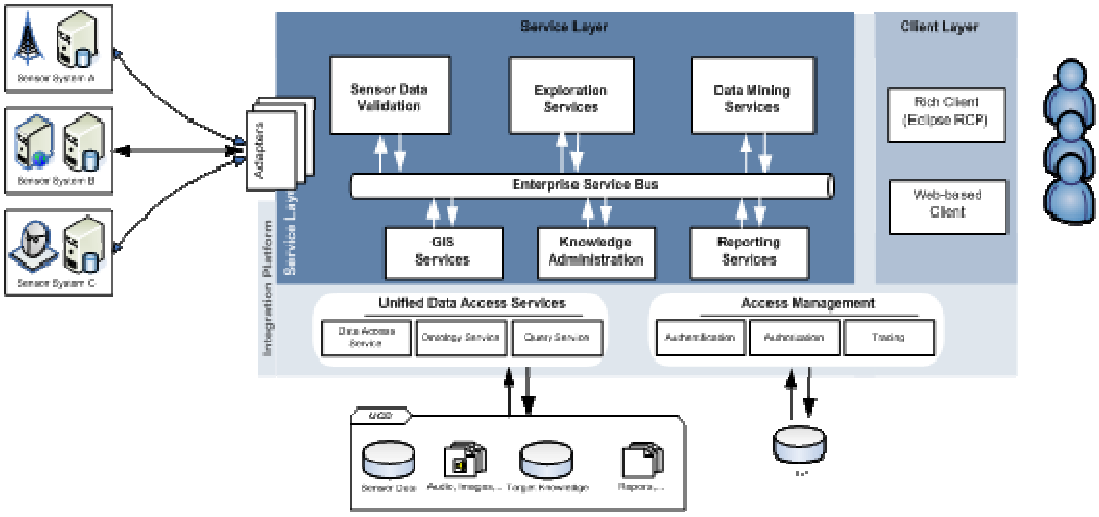

Fig. 2: Typical architecture of a modern intelligence gathering and reconnaissance system.

architecture needs to rely on a set of isolated services: Each service can be implemented without knowledge of the other services to optimize results. The stream of information and the knowledge base act as blackboards for information sharing between services. Sample services include

- *data aggregators* to combine several intercepted technical data events to one real world event, e.g. to detect SIM-switching in mobile phones,
- *enriching services* to align data events on the CSI to background knowledge, e.g. e-mails to known subjects, or
- *semantic services* to align events to an ontology (from the knowledge base), e.g. to extract entities from a textual document.

Fig. 3 sketches the fusion of an event-driven with an service oriented architecture on the example of the JDL data fusion levels [5]. The JDL fusion levels provide an architectural template that ranges from preprocessing sensor information, over identifying objects up to the assessment of threats. This chain first and foremost is based on sensor data which is received as a stream. The use of an event driven architecture ensures that for any identified object or detected situation a new stream of information is generated and pushed forward to higher JDL levels. Entities but also organizational parts who are interested in these streams can subscribe to it, very similar to as everyone can nowadays subscribe to news feeds in the internet. Within each JDL level, background data needs to be accessed and the sensor information correlated with it. This background data contains information on which objects are relevant and what constitutes situations and threats of interest. They are accessed via services. The services on themselves are isolated. Each one does not need any other for delivery. At the same time, they are orchestrated to serve the need of the individual JDL level. Services can be shared across JDL levels and thus remove complexity from system design.

"Smart Architecture" does not rest on cost intensive full automation, but offers specific automatic support where this is most efficient. For instance, the identification of norm behavior and norm deviation, based on the "Discovery of Change", is a useful automation field to deal with big amount of data. The same is true for the semantic analysis of texts.

All components within this "Smart Architecture" can be flexibly user or scenario oriented put together with the work flow, for instance for the temporary integration of external resources.

Under the term "Smart Data", future intelligence solutions subsume the supply to users of exactly the data they need, taking into account information needs, rights and confidentiality requirements. Instead of an active information handover, the system immanently shares information as cooperation basis ("need to share" principle). A use case: An operator identifies a satellite telephone used by pirates based on the content of a telephone call. He or she tags the data of the equipment accordingly. In future calls, the operator does not have to report the location, rather the operation unit in the area where the telephone is used the next time will be informed about the nature of the telephone and its position without intervention of the operator, just because this unit subscribed to the corresponding notifications. Due to "Smart Data", the security of the operation units will increase through adequate situation knowledge, without overcharging it with unneeded information. Fig. 4 provides an example how data is made smart by allowing operators to tag it with contextual background knowledge.

