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NATO Interoperability Standards and Profiles

Volume 3

Mid to Far Term

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C3 CCSC NATO Open Systems Working Group

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1. INTRODUCTION

001. This agreed document was developed by the NATO Open Systems Working Group (NOSWG) under the authority of the NATO Consultation, Command and Control Board (NC3B). It was noted by the NATO C3 Board (AC/322-N(2011)0021-REV2-AS1 Dated 26 Apr 2011) making the Volume 2 standards and profiles mandatory for use in NATO common funded systems, and made available to the general public as a replacement for ADatP-34(D).

002. NATO Network-Enabled Capability (NNEC) aims to provide an environment where connected collectors, decision-makers, effectors, and information sources are integrated in a common network of networks and can be provided with, search for, or supply data and information from any location under user-adapted format and within user relevant time constraints. Advantage is taken of the great advances within civilian information and communication technology. Solutions under network-oriented concept are based on:

- Service-Oriented Architecture (SOA)
- Federation of systems, including federated networks.
- Situation adapted combinations of units and systems

Figure 1.1. NNEC Concept

003. Volume 3 of this NISP will continue the evolution from platform based legacy systems to the federated Network Enabled Capabilities environment where the functionality is made generally available as "services on the net". Ultimately the goal is that the functionality of the most useful services shall be available to authorized users in each situation. The focus of this section of the volume is on the mid-term perspective having a time frame of 2 to 10 years into the future from the publication of this version of the NISP. This timeframe encompasses the realization of a fully network enabled NATO environment.

004. Within this part of the document, the focus is on the mid-term to far-term perspective. This perspective has a time frame of 2 to 10 years into the future from the publication of this version of the NISP. This time frame should encompass the realisation of a fully network enabled NATO coalition environment.

005. The purpose of this section is to identify a number of key emerging (commercial) technologies that are relevant to NATO and to provide a useful level of analysis about their possible application within military systems. While the emerging technologies discussed in this section are not exhaustive, the content of this section does draw significantly upon the technology tracking

efforts of the NOSWG member nations. Once technologies are identified and their applicability analysed, then informed decisions can be made on what role each technology or standard will play in the current technical architecture. The rapid pace of technological change carries with it the potential benefits of faster and more cost-effective improvements in operational capability; however, the rapidity of change upon a broad technology front also makes the task of identifying emerging technologies particularly difficult.

006. The intention of this element of the NISP volume 3 is to be informative, whilst maintaining brevity, on a range of technologies. Consequently, the information is presented as a series of short articles that cover the essential points of interest. This flexible format is intended to facilitate the rapid change of content that will inevitably happen between issues of the NISP.

1.1. COMMUNICATIONS & NETWORKING

1.1.1. Disruption Tolerant Networking (DTN)

007. Disruption Tolerant Networking (DTN) are comprised of technologies that will provide network services when no end-to-end path exists through the network because of periodic or intermittent disruptions. Disruption may occur because of the limits of wireless radio range, sparsity of mobile nodes, energy resources, enemy attack, and noise. Such a robust communications network would have to be autonomic, secure and opportunistic.

008. **Implications**: The research in this area is principally aimed at providing internet-like services and supporting "long-haul" reliable transmission in interplanetary space, but it has applications in other environments as well. The work done to overcome delays caused by interplanetary distances can easily be appealed to tactical military networks. Distance delays are just a subset of the more general group of Disruption sources.

1.1.1.1. Bundle Protocols

009. Research goals in this area are to provide disruption tolerance by organizing information flow into bundles. These bundles are to be routed through an "intelligent" network that can manage the delivery of the bundles to the maximal extent permitted by the available topology. This method will allow messages to pass through the network with successive responsibilities, rather than the traditional end-to-end scheme. The mechanism of bundling will allow a network node to hold data if the next hop in the network is unavailable.

010. **Status**: The Internet Engineering Task Force (IETF) has recently published RFC 4838 and RFC 5050 to provide the common defining framework for the formation and transport of bundles of data. In 2008, the Bundle Protocol was successfully tested in space on the UK-DMC Disaster Monitoring Constellation satellite.

1.1.1.2. Licklider Transmission Protocol (LTP)

011. The Licklider Transmission Protocol (LTP) was designed to provide retransmission-based reliability over links characterized by extremely long message round-trip times (RTTs) and/or frequent interruptions in connectivity.

012. The Licklider Transmission Protocol (LTP) would replace both IP and TCP. Picturing protocols as layers in a stack, if the bottom layer is the physical wire line or radio wave connecting two devices, the Licklider Transmission Protocol sits just above that. It makes the link between two routers more reliable than IP and TCP.

013. **Status**: In 2008, the IRTF Working Group of the IETF established an experimental RFC (RFC 5326) on this topic

1.1.2. Wireless Networking

014. Several wireless network standards have been developed to encompass the wide range of mobile environments and applications.

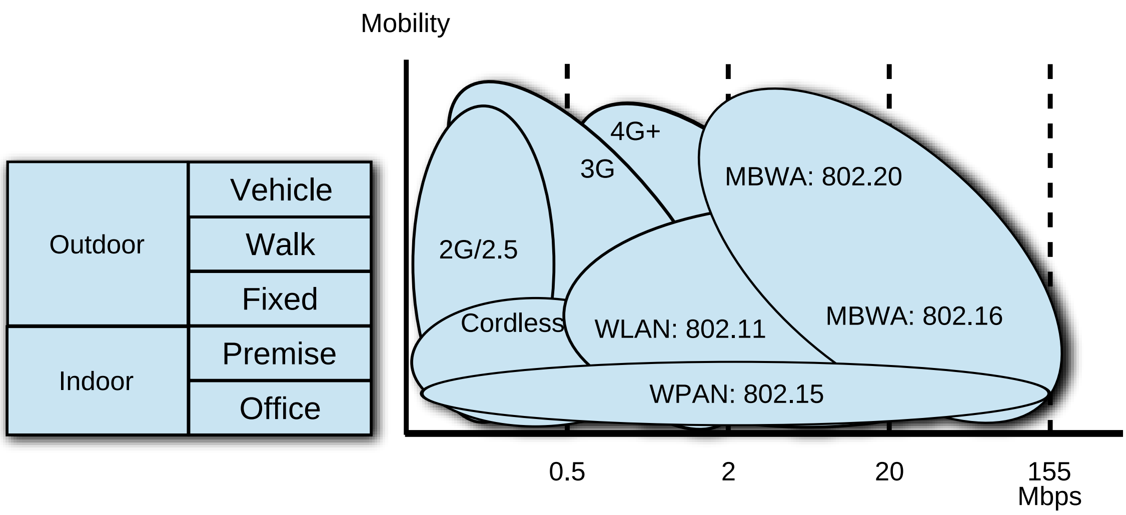

Figure 1.2. Standards, Mobility, and Data Rates

1.1.2.1. Wireless Personal Area Network (WPAN)

015. A wireless personal area network (WPAN) is a computer network used for communication among computers, I/O peripherals (such as keyboards, printers, scanners, etc) and devices (such as wireless access points, cell phones and personal digital assistants) within reach of a person. The devices may or may not belong to the person in question. The range of a WPAN is typically less than 10 metres, and up to 1 kilometre under ideal conditions. WPANs can be used to replace cables between computers and their peripherals, to establish communities, or to

establish location aware services. WPANs can be used for communication among the personal devices themselves (intra-personal communication), or for connecting to a higher level network and the Internet (an up link).

