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WEB SERVICE INTRODUCTION IN THE CONTEXT OF HETEROGENEOUS MILITARY NETWORKS

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Abstract: *Web services technology is becoming increasingly popular for introduction in the context of heterogeneous military networks. Some issues related to adopting Web services technology in heterogeneous military network are discussed. In particular, a network of proxies for Web services designed to handle all types of information and traffic flows is mentioned together with the communication protocols used in Web services across tactical networks. An offer aspect of using Web services in tactical environment is when invoking service discovery gateways as a means of interconnecting the service discovery mechanisms across the heterogeneous networks without requiring changes to existing clients and services.*

Key words: *Military networks, Web services, Heterogeneous networks, IP multimedia subsystem, service discovery.*

1. Introduction

Next generation wireless systems respect heterogeneous environment, characterized by multinetwork topology including many administrative domains, multiservice communication and multimedia terminals [1]. The existing techniques do not completely satisfy the demands from the covering technologies point of view, as well as analyzing parameters adequacy, and implementation complexity together with invoking the all entities to the access network selection. An important characteristic of next generation wireless networks is the compositeness of communication model. The communication of different wireless technology and architectures can be used for providing a large variety of multimedia services for users to access from any place and any time.

Since the introduction in the late 1990s, the concept of network – centric operation to enable information sharing has been a fundamental element of the vision of military organization throughout the world [2]. As the complexity of operational

environments increases, military communications network technologies must provide key characteristics such as self – organization and decentralization, which will speed introduction flow. In addition, given the rapid evolution of commercial communication network technologies, and the applications and services that utilize them, military organizations are looking at adopting commercial communications technologies where practical. This is especially time in the mobile wireless communication that are at the heart of tactical military operations.

This article is organized as follows. After a brief description of requirements in military networks, Web services in IP multimedia subsystems are presented. Next, Web services invoking in heterogeneous networks is discussed. This is followed by Web services discovery in the context of military networks considering a service – oriented architecture as a capability offered through a standardized interface.

2. Requirements in military networks

As for military networks, there are different operational levels. Each level has different communication needs and technologies [2]. Strategic level, tactical deployed level, and tactical mobile level, are shown in Figure 1.