Besides the increased security, "Smart Architecture, Smart Data" leads to an efficiency increase through the minimization of friction losses. The integration of nearly

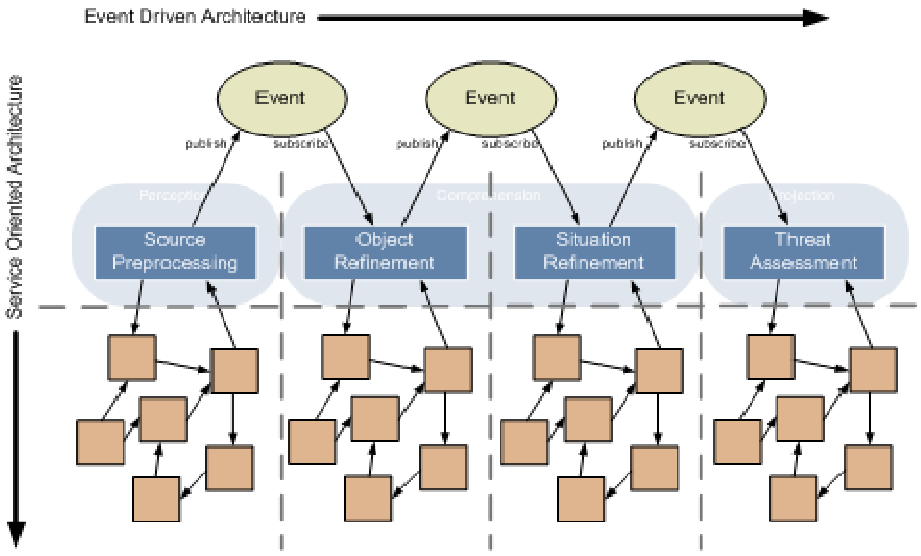

Fig. 3: Smart architecture as fusion of the principles "Event Driven Architecture" and "Service oriented Architecture"

arbitrary data sources, especially third parties' data, and the seamless handover lead also to a cost reduction, since the data do not have to be collected several times and the sharing runs internally in the system, without spending work time.

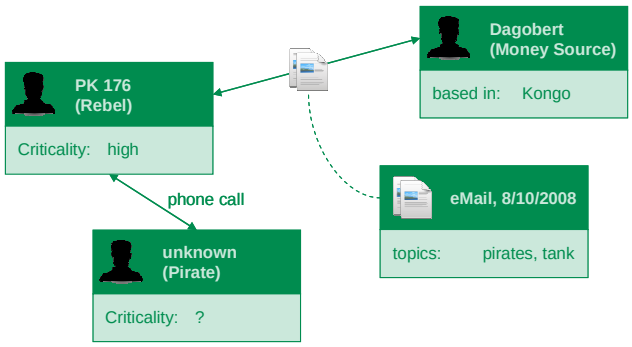

Fig. 4. Tagging an e-mail with "pirate" routes the information automatically to corresponding subscribers

Visual

„Visual Analytics", the graphical and interactive representation of relationships and dependencies, is not only a tool for scientific and engineering applications. Also in intelligence gathering and reconnaissance such techniques are applied to an increasing number of areas. The reason is rather simple: Humans have significant optical and, linked to them, cognitive abilities which allow them not only to survive in everyday life but also to spot relationships and dependencies in graphical representations of data, which would otherwise not, or only with a high effort be discoverable in tabular displays. Examples include the identification of communicating partners from radio emissions [6] or the discovery of groups within large social networks. The emergence of widespread applications of visual analytics is in part also driven by the off-the-shelf availability of high performance hardware, such as graphics cards and 3D displays. Fig. 5 shows several examples of visual analytics technologies.

The advantage of visual analytics lies within its effectiveness: It allows analysis results that are impossible to generate purely automatically, and thus complements data mining and machine learning methods.