Standard	Frequencies	Spectrum Type	Data Rates
Bluetooth	2.4GHz	Unlicensed ISM	2.1 Mbit/s
Wibree	2.4GHz	Unlicensed ISM	1 Mbit/s
ZigBee	868 MHz, 915 MHz, 2.4GHz	Unlicensed ISM	40-250 kbit/s
Wireless USB, UWB	5GHz+	Unlicensed UWB	250 kbit/s

Table 1.1. PAN Summary

016. **Importance**: A key concept in WPAN technology is known as plugging in. Ideally, when any two WPAN-equipped devices come into close proximity (within several metres of each other) or within a few kilometres of a central server, they can communicate as if connected by a cable. Another important feature is the ability of each device to lock out other devices selectively, preventing needless interference or unauthorised access to information.

017. **Implications**: Collaboration between units in the same physical area is possible. Useful on the battlefield as a method for soldier communications and monitoring.

1.1.2.1.1. IEEE 802.15.1 (Bluetooth 3.0)

018. The next version of Bluetooth, currently code named , includes a number of features to increase security, usability and value of Bluetooth. The following features are defined:

- Atomic Encryption Change - allows encrypted links to change their encryption keys periodically, increasing security, and also allowing role switches on an encrypted link.
- Extended Inquiry Response - provides more information during the inquiry procedure to allow better filtering of devices before connection. This information includes the name of the device, and a list of services, with other information.
- Sniff Sub-rating - reducing the power consumption when devices are in the sniff low power mode, especially on links with asymmetric data flows. Human interface devices (HID) are expected to benefit the most with mice and keyboards increasing the battery life from 3 to 10 times those currently used.
- QoS Improvements - these will enable audio and video data to be transmitted at a higher quality, especially when best effort traffic is being transmitted in the same piconet.
- Simple Pairing - this improvement will radically improve the pairing experience for Bluetooth devices, while at the same time increasing the use and strength of security. It is expected that this feature will significantly increase the use of Bluetooth.

019. Bluetooth technology already plays a part in the rising Voice over IP (VoIP) scene, with Bluetooth headsets being used as wireless extensions to the PC audio system. As VoIP becomes more popular, and more suitable for general home or office users than wired phone lines, Bluetooth may be used in Cordless handsets, with a base station connected to the Internet link.

020. The version of Bluetooth after , code-named , has many of the same features, but is most notable for plans to adopt Ultra-wideband radio technology. This will allow Bluetooth use over UWB radio, enabling very fast data transfers, synchronisations and file pushes, while building on the very low power idle modes of Bluetooth. The combination of a radio using little power when no data is transmitted, and a high data rate radio used to transmit bulk data, could be the start of software radios. Bluetooth, given its worldwide regulatory approval, low power operation, and robust data transmission capabilities, provides an excellent signalling channel to enable the soft radio concept.

021. **Status**: On 28 March 2006, the Bluetooth Special Interest Group (SIG) announced its selection of the WiMedia Alliance Multi-Band Orthogonal Frequency Division Multiplexing (MB-OFDM) version of Ultra-wideband (UWB) for integration with current Bluetooth wireless technology. UWB integration will create a version of the globally popular Bluetooth wireless technology with a high speed/high data rate option. This new version of Bluetooth technology will meet the high-speed demands of synchronising and transferring large amounts of data as well as enabling high quality video and audio applications for portable devices, multi-media projectors and television sets, wireless VoIP. At the same time, Bluetooth technology will continue catering to the needs of very low power applications such as mice, keyboards and mono headsets, enabling devices to select the most appropriate physical radio for the application requirements, thereby offering the best of both worlds.

1.1.2.2. Wireless Local Area Network (WLAN)

022. A wireless local area network (WLAN) is the linking of two or more computers without using wires. WLAN utilises spread-spectrum technology based on radio waves to enable communication between devices in a limited area, also known as the basic service set. This gives users the mobility to move around within a broad coverage area and still be connected to the network.

023. **Importance**: Wireless Local Area Networks are more convenient, mobile, deployable, expandable, and cheaper than wired networks.

024. **Implications**: The wireless nature of such networks allows users to access network resources from nearly any convenient location within their primary networking environment. Initial setup of an infrastructure-based wireless network requires little more than a single access point. Eliminates the cost, time, and labour of running physical cables.

1.1.2.2.1. IEEE 802.11 (WiFi)

025. Many are familiar with 802.11, also known as WiFi, as a short-range wireless networking protocol for home and office connections. 802.11 represent a family of wireless standards. The

802.11 series has been developed by the IEEE over the past 10 years as part of the range of communications protocols under the 802 standards series.

026. Each family member is identified by a letter suffix to the series name. Currently these letters run from "a" to "w", although there is the original base 802.11 wireless standard as well. Note that there is no L standard. Some family members represent amendments (a, b, g, i) to the original standard, whereas some represents enhancements or extensions (c-f, h-j, n).

027. The 802.11 family of protocols share two common frequency bands, 2.4GHz and 5GHz, the so-called Industrial, Scientific and Medical (ISM) bands. Further more, each of these bands are divided into 14 channels. The availability of channels is regulated by nation, constrained in part by how each nation allocates radio spectrum to various services. At one extreme, Japan permits the use of all 14 channels (with the exclusion of 802.11g/n from channel 14), while at the other Spain allowed only channels 10 and 11 (later all of the 14 channels have been allowed), to which France adds 12 and 13. Most other European countries are almost as liberal as Japan, disallowing only channel 14, while North America and some Central and South American countries further disallow 12 and 13. The emerging standards within the 802.11 family are as follows:

028. **802.11-2007**: Consolidated amendments 802.11a,b,d,e,g,h,i,j with the original base standard to form the latest base standard. **Status**: Approved as standard in March of 2007.

029. **802.11k**: Intended to improve the way traffic is distributed within a network by discovering the best available access point. In a wireless , each device normally connects to the access point (AP) that provides the strongest signal. Depending on the number and geographic locations of the subscribers, this arrangement can sometimes lead to excessive demand on one AP and underutilisation of others, resulting in degradation of overall network performance. In a network conforming to 802.11k, if the AP having the strongest signal is loaded to its full capacity, a wireless device is connected to one of the underutilised APs. Even though the signal may be weaker, the overall throughput is greater because more efficient use is made of the network resources. 802.11k and 802.11r are the key industry standards now in development that will enable seamless Basic Service Set (BSS) transitions in the WLAN environment. **Status**: Still in draft form, but expected to be ratified in 2008.