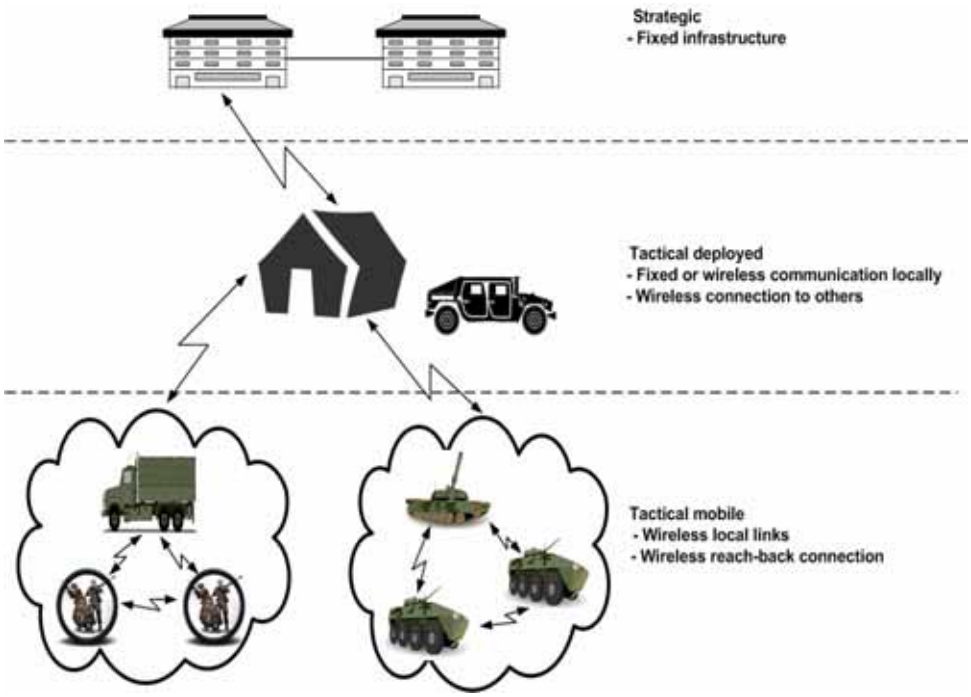

Figure 1. *Different operational levels in military networks.*

Constraints on network availability and topology, available services, intended uses and required robustness vary with each deployment, and thus add to the complexity of such architecture.

Strategic level has a large fixed infrastructure and hosts a large number of services. In this end of networks, there will be hundreds to thousands of nodes. Services in this domain require a solution that can scale to a large number of users and contain information about a large number of services.

Tactical deployed level uses a mostly fixed infrastructure. Such networks constitute the backbones of the deployed networks. These deployed networks need to communicate with other networks both at the same operational level and higher or lower in the hierarchy. For such communication, they employ radio or selective links, which are fairly large fixed networks, but some dynamicity is extended due to their interconnection with unreliable times. The networks are large with hundreds and thousands of nodes and services. What we need, at this level, are solutions that can scale to a large number of users and handle some dynamicity.

The tactical mobile level, the lowest level in the hierarchy composing the disadvantages grids are characterized by low bandwidth, variable throughput, unreliable connectivity and energy constraints imposed by the wireless communication grid that links nodes [3, 4]. The networks are small with 4 to 20 nodes, and a small mission specific set of services (sensors, positioning information, etc.). The networks use wireless links, which are prone to disruption. At this level a service discovery mechanism that can handle a highly dynamic environment, is needed. Also, it should be resource efficient.

3. Web services in IP multimedia subsystems

IP multimedia subsystems (IMS) architecture defines that incoming services are carried out over session initiation protocol (SIP), which is an Internet standard protocol [5] for initiating, modeling and terminating an interactive multimedia session. The multimedia session, involves various applications such as video, voice, in start messaging. Moreover, SIP is accepted as a call – control protocol in IMS. SIP can be also employed to support mobility at the application layer. SIP is an appropriate solution especially for interactive multimedia – applications that need an explicit signaling for session management. In addition, SIP allows users to maintain access to their services while moving (service mobility) and to maintain session while changing terminals. SIP session are rather short – lived compared to the long – lived sessions and transactions used by many high – level middleware technologies like Web services (WS). WS are access via Web protocols and data formats such as Hyper Text Transfer Protocol (HTTP) and Extensive Mark-up Language (XML). In this sense, WS combine component – based deployment and Web technologies.WS benefit from universally accept standards based on XML, such as Simple Object Access Protocol (SOAP) and Web Services Description Language (WSDL) for invocation and interface description.

Web services use XML. These kind of documents tend to be large consuming significant overhead. These represent a problem when trying to extend Web services into tactical networks. In addition, the transport protocol normally used in Web services implementations is not suited for networks characterized by high delay and frequent descriptions. This is of importance when considering users in the field who may only communicate with others over tactical communication systems with low data rates, high delays, and frequent descriptions. In web services all communication is based on sending XML – based SOAP messages. A SOAP message is an envelope consisting of a header

and a body. The header contains information related to the handling of the message, such as addressing and security information, while the body contains the application data. In web services, SOAP messages are transmitted using the HTTP protocol, which in turn uses the TCP protocol for reliable transfer of the messages.

4. Web services in heterogeneous networks

The question often arises is how to enable the use Web services in tactical communication systems with low data rates, high delays, and frequent description, as well as across heterogeneous networks. This question can be broken down into three requirements that must be met, [6], i. e.:

a) Reduce the network traffic generated by web services,
b) Remove the dependence on end – to – end connections,
c) Hide network heterogeneity.

