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Network Descriptions and NEC

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ABSTRACT

The network is one of the most important components of NEC. In order to achieve high levels of agility and flexibility it is important that all users and providers have a good overview of the capabilities and possibilities of the network. Historically network applications have used their own discovery mechanisms and network representation, making it hard to share and interoperate.

In this paper we present our work on improving the management of the TITAAN tactical network. To do this, we used NDL – Network Description Language – a data model offering users and network providers with a common ontology to describe topology information of networks. The strength of NDL is that it provides an interoperable model for network descriptions, that is, the same description can be used as input to different applications, such as visualisation, and asset management, but also path-finding. The common information source is particularly important when considering inter-domain or multi-national network connections.

Since NDL is based on Semantic Web techniques, it is straightforward to parse and export to NDL, or to relate NDL with application-specific ontologies.

By listening in on the management traffic of the TITAAN network we are able to automatically create NDL descriptions of the network. These descriptions are used to monitor the status of the network, to determine which paths will be used between nodes in the network. This allows the administrators to monitor the network and quickly determine possible bottlenecks.

In this paper we give a short overview of NDL, its use in several applications, and the application of NDL in the TITAAN network.

1. INTRODUCTION

One of the key requirements on a modern army is the ability to deploy rapidly to a remote location and support itself in a hostile environment. This support includes providing its own field deployable communication and information systems (CIS), a so called tactical network.

A modern tactical network consists of communication infrastructure, network components and information systems that support information processing and communication of all entities ranging from the manoeuvre battalion to the theatre rear boundary. A tactical network has to support the whole spectrum of operations, ranging from disaster relief to large-scale combat operations. It has to provide command, control, communications, intelligence, surveillance and reconnaissance support capabilities that are mobile, secure, survivable, seamless, and capable of supporting multimedia tactical information systems within the war fighters' battle space.

All the services enumerated above (and future services) should coexist on the network and preferably should be aware of the networks status, and other applications desires, so that they can adapt their

behaviour. Currently this is all done through pre-configuration of the network, and by monitoring the network using management tools.

There are many tools available to manage networks, providing operators with a view of the current state of the network, and past performance. However, these tools generally do not allow the exportation of the description, or store it in a closed, proprietary format. This means that other tools cannot benefit from the knowledge of the management applications.

In this paper we will first provide a short introduction to TITAAN in section 2, where we also explain some management problems. In section 3 we provide a short introduction to NDL, and explain how we used this to solve these problems, and create a network information system. In section 4 we explain our ideas for future research, followed by a conclusion in section 5.

2. TITAAN

TITAAN—Theatre Independent Tactical Army and Air Force Network— is a Communications and Information Systems (CIS) infrastructure, designed for the mobile military environment. Based on ruggedized vehicles and boxes, TITAAN delivers services for both data and telephony.

TITAAN delivers a set of basic data services:

- File sharing and Printing
- E-Mail and Web-based services
- Data replication
- Data availability services

In addition to these basic services, applications including video teleconferencing, a portal service and the Dutch C2 system, ISIS, have been tested on TITAAN.

TITAAN is an integrated network for all services. Voice communication is implemented with the TITAAN Converged Telephony Service (TCTS), using Voice-over-IP (VoIP), which transports voice telephony over the IP network. To be able to guarantee that the different services within TITAAN are transported with acceptable quality over the IP network, Quality-of-Service (QoS) using priority classes for different types of traffic, and admission control is implemented.

Management is implemented in a distributed design. Each Command Post has its own management server running a state-of-the-art management application, which dynamically adjusts its map of the network when a change occurs. This management server is able to upload condensed management information regarding its own Command Post to a central management server. The central server is responsible for all WAN connections and provides the information for the second line support staff.

Problem Description

In line with the thoughts around a Common Operational Picture (COP) and situational awareness as part of the NEC philosophy, a *COP on the CIS* environment is a valued asset. The CIS environment consists of many different components, both hardware and software. In order to provide a *COP on the CIS* it is required to have an insight in the state of all these components combined. One of these is the routed network. Information about the *routed network* is especially important, because it determines the data communication flows through the entire network. This applies even more for networks that are asymmetric in terms of bandwidth, utilization, delay and availability.

To achieve a representation of the routed network and effectively use this information in other systems, it needs to be captured in a generic model. On this model a specific business logic could be applied, to put the information into context.

The information retrieved from the routed network can be used to present a graphical overview of the networks configuration and state, allowing support engineers to quickly identify the root cause of incidents in the network, and make a better assessment of the consequential loss of services caused by this incident.

For a more pro-active management of the CIS, the information of the routed network could be used to identify strategic/critical components in the network, for which precautionary measurements could be prepared and/or implemented.

In a policy-based (network) management architecture the state of the routed network could be a valued input parameter for making policy-based decisions. Based on the flows in the network, services could be enabled/disabled and or (re)marked for a different QoS.

Adding information retrieved from the routed network to the management tools, will enrich the presentation with of the state of the overall CIS to the decision makers and support personnel, allowing for better, justified decisions on how the use the CIS for achieving the Military goals.