030. **802.11n**: Focuses on improvements on the 802.11 standard to obtain data throughput of at least 100Mbps, improved coverage, and longer range. Such advances will be achievable through multiple-input/multiple-output (MIMO) communication. MIMO uses multiple radios simultaneously transmitting and receiving different signals to and from at least two radios on the client side to and from two or more on the access point. **Status**: Expected to be ratified in 2009. There are still some interoperability issues. There are many products available based on the pre-draft standard.

031. **802.11p**: "Wireless Access in Vehicular Environments (WAVE)" - Wireless communication between fast moving vehicles or between a fast moving vehicle and a stationary object. This standard supports speeds of minimum of 200km/h and ranges of up to 1km. It uses 850-5.925 GHz band and defines enhancements to 802.11 required to support Intelligent Transportation Systems (ITS) applications. The vision is for nationwide network that enables communications

between vehicles and roadside access points or other vehicles. Such networks would enable toll collection, vehicle safety services, and commerce transactions via cars. **Status**: Expected to be ratified in 2009. This standard would be the foundation for projects like the Communications, Air-interface, Long and Medium range (CALM) system in Europe, and Dedicated Short Range Communications (DSRC) in the United States.

032. **802.11r**: "Fast Roaming" - This proposed standard will specify fast Basic Service Set (BSS) transitions that address the faster transfer of a station from one access point to another. Faster transitions are essential to support real time applications such as VoIP ("voice over IP", or Internet-based telephony) via mobile phones designed to work with wireless Internet networks, instead of (or in addition to) standard cellular networks. This will permit connectivity aboard vehicles in motion, with fast handoffs from one base station to another managed in a seamless manner. Handoffs are supported under the "a", "b" and "g" implementations. **Status**: Ratified and published in July of 2008.

033. **802.11s**: "Mesh Networking" - Wireless Distribution System (WDS) protocol that is able to auto-configure paths between APs.

034. **802.11u**: "Inter-working with External Networks" - The primary focus is on inter-working with cellular networks. **Status**: Ongoing; still being evaluated.

035. **802.11v**: "Wireless Network Management" - Management (monitoring, configuring, updating) of attached stations through layer 2. It is to complement 802.11k that gathers information from the stations.

036. **802.11y**: "3650-3700 MHz Operation in the U.S" - This amendment to 802.11-2007 would allows WiFi "like" equipment to operate at higher power levels with a range of up to 5 kilometres in the United States. It introduces three new concepts to the 802.11-2007 standard: Contention Based Protocol, Extended Channel Switch Announcement, and Dependent Station Enablement. Even though the current form is specific to operations in the United States, care was taken so that, if the light licensing concept was well received, it would not be necessary to start the 3+ year task group process in order for 802.11y devices to operate in other countries or in other frequency bands. As a result, lightly licensed 802.11 devices will be able to operate in any 5, 10, or 20Â MHz channel that regulators make available by simply adding entries to the country and regulatory information tables in Annex I and J of 802.11. Has implications in the following areas: Back haul for Municipal Wi-Fi networks, Industrial automation/controls, Campus/Enterprise networking, Last Mile Wireless Broadband Access, Fixed Point to point links, Fixed point to mobile links, and Public safety and security networks. **Status**: Submitted for approval in June of 2008; Still not ratified.

Standard	**Description**	**Status**
IEEE 802.11k	Radio resource measurement enhancements	Ongoing
IEEE 802.11n	Higher throughput improvements (e.g. MIMO)	Ongoing. Estimated ratification in 2009

IEEE 802.11p	WAVE -Wireless Access for the Vehicular Environment (such as ambulances and passenger cars)	Ongoing. Estimated ratification in 2009.
IEEE 802.11r	Fast roaming	Ratified in July of 2008
IEEE 802.11s	EWireless mesh networking	Ongoing
IEEE 802.11t	Wireless Performance Prediction (WPP) -test methods and metrics	Ongoing
IEEE 802.11u	Inter-working with non-802 networks (e.g., cellular)	Ongoing
IEEE 802.11v	Wireless network management	Ongoing
IEEE 802.11w	Protected Management Frames	Ongoing
IEEE 802.11y	3650-3700 Operation in USA with wide range	Ongoing. Estimated ratification in 2009.

Table 1.2. Emerging 802.11x Summary

1.1.2.3. Mobile Broadband Wireless Access (MBWA)

037. While many military installations have some sort of high-speed network backbone connected by fibre optic cabling, many of the buildings do not have high-speed connections to the backbone. This is because fibre-optic cabling, necessary for most high-speed communications, must first be installed in the ground.

038. Three emerging mobile data architectures have the most promise to eliminate the need for cables. In an effort to further improve mobile technology bandwidth, the IEEE 802 standards group which is already developing 802.11 (Wireless , WLAN), 802.15 (Personal Area Networks, PAN), 802.17 (Fixed Broadband Wireless Access, FBWA) has turned its attention to a new standardisation efforts on mobile broadband wireless access (MBWA).

039. As with many civil based technologies the key question is likely to be the performance of the system under stress (e.g. Interference/jamming). However, there exists a possibility of a low cost wireless network offering all IP connectivity for easy integration with other component networks, rapid base-station deployment, basic network security (allowing higher security to layer on top) and high performance to many users.

040. **Importance**: Installing fibres is a disruptive, costly and time-consuming process. Trenching costs become prohibitive to reach remote areas, such as transportation depots and ranges. Also, right-of-way issues and physical barriers such as lakes and historical grounds can increase the cost of installing fibre-optic cabling.

041. **Implications**: In the tactical world, MBWA may be well suited for quickly establishing links between temporary camps, command centres, and vehicles.

Characteristics	**Mobile Data Architectures**			
	802.16e	**802.20**	**HiperMAN**	**4G+**

Standard Type		Open	Open	Open	Open
Cell Radius	Line-of-sight	48 km	-	10 km	-
	Non Line-of-sight	3 km	-	4km	-
Cell Speed		60 miles/hr	250 km/hr	-	-
Data Rate	Moving	< 10 Mbps	-	-	280 Mbit/s
	Stationary	10 Mbps	-	14 Mbit/s	1 Gbit/s
	Peak	70 Mbps	1 Mbps	63 Mbit/s	-
Spectrum		< 6 GHz	-	5.725-5.875 GHz	-
Architecture		Packet	Packet	Packet	Packet/Circuit
Bands		Selectable Between 2-6 GHz	Licensed Bands below 3.5 GHz	Selectable Between 2-11 GHz (Mainly 3.5 GHz)	Licensed Bands below 2.7 GHz
Latency		Low	Low	High	High

Table 1.3. Data Architecture

1.1.2.3.1. Mobile Telephone (4G+)

042. Although the new 3G systems (mobile phone companies have invested heavily in this technology) have just been launched not long ago, many companies have already started on researching and developing on the fourth generation (4G) system. Researchers are hoping that the 4G system can reach a much faster speed, a connection speed over 100Mb per second during connection, tighter network security and also bring up the quality during communication no matter on voice or video calls. Via mobile phones, many things such as the security system, surveillance on certain items could be done easily.