In operation, soldiers have to process a multitude of information within shortest time. Suitable visual representations allow for fast information recognition and processing without causing high cognitive load. This leads to a shorter reaction time which eventually leads to more security and an advantage in battle space. One example comprises a soldier who by means of augmented reality sees the position of known targets' mobile phones in his head mounted display, almost at the same time they are intercepted by a reconnaissance unit.

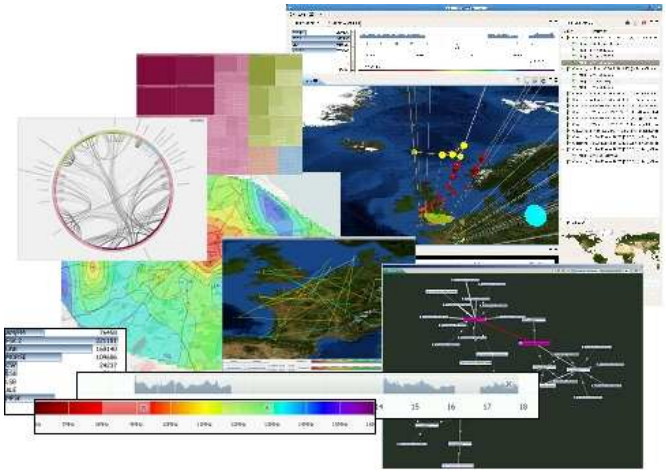

Fig. 5 Different visualizations: a social network, a geographical referenced network, a heat map and a tree map, visual selectors and at the top right a visual analytics workplace with a visualisation of a communication structure over time.

Collaborative

‚Need to share' is one of the intelligence work principles of the future. Separated and not interconnected data storage in organisation and data replication must be avoided, to avoid missing critical pieces of information. Instead, the intelligence gathering and reconnaissance of the future builds upon the implicit propagation of knowledge and information. All participants have access to the same data, as described above under ‚Smart Data', under consideration of access right and confidentiality degree. Many related ideas can be found in rather civilian applications. Distributed version control systems, for example, allow to work independently from another, to synchronise and consolidate results. They also employ strong cryptography to prevent data from being compromised. Peer-to-peer networks and grid computing are essential building blocks of a ‚Smart Architecture'.

Network-centric intelligence requires the integration of several approaches, first and foremost "Knowledge Development". But also the cooperation between national and international organisations plays a vital role. An open and expandable solution thus allows partners to realise quick wins without requiring deep technical or organisational changes. Similar to the integration of intra-organisational data from different sources, a data fusion over temporal and spatial structures is required („Information Fusion over Space and Time").

The openness of the ‚Smart Architecture' is essential, in particular when considering that financial and strategic aspects. Other organisations can integrate themselves independently such that effort on the side of other partners is avoided. Nevertheless, an open architecture must also obey laws, regulations and security policies. On the technical side, this requires a sophisticated and fine-grain rights management tightly interwoven with the data in order to be incompromisable at system and organisational boundaries.

The main benefit of a shared view on data and knowledge is an acceleration of the information interchange between those who produce data and those who analyse and those

forces in action whose information need can be satisfied in almost real time. At the moment, this propagation may need hours, sometimes days or even weeks. Eventually, this acceleration leverages the security of the troops and increases the probability of operation success. A further advantage are emerging synergies.

The Way To Go

The future is approaching fast, such that the course to the discussed approach must be set early. A mandatory requirement is to set-up an adequate and fundamental infrastructure for intelligence services and priorities for the subsequent steps, which include but are not limited to expansion of the infrastructure and specialised services for accessing and processing data. It also requires new ways of cooperating between intelligence gathering organisations and industrial partners, to have short feedback cycles that allow a quick reaction to emergent requirements.

V. SUMMARY

Future intelligence solution will be smart, visual and collaborative driven by advances in solutions provided by industrial partners, the emergence of high performance yet cheap hardware, and the ongoing internal re-organisations of many armies and intelligence service. In this article we described an approach that can be termed „Smart Architecture, Smart Data“. It comprises a platform as a fundament for specialised intelligence solutions to support armies in mission planning and in action. Only in this way performance measures can be increased in light of tight budget constraints.

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