3. NETWORK DESCRIPTION LANGUAGE

The Network Description Language provides an ontology for computer networks. NDL uses the Resource Description Framework, a Semantic Web technique, to describe networks. We use several classes and properties to describe the topology and configuration of computer networks, refer to [1,2,3] for detailed introductions to NDL. Below we show an example of a network description. This particular example is written in XML syntax, but there are also other compatible syntaxes.

```
<ndl:Device rdf:about="#switch1">
    <rdfs:label>Switch 1</rdfs:label>
    <ndl:hasInterface rdf:resource="#switch1-if0"/>
    <ndl:hasInterface rdf:resource="#switch1-if1"/>
    <capability:hasSwitchMatrix>
        <capability:SwitchMatrix rdf:about="#switch1SwitchMatrix">
            <ndl:hasInterface rdf:resource="#switch1-if0"/>
            <ndl:hasInterface rdf:resource="#switch1-if1"/>
        </capability:SwitchMatrix>
    </capability:hasSwitchMatrix>
</ndl:Device>

<ndl:Interface rdf:about="#switch1-if0">
    <rdfs:label>Interface 0</rdfs:label>
    <ndl:connectedTo rdf:resource="#switch4-if2" />
    <ip:metric>10</ip:metric>
</ndl:Interface>
```

Figure 1. Example NDL description of a device and interface

In this example we describe a device “#switch1”, which has two interfaces, “#switch1-if0” and “switch1-

if1". Both interfaces are part of the switch-matrix of the device, which means that data coming into an interface can be switched to the other interface. Next is a description of the interface, defining its human-readable label, where it is connected to, and the metric cost for paths using this interface.

Network descriptions can be created by hand, but also using automatic discovery. We used the latter method in the TITAAN network. By listening in on the standard management messages of the OSPF protocol, we are able to extract a description of the network, similar to the example above.

From the network descriptions it is possible to create a graphical overview of the network and its links. The example picture below shows a network with 4 switches, connected through two broadcast segments, with links of different metrics. The lower the metric, the thicker the line is in the figure. This is in line with the standard practice to assign lower metrics to connections with higher bandwidth.

The picture in the example is a snapshot of the state of the network, generated from the management output of the network at that time. However, it is also possible to use this in an application that can interactively show how paths from different points will travel through the network. While in a network as in the example this is fairly easy to see, it can become more complex when the network grows, especially when multiple different metrics are used. The paths chosen through the network is not always obvious, it is not always the shortest one, but depends on the total metric.

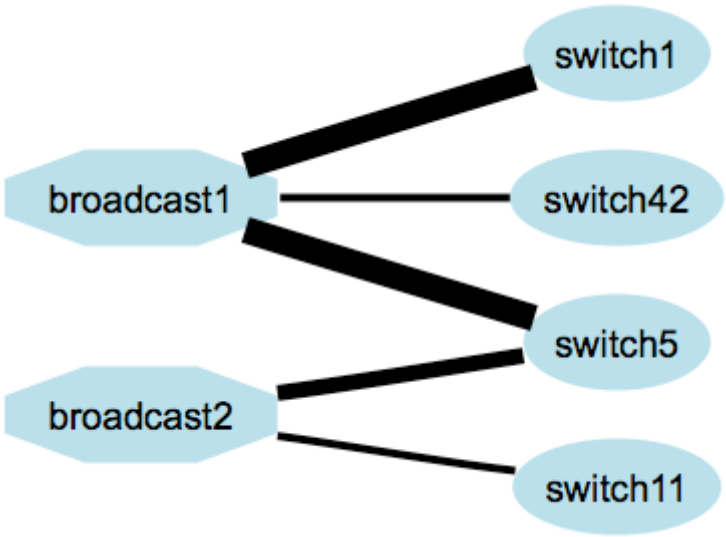

Figure 2. Example visualisation of a network

4. FUTURE RESEARCH

We are currently working on automatically abstracting NDL descriptions. This allows a domain to keep a full view of the network, but also to publish an abstracted view to connected networks. Clients of the network can then gather (abstracted) connectivity information, and have an overview of the whole inter-domain network. This idea can support other research, such as the NATO Protected Core Networking[4].

In the future we hope that the semantic network descriptions, together with ontologies for other domains (applications, devices, etc.) will make it easier for the user to express workflows. See also section 4.4 in [5].

5. CONCLUSION

In this paper we have briefly described the TITAAN network, and have shown that it is in need of an information model for its network, preferably an information model that can be integrated with other applications. One of such models is the Network Description Language. NDL is based on the semantic web, and provides easy interoperability with other applications. We have shown that descriptions in NDL can be automatically generated from existing management traffic, thereby providing an automatic real-time view of the network.

The network description can also be used in other applications, as a proof-of-concept, we have built an application that mirrors the path-finding behaviour of the network itself. This kind of information can also be incorporated into the COPS, or other pictures.

The view of the network can also be abstracted, so as to hide possibly sensitive information about the network, yet provide enough information to allies. With these shared abstracted views, a large view of the whole allied network can be created, to make optimal use of the available infrastructure.

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