043. One 4G+ standardisation effort called Ultra Mobile Broadband (UMB) is being coordinated by 3GPP2 (Collaboration between five Asian and North American standards bodies. It will improve the CDMA2000 mobile phone standard for next generation applications and requirements. The proposed system intends to employ OFDMA technology along with advanced antenna techniques to provide peak rates of up to 280 Mbit/s. Goals for UMB include significantly improving system capacity, greatly increasing user data rates throughout the cell, lowering costs, enhancing existing services, making possible new applications, and making use of new spectrum opportunities. The technology will provide users with concurrent IP-based services in a full mobility environment.

044. **Status**: The UMB standardisation is expected to be completed in late 2007, with commercialisation taking place around mid-2009 or early 2010.

1.1.2.3.2. High Capacity Spatial Division Multiple Access (HC-SDMA, or iBurst)

045. The HC-SDMA interface provides wide-area broadband wireless data-connectivity for fixed, portable and mobile computing devices and appliances. The protocol is designed to be implemented with smart antenna array techniques to substantially improve the radio frequency (RF) coverage, capacity and performance for the system.

046. The HC-SDMA interface operates on a similar premise as GSM or CDMA2000 for cellular phones, with hand-offs between HC-SDMA cells reportedly providing the user with a seamless wideband wireless experience even when moving at the speed of a car or train.

047. **Status**: HC-SDMA is being incorporated by ISO TC204 WG16 into its standards for use of wireless broadband systems in the continuous communications standards architecture, known as CALM. The IEEE 802.20 working group had adopted a technology proposal that includes the use of the HC-SDMA standard for the 625kHz Multi-Carrier Time Division Duplex (TDD) mode. Technology is available Asia, Europe, Africa, Middle East, and North America.

1.1.2.4. Ad-Hoc Networking

1.1.2.4.1. Mobile Ad-Hoc Networks (MANET)

048. A mobile ad-hoc network (MANET) is a self-configuring network of mobile routers (and associated hosts) connected by wireless links. The routers are free to move randomly and arbitrarily organise themselves. Accordingly, the topology of the wireless network may change rapidly and unpredictably. Such a network may operate in a standalone fashion, or may be connected to the larger Internet. With attributes such as minimal configuration and quick deployment make ad hoc networks appropriate for situations like disasters (natural or man-made), medical emergencies, military conflicts, etc.

049. The earliest predate the Internet and were called "packet radio" networks. These early packet radio systems were part of the motivation of the original Internet Protocol suite. Current are designed principally for military utility; examples include Joint Tactical Radio System (JTRS) and the High-Capacity Data Radio (HCDR).

050. The widespread IEEE 802.11 ("WiFi") wireless protocol incorporates an ad-hoc networking system when no wireless access points are present, although it would be considered a very low-grade ad-hoc protocol by specialists in the field. The IEEE 802.11 system only handles traffic within a local "cloud" of wireless devices. Each node transmits and receives data, but does not route anything between the network's systems. However, higher-level protocols can be used to aggregate various IEEE 802.11 ad-hoc networks into .

1.1.2.4.2. Sensor Networks

051. A sensor network is composed of a large number of sensor nodes that are densely deployed either inside an area of operation or very close to it. The sensor nodes are tiny, low-

cost, low-power, self-organising and multi-functional (sensing, data processing, and communicating). Since the sensor nodes can be random deployed, such networks are ideal in inaccessible terrains or disaster relief operations

Characteristics	Sensor Networks	Traditional Ad-Hoc
Communication	Broadcast	Point-to-Point
Node Numbers	Large	Small
Node Density	High	Low
Node ID	None	Individual
Failure Rate	High	Low
Mobility	No	Yes

Table 1.4. Sensor vs. Ad-Hoc

052. The differences between a sensor network and a traditional ad-hoc network can be seen in Table 1.4. The protocols and algorithms used in traditional ad-hoc networks do not work well with sensor networks primarily because of the relatively large number of sensor nodes used by sensor networks.

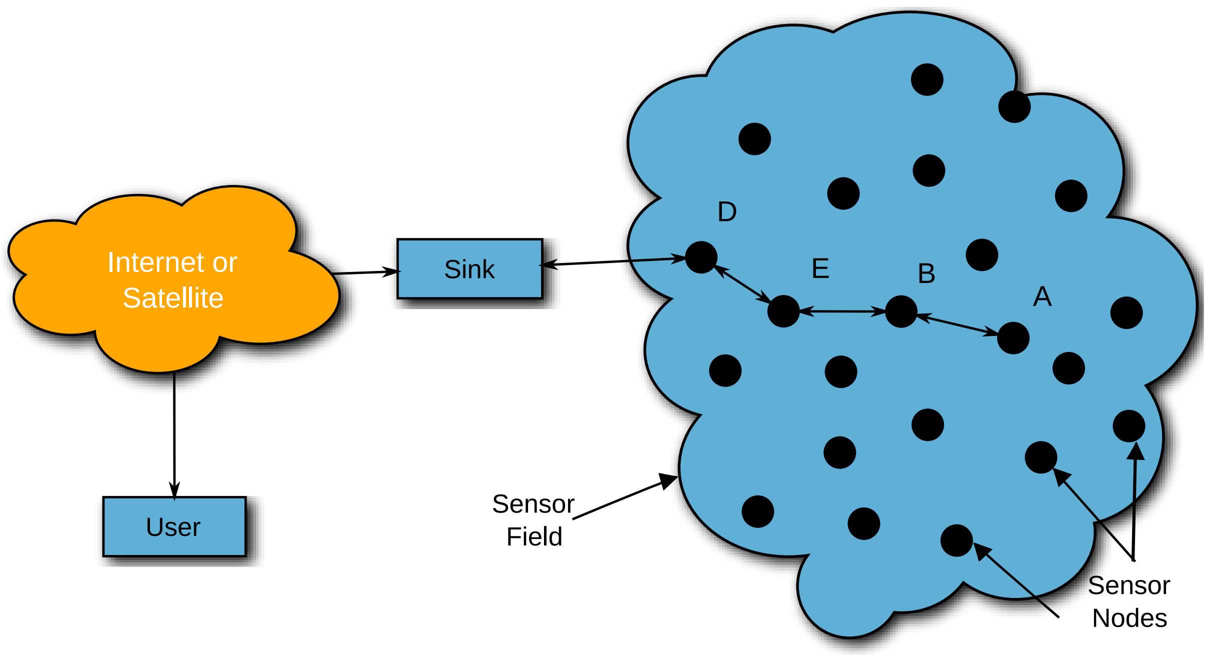

Figure 1.3. Sensor Field

1.1.2.5. Radio

1.1.2.5.1. Radio over Internet Protocol (RoIP)

053. Radio over IP is an method of converting analog radio signals into packets that transmited over an IP network. This capability of integrating disparate data and video signals with an IP infrasturcture could be the long disatnce hauler of short distance radio signals. With RoIP, there are no interoperability issues, all radio signals (e.g. VHF, UHF, POTS telephone, cellular telephone, SATCOM, air-to-ground) are packetized the same. Demodulation and detection of the orignal message is done after it has been transported.