The first problem is related to the amount of network traffic generated by Web services. Namely, it is necessary to reduce both the size of individual messages and the number of messages being transmitted. For example, XML is a rather verbose language producing much large messages than binary format does. Compression will reduce the size and thus the bandwidth requirements of each individual messages sent between nodes. There are several ways of limiting the number of messages such as:

- Employing caching near the clients, which allows for reuse of older messages,
- Allowing the same message to be sent to multiple clients,
- Employing content filtering to ensure that only relevant data is transmitted.

The second issue is that regular Web services defend on direct end – to – end connection the client and the service. In tactical networks with high error rates and high latencies the congestion control of TCP will cause the suboptimal utilization of the network due to frequent connection timeout. When multiple networks are connected, TCPs need to establish an end - to – end connection increases this problem. Figure 2 shows HTTP and TCP establishing end – to – end connection. Each traversed network adds delay, increasing the risk of connection time out.

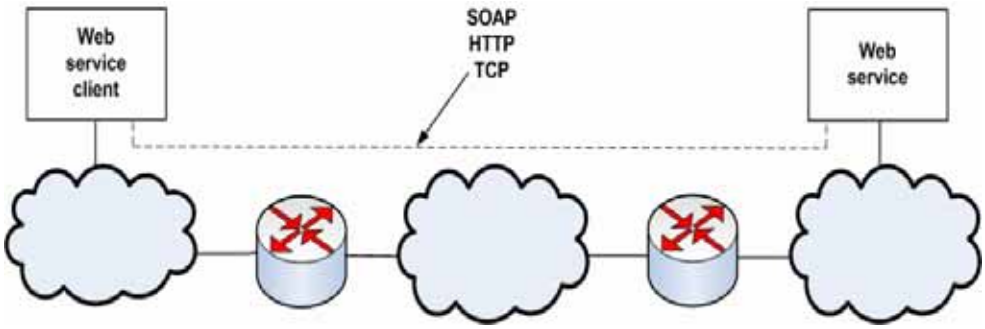

Figure 2. *End – to – end connections established using HTTP and TCP.*

The fact that HTTP is synchronous means that when a SOAP request is sent, the HTTP connection is kept open until the SOAP response is returned in the HTTP

acknowledgement message. The solution to this problem is to replace HTTP and TCP with other more suitable protocols. This requires modifying the application software. Alternatively, an extra communication layer can be introduced. Within this layer, hidden from the applications, more suitable protocols can be used. By implementing this extra communication layer in a proxy solution, standards compliance can be retained. A proxy is a node in the network between a client and a server through which the network traffic passes. A proxy is used for caching fire – walling and content adaption. Introducing an extra communication layer means increased flexibility when it comes to selecting with transport mechanisms to use. Also, using its approach means that the end – to – end connection dependence is removed in favor of per – hop – behavior.

The third problem arises when the heterogeneous networks are interconnected. Connecting each networks to faster networks has to drop packets due to its buffers filling up faster then the packets can be transmitted out in the lower capacity network. A store – and – forward capacity can help alleviate the problems that arise from frequent communication disruptions, which can prevent a massage from being delivered immediately. Store – and – forward support can ensure that the message is not dropped and has to be retransmitted. When traversing heterogeneous networks, different communication protocols maybe required. This means that a message traversing several networks may have to use multiple different protocols on its way from sender to recipient. Therefore, it is necessary to add, store – and – forward functionality on the application layer.

5. Web services discovery

Discovery is the act of locating a machine – processible description of the a Web service – related resource that may have been previously unknown and that meets certain functional criteria [7]. In what follows Web services discovery in the context of military networks will be introduced. Consider service – oriented architecture (SOA) as a capacity offered through a standardized interface. The service descriptions are formatted using the Web Service Description Language (WSOP), while the communication is done using SOAP. In a Web service deployment, there are three central entities. Figure 3 shows how these entities communicate with each other. The service provider has the capacity that it wants to make available to others. It does this by offering this capacity as a service. The service provider has to supply a description of the service and can make its service known to potential uses by publishing the service using service discovery mechanism. The responsibility of the service provider is limited to providing the service discovery mechanism with the service description. The distribution of this description is handled by the service discovery mechanism.