054. **Status**: Draft standard is being developed by NIST, for the Bridging System Interface (BSI) hardware and software that enables radio gateway interoperability on a RoIP system. A half-dozen companies now offer Radio Over IP solutions. The tactical use of this technology has been demonstrated by coalition military forces in Afganistan and Iraq to protect convoys spread out across large geographic distances.

1.1.2.5.2. Radio Frequency Identification (RFID)

055. Radio Frequency Identification technology shares some similar characteristics with IP technology. IP is a remarkably flexible addressing system for information while RFID is a flexible addressing system for physical objects. RFID creates "an Internet of things" - a world of objects connected by Internet technologies. Indeed, it is possible that this new Internet of objects could significantly affect network architecture in the years to come.

056. RFID is the labelling system behind IP-enabled inventory and supply. Standard RFID tags contain three times the amount of information that can be stored in bar codes. They transmit data without contact or Line-of-sight with the reader, and can be read through dust, snow, ice, paint, or grime - conditions that render optical technologies, like bar coding, useless. Long-range tags can be read at speeds achievable by cars or trains, automated toll readers are a good example of this.

057. Capacitor / Coil (1) RFID reader Broadcasts electromagnetic signal to tag (4). The tag's coils release an encoded radio wave containing the information in the tag, which the reader then demodulates.(2) Antenna in the tag receives the signal from the reader and stores charge in a capacitor.(3) When the capacitor has built up enough energy, it releases it over time to the tag's coils.

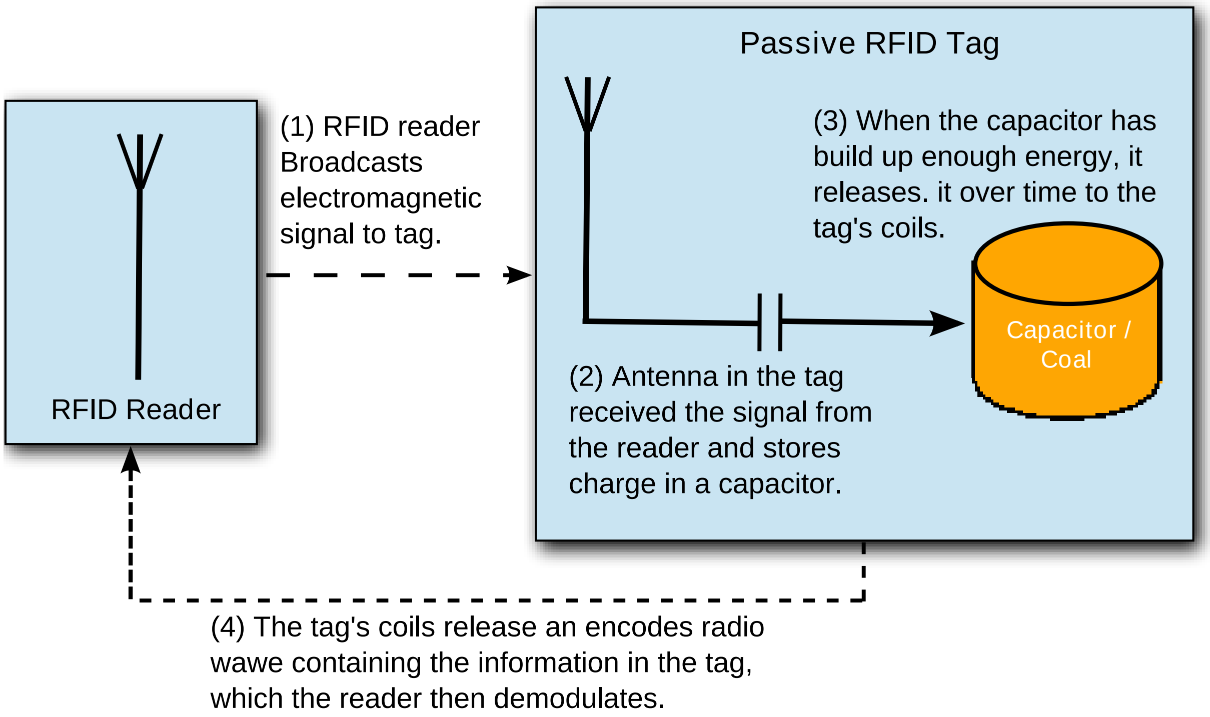

Figure 1.4. RFID Example

058. Most RFID tags are passive and read-only. With a virtually unlimited operating lifetime, they consist of little more than a computer chip and an antenna. A compatible reader provides power to the tag over short distances between a few centimetres to thirty meters. The tag "awakens" and reports any information it has available to the reader. Active tags, on the other hand, are self-powered, have longer ranges than passive tags, and are constantly reporting relevant information to any reader within range. Active tags are becoming increasingly common, especially on expensive items, or cartons of items. A reader installed in a lock, for example, can automatically receive information from active tags in every vessel and shipping box that passes through. Additionally, some RFID tags are writable as well as readable.

059. Security is the key challenge with RFID. If a NATO nation implements RFID in its supply chain, and does not want other NATO nations to track its shipments and inventory, then that nation would perceive RFID technology as a significant security vulnerability.

060. Some researchers have proposed schemes that would require tags to authenticate readers, transmitting information only to authorised readers. The tags would have to store ID numbers for authorised readers, and a reader would have to broadcast its ID to the tag. To protect the reader's ID and prevent others from eavesdropping and stealing the information, the reader uses either a fixed or randomly generated number to hash (encrypt) its ID. If the tag cannot authenticate the reader's identity, the tag will refuse to transmit the information it stores. Like most security tactics, this scheme is vulnerable to attacks, such as man in the middle, or reverse engineering.

061. **Importance**: An advanced way to automate the tracking of people and things.

062. **Implications**: Improved logistics through better management of supplies and inventories.

063. **Status**: Because of the potential market, several vendors are actively researching security and legacy integration issues. The big challenge to RFID is its integration into existing systems. Several vendors are developing RFID middle-ware that will link new RFID systems into existing back-end infrastructures. middle-ware, for example, can help with the current lack of standards in RFID. If an organisation picks a standard that changes or loses its market prevalence, middle-ware can transform the data from readers into the format supported by back-end systems.

1.1.2.5.3. Software Defined Radio (SDR)

064. Software Defined Radio (SDR) technology uses software to modulate and demodulate radio signals. This flexible approach would solve the problem of having to carry several types of special purpose radio. Ideally, one radio could can receive and transmit a new form of radio protocol just by running new software. All functionality and expandability is built upon the Software Communications Architecture (SCA), an international open architecture framework available from the Object Management Group (OMG).

065. **Importance:** Reduces the need for troops to carry multiple radios.

066. **Implications**: Adaptable radios can solve cross-nation, and cross organisation communication interoperability problems.

067. **Status**: All the pieces needed to make this technology work in a tactical military environment are not ready. The biggest hurdles are form-factor, power consumption, and antenna size. Packaging such a radio that can handle every waveform used on a battlefield is daunting. Putting a 50 lb radio with a 30 foot antenna on the back of a foot solider is not practical.

1.1.2.5.4. Cognitive Radio Technology

068. Cognitive Radio technology is, when combined with Software Defined Radio technology, an effort to efficiently utilise the electromagnetic spectrum. The argument is that in any given region of the world, some portions of the spectrum are over utilised while some are underutilised. A cognitive radio will analyse the local spectrum and determine where there are spectrum "holes", or under-used spectrum. It is in these "holes" that the adaptive radio will operate by using software defined radio technology to reconfigure its broadcasting characteristics as needed.

069. The real issue is how that spectrum is managed, not the lack of available spectrum. A cognitive radio will not only analyse the spectrum usage, but negotiate usage with nearby devices. Compare the scheme to a driver's reacting to what she sees other drivers doing. If you are in a traffic lane that is heavy, maybe it's time for you to shift to another lane that is not so busy. When shifting lanes, however, a driver needs to follow rules that prevent her from bumping into others.

070. The MAC layer of the IEEE 802.22 wireless standard will be based in Cognitive Radio Technology. It needs to be also able to adapt dynamically to changes in the environment by sensing the spectrum. The MAC layer will consist of two structures: Frame and Superframe.

A superframe will be formed by many frames. The superframe will have an SCH (Superframe Control Header) and a preamble. These will be sent by the BS in every channel that it's possible to transmit and not cause interference. When a CPE is turned on, it will sense the spectrum, find out which channels are available and will receive all the needed information to attach to the BS. Two different types of spectrum measurement will be done by the CPE: in-band and out-of-band. The in-band measurement consists in sensing the actual channel that is being used by the BS and CPE. The out-of-band measurement will consist in sensing the rest of the channels. The MAC layer will perform two different types of sensing in either in-band or out-of-band measurements: fast sensing and fine sensing. Fast sensing will consist in sensing at speeds of under 1ms per channel. This sensing is performed by the CPE and the BS and the BS's will gather all the information and will decide if there is something new to be done. The fine sensing takes more time (approximately 25 ms per channel or more) and it is utilized based on the outcome of the previous fast sensing mechanism. These sensing mechanisms are primarily used to identify if there is an incumbent transmitting, and if there is a need to avoid interfering with it.

071. **Importance:** Enables efficient usage of available limited spectrum.

072. **Implications**: Ideal companion technology to Software Defined Radio Technology.

073. **Status**: Approved by IEEE in january of 2008, the 802.22 standard is the first wireless standard based on cognitive radios.

1.1.3. Wired Networking

074. When compared to wireless networking, the more mature wired networking area provides benefits in cost, reliabilty and performance.

075. **Implications**: The need for wired networking will be dictated by the operational environment.

1.1.3.1. Fibre-Channel over Ethernet (FCoE)

076. Fibre-Channel over ethernet allows Fibre-Channel devices to connect with one another over ethernet based networks. With FCoE, native Fibre-Channel frames are encapsulated into ethernet frames to be sent over a 10-Gbit Ethernet network. Considered a low-cost, high performance alternative to Fibre-Channel over long distances. The main applications that benifet from this technology are sStorage Area Networks (SANs). With FCoE, network (IP) and storage (SAN) data traffic can be consolidated using a single network switch. This consolidation can:

- reduce the number of network interface cards required to connect to disparate storage and IP networks
- reduce the number of cables and switches
- reduce power and cooling costs

- increase utilization of servers through server virtualization technologies

077. **Status**: Not yet apporved as a standard by INCITS, InterNational Committee for Information Technology Standards organisaton, but several vendors are shipping products that will support the future standard. Expected to be ratified in late 2009 or early 2010.

1.1.4. Transport Layer

1.1.4.1. Stream Control Transmission Protocol (SCTP)

078. The Stream Control Transmission Protocol operates on top of the Internet Protocol (IP), and is defined in the RFC 2960 (IETF standard). SCTP was developed to provide reliable transport of SS7 messages over an IP network.

079. The Stream Control Transmission Protocol (SCTP) is a new IP transport protocol that operates on top of the Internet Protocol (IP), and is defined in the RFC 2960 (IETF standard). It exists at an equivalent level with UDP (User Datagram Protocol) and TCP (Transmission Control Protocol), which provide transport layer functions to many Internet applications.

080. Like TCP, SCTP provides a reliable transport service, ensuring that data is transported across the network without error and in sequence. Like TCP, SCTP is a session-oriented mechanism, meaning that a relationship is created between the endpoints of an SCTP association prior to data being transmitted, and this relationship is maintained until all data transmission has been successfully completed.

081. Unlike TCP, SCTP provides a number of functions that are critical for telephony signalling transport, and at the same time can potentially benefit other applications needing transport with additional performance and reliability.

082. **Status**: SCTP has been approved by the IETF as a Proposed Standard. The error check algorithm has since been modified. Future changes and updates will be reflected in the IETF RFC index. SCTP has been implemented on several OS: Windows XP, Linux, AIX, BSD, Solaris, and QNX Neutrino.

1.2. GREEN INFORMATION TECHNOLOGY

083. There has always been a push to make technology faster. Now, emerging new trends are driving technologies to become more efficient as well. The drivers of these new trends vary from higher energy costs to environmental concerns. In the past, military interests in technology were less concern with how efficient it was, than how competent it was in producing a desired effect.

084. **Implications**: Reduction of power consumption during mlitary operations directly effects the costs of conducting such operations. From a NATO perspective, cost-savings incurred through efficiency will have larger impact on participants with less finanical resources to devote to NATO operations.

1.2.1. IEEE 802.3az (Green Ethernet)

085. The goals of the IEEE 802.3az task force are pretty straightforward: define a mechanism to reduce power consumption during periods of low link utilization and a protocol to coordinate transitions to or from a lower level of power consumption. It'll work only on new hardware, of course, but that hardware should be fully backward-compatible. Using "channel staggering" in combination with a few other technologies may lead to a 50-85% power savings.

086. **Status**: First draft of the specification should by out by the end of 2008, though the final version won't be ratified until early of 2010.

1.2.2. IEEE 1680 (Environmental Assessment)

087. Modern IT systems rely upon a complicated mix of people, networks and hardware; as such, a green computing standard must be systemic in nature, and address increasingly sophisticated problems. The IEEE 1680 standard defines 51 criteria used in the assessment of computing products for enironmental imapct. Impact is measure by reduced use of hazardous materials, maximum energy efficiency during a product's lifetime, and promotion of recyclability or biodegradability of defunct products. Products that passes at least 21 of the the 51 criteria, are eligble to be certified as Energy-Star or EPEAT compliant.