In military networks, discoverable service would include capabilities such as friendly force tracking and various sensors. To discover services, one can choose from different mechanisms ranging from a network address or universal resource identifier (URI) provided by out – to – band means, via a decentralized peer – to – peer (P2P) based registry to a centralized registry [8]. Using a service discovery mechanism at run time provides late binding between consumers and services, which provides us with a dynamic architecture.

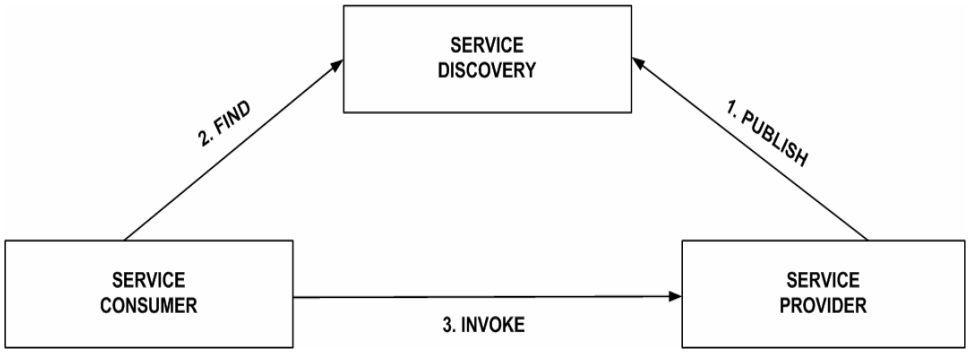

Figure 3. *Web services with three control entities flow.*

A service consumer wanting to use a service will first find the services that are available to it, using the service discovery mechanism. The consumer retrieves the service description, and uses the information to invoke the service directly from the service provider.

Service discovery, and selection, can be performed at design tie as runtime. Step 1 and 2 in Figure 3 are performed once at design time, while only step 3 is performed at runtime.

When Web services operate over military networks, it is important to consider that Web services messages are relatively large compared to typically bandwidth capabilities and other network resource capacities of radio – based military networks.

Finding a suitable for of service discovery for military networks can be divided in two tasks. First, one needs to find a protocol (or a set of protocols that meets the requirements of each individual network). Second, one needs to find a means of interconnection the service discovery mechanisms across the heterogeneous networks.

The different ways of achieving service discovery can be classified in 3 categories: adaptive service discovery layered service discovery and service discovery gateways. Adaptive service discovery means that one single service discovery protocol is used across all network domains. The protocol has to adapt its behavior to the capabilities of the underlying network. This protocol must be used by all applications in the network.

Layered service discovery adds a common abstraction layer to several existing discovery protocols. Each network domain can use a dedicated protocol, while every client must interact with the abstraction layer. The protocol that is layered on the top, controls and connects the different service discovery protocols.

Using service discovery gateways, each network domain can employ the most suitable protocol. Interoperability in this case is ensured by using service discovery gateways between the domains that can translate between the different service discovery mechanisms. Also, interoperability is ensured by the creation and interpretation of service descriptions in client's servers and gateways. As for the gateways, it needs to host the missing meta data in order to achieve full interoperability.

Considering these three techniques, the gateway approach is best suited for heterogeneous military networks. Namely, it is the only one of the three approaches that

does not require changing the already existing clients and services. The gateway approach to service discovery is shown in Figure 4.

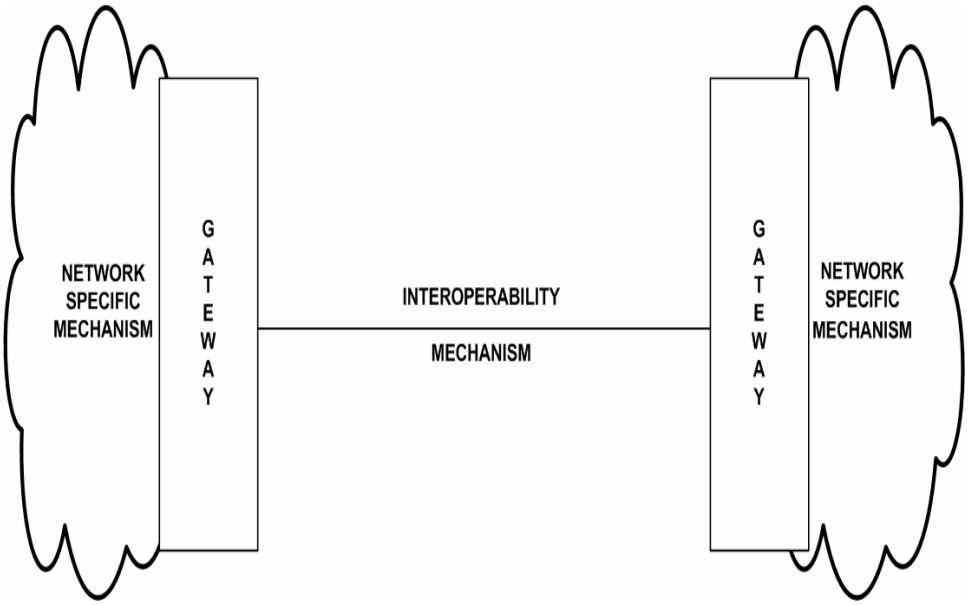

Figure 4. *The gateway approach to service discovery.*

Gateways have the benefit of adding low complexity to the systems needs deployment only in the connection point between the networks. Low capacity is convenient in the long run, since it means low development and maintenance costs.

6. Conclusion

Military network enabled capability about achieving better interaction between the different actors involved in military operations. This implies efficient exchange of information. Consequently information infrastructure will consist of federation of systems including a plethora of different information and communication systems as well as a mix of new and legacy systems. A service oriented architecture approach based on Web services to enable a federation of different communication and information systems is recommended. Robust Web services is heterogeneous military networks look at the potential to using service oriented architecture approach based on Web services to enable such on information infrastructure. Extending such an approach to tactical networks must deal with the issues of exchange of large XML documents in a bandwidth – challenged environment, the difficulty of using TCP in networks with high delay and/or intermittent connectivity, as well as interconnection of heterogeneous network types.

Compared to many civilian systems, military networks vary greatly in terms of computing resources, network bandwidth, mobility and stability. Distributed applications use different networks concurrently or interact across them. In such dynamic,

heterogeneous, runtime service discovery is a necessity. Transparent discovery between proprietary solutions and Web services discovery standards must be achieved.

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Sadržaj: *Tehnologija bazirana na Web servisima postaje sve više popularna za uvođenje u vojne heterogene mreže. U radu su razmatrana neka pitanja koja se odnose na prihvatanje tehnologije koja je bazirana na Web servisima u vojnim heterogenim mrežama. Posebno je navedena mreža proksi čvorova za Web servise koja je dizajnirana da opsluži sve tipove informacija i saobraćajnih tokova zajedno sa komunikacionim protokolima koji se koriste kod Web servisa u taktičkim mrežama. Drugi aspekt korišćenja Web servisa u taktičkom okruženju je kada se obraćaju gejtvejima u smislu interkonekcije pronađenih servisnih mehanizama kroz heterogene mreže bez zahtevanih promena za postojeće klijente i servise.*

Ključne reči: *Vojne mreže, Web servisi, Heterogene mreže, IP multimedijalni podsistem, pronalaženje servisa.*

UVOĐENJE WEB SERVISA U KONTEKSTU VOJNIH HETEROGENIH MREŽA

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