088. **Status**: Ratified in 2006, the standard was viewed as ambiguous in how to apply specific criteria. Recent verification rounds has prompted detailed clarification and established Interpretations of some portions of the IEEE 1680 standard. With the new supplemental guidance it should be more widely accepted over the next 3-5 years.

1.3. CLOUD COMPUTING

089. The "Cloud" in Cloud computing describes a combination of inter-connected networks. This technology area focuses on breaking up a task into sub-tasks. The sub-tasks are then executed simultaneously on two or more computers that are communicating with each other over the “Cloud”. Later, the completed sub-tasks are reassembled to form the completed original main task. There are many different types of distributed computing systems and many issues to overcome in successfully designing one. Many of these issues deal with accommodating a wide-ranging mix of computer platforms with assorted capabilities that could potentially be networked together

090. **Implications**: The main goal of a cloud computing system is to connect users and resources in a transparent, open, and scalable way. Ideally this arrangement is drastically more fault tolerant and more powerful than many combinations of stand-alone computer systems. If practiced in a NATO environment, member nations would consume their IT services in the most cost-effective way, over a broad range of services (for example, computational power, storage and business applications) from the "cloud", rather than from on-premises equipment.

1.3.1. Platforms

091. Cloud-computing platforms have given many businesses flexible access to computing resources, ushering in an era in which, among other things, startups can operate with much lower infrastructure costs. Instead of having to buy or rent hardware, users can pay for only the processing power that they actually use and are free to use more or less as their needs change. However, relying on cloud computing comes with drawbacks, including privacy, security, and reliability concerns.

1.3.1.1. Amazon's Elastic Compute Cloud (EC2)

092. Amazon Elastic Compute Cloud (Amazon EC2) is a web service that provides resizable compute capacity in the cloud. It is designed to make web-scale computing easier for developers. If your application needs the processing power of 100 CPUs then you scale up your demand. Conversely, if your application is idle then you scale down then amount of computing resources that you allocate.

093. **Status**:The first company to successfully levearge the excess computing resources from its primary bussiness. Currently, CPU cycles and storage are at pennies per hour or GB.

1.3.1.2. Microsoft's Azure Services Platform

094. Windows® Azure is a cloud services operating system that serves as the development, service hosting and service management environment for the Azure Services Platform. Windows Azure provides developers with on-demand compute and storage to host, scale, and manage Web applications on the Internet through Microsoft® data centers.

095. **Status**: During the Community Technology Preview (CTP) developers invited to the program, which includes all attendees of the Microsoft Professional Developers Conference 2008 (PDC), receive free trial access to the Azure Services Platform SDK, a set of cloud-optimized modular components including Windows Azure and .NET Services, as well as the ability to host their finished application or service in Microsoft datacenters.

1.3.1.3. Google App Engine

096. Google App Engine enables you to build web applications on the same scalable systems that power Google applications. App Engine applications are easy to build, easy to maintain, and easy to scale as your traffic and data storage needs grow. With App Engine, there are no servers to maintain: You just upload your application, and it's ready to serve to your users. Google App Engine applications are implemented using the Python programming language.

097. **Status**: Currently in the preview release stage. You can use up to 500MB of persistent storage and enough CPU and bandwidth for about 5 million page views a month for free. Later on if you want additional computing resources, you will have to purchase it.

1.3.2. Grid Computing

098. Grid computing is the collective name of technologies that attempt to combine a set of distributed nodes into a common resource pool. The term grid computing stems from an analogy with electric power grids that combine a large set of resources (power plants, transformers, power lines) into simple well defined product (the power outlet) that the user can use without having to know the details of the infrastructure behind it.

099. Typical for grid computing is also that it offers a framework for management of node memberships, access control, and life cycle management. Common applications of grid computing allow well defined organisations to share computational resources or storage resources so that resources may be used efficiently and resource demanding tasks can be performed that would otherwise have required large specialised and/or local investments.

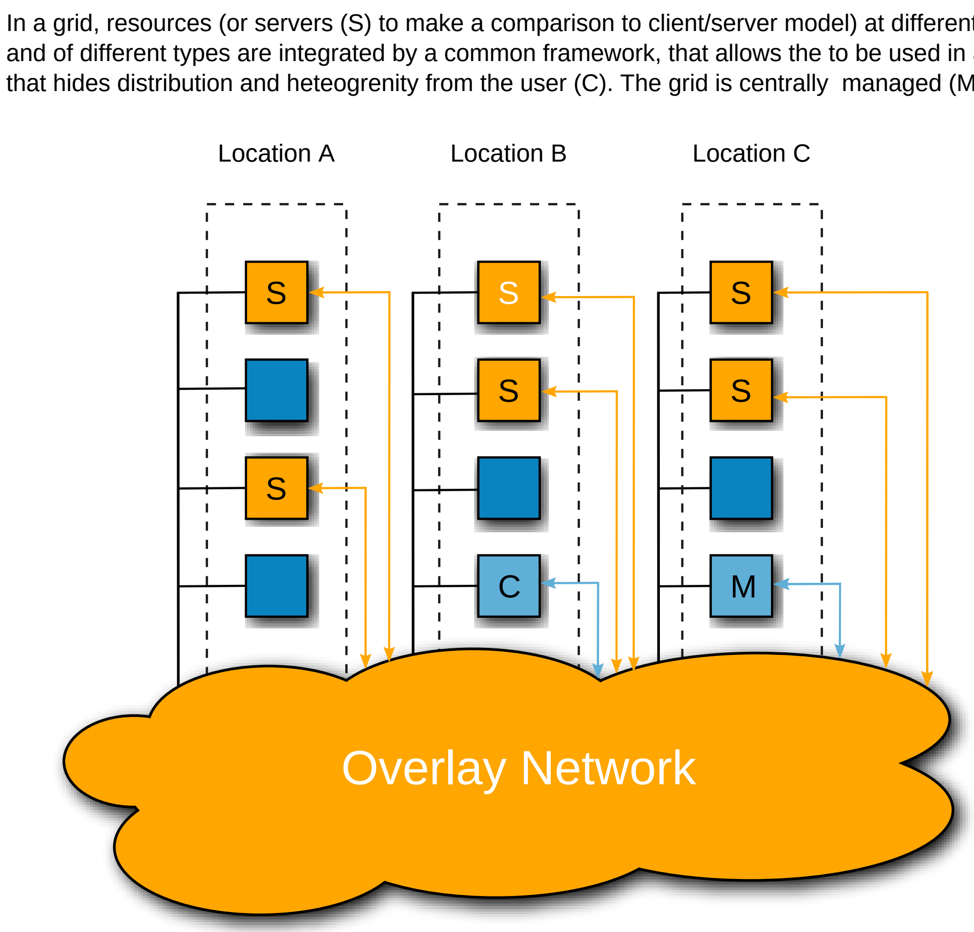

Figure 1.5. Grid Computing

100. While some grid computing systems have been designed for a specific purpose, some standards for Grid infrastructure have also evolved that make the task of setting up a Grid easier

and provide a common interface to application developers. Such standardisation efforts have resulted in Globus Toolkit [19] and OGSA (Open Grid Services Architecture) [21].

101. The Global Grid Forum (GGF) [20] is a set of working groups where much work on grid computing standardisation is ongoing, and that also is behind the OGSA standard. Their web site is a good source of information about ongoing work in the field and examples of grid projects.

1.3.2.1. Globus Toolkit

102. Globus Toolkit [19] offers tools and APIs for building secure grid infrastructures. It offers a secure infrastructure (GSI) on top of which support for resource management, information services, and data management is provided. It is being developed by Globus Alliance [18], and is among other applications being used as a foundation for implementation of OGSA.

1.3.2.2. OGSA

103. OGSA [20] (developed by the Global Grid Forum, GGF [20]) builds on a combination of Globus Toolkit [19] (developed by the Globus Alliance [18]) and Web service technologies to model and encapsulate resources in the Grid. A number of special Web service interfaces are defined by OGSA that support service management, dynamic service creation, message notification, and service registration. A number of implementations of OGSA have been made, including for example OGSI (Open Grid Services Infrastructure) and WSRF (Web Services Resource Framework, developed by OASIS [17]). Today, WSRF is the chosen basis for further development of OGSA

1.3.2.3. OSGi

104. OSGi is a standard for a framework for remotely manageable networked devices [5]. Applications can be securely provisioned to a network node running an OSGi framework during runtime and thus provides the possibility to dynamically manage the services and functionality of the network node. The OSGi model is based upon a service component architecture, where all functionality in the node is provided as "small" service components (called bundles). All services are context aware of each other and heavily adapt their functionality depending on what other services are available. Services must degrade gracefully when the services they depend upon are not available in the framework. These network nodes are designed to reliably provide their services 24/7/365. Adding an OSGi Service Platform to a networked node/device adds the capability to manage the life cycle of the software components in the device. Adding new services thus makes it more future proof and gives the node flexibility.

105. OSGi adopts a SOA based approach where all bundles deployed into an OSGi framework are described using well defined service interfaces. The bundle uses the framework's name service for publishing offered services and to retrieve services needed by the bundle itself. OSGi works well together with other standards and initiatives for example Jini or Web Services. OSGi is also an example of a technology where integration is carried out in the Java environment but the actual implementation of the services can be written in other languages, such as C.

1.3.3. Decentralised Computing

106. Another trend in distributed system is to decrease the dependence on centralised resources. A centralised resource is typically some service of function implemented by dedicated nodes in the distributed system that many of or all other nodes depend on to perform their own services or functions. Examples of such services are shared databases, network routing and configuration functions, and name or catalogue services. Obviously, this may cause dependability problems as the centralised server becomes a potential single point of failure (). From some points of view, decentralisation (i.e To decrease the dependence single nodes), is therefore a property to strive for. However, decentralisation may also result in a (sometimes perceived) loss of control that fits poorly with traditional ways of thinking of, for example, security. Decentralisation can thus have a rather long-reaching impact on the way distributed systems are designed.

107. Taken to its extreme, decentralisation strives for distributed systems where all nodes are considered equal in all respects (except of course their performance and capacity), i.e., all nodes are considered to peers. This is the foundation to peer-to-peer (P2P) systems, which will be discussed later. In such systems, decentralisation is realised by offering mechanisms to maintain a global shared state that is not stored by any single node.

1.3.3.1. Peer-to-Peer (P2P)

108. Peer-to-peer, or P2P for short, is a technology trend that has received much attention in recent years. Unfortunately, much of this attention has been oriented towards questionable applications of P2P, such as illegal file sharing, rather than towards its merits as a technology that addresses important problems with traditional distributed systems.

109. The fundamental idea behind P2P is, as is implied by its name, that all participating nodes in a distributed system shall be treated as peers, or equals. This is a clear deviation from the client/server concept, where some nodes play a central role as servers and other nodes play a role as clients. In those systems, the server nodes become critical for the system function, and thus need to be dependable, highly accessible, and dimensioned to handle a sometimes unpredictable workload. Obviously this may make a server node both a performance bottleneck and a dependability risk. P2P addresses such problems.

In peer-to-peer (P2P) systems, all participating network nodes contribute to the total functions and services offered by the system. To achieve this, the nodes are interconnected by an application specific overlay network. All nodes can thus be said to operate as both clients and servers. This result in decentralisation and loss dependence on the reachability of individual nodes.

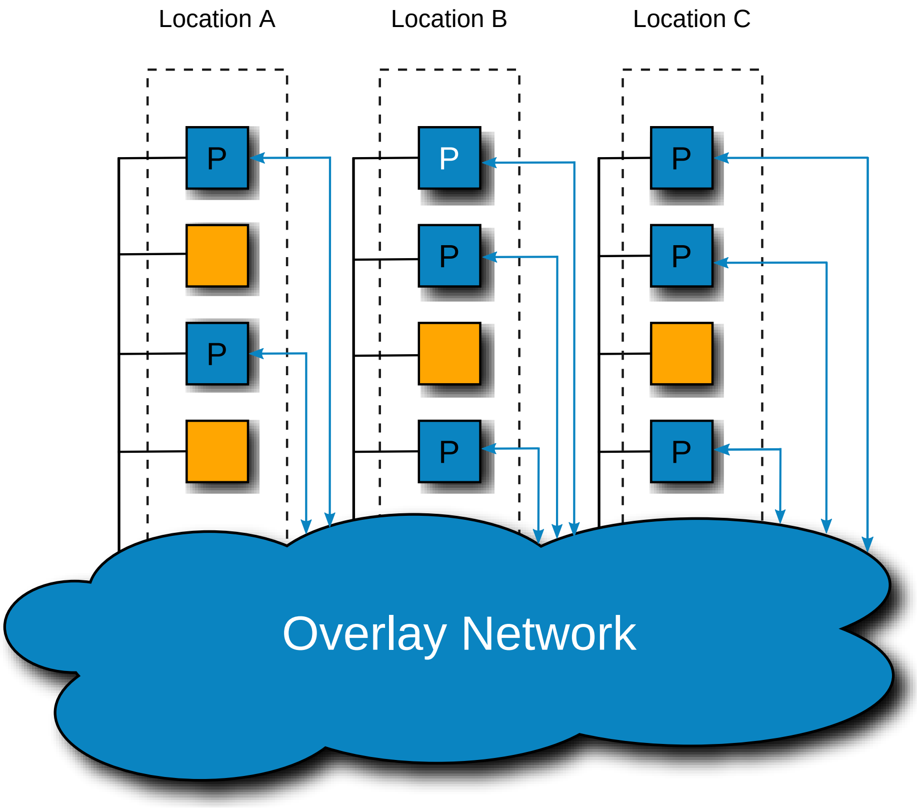

Figure 1.6. Peer-To-Peer

110. The fundamental important property of many P2P applications is that they allow storage of named objects, such as files, services, or database entries, to be spread over all nodes in a system instead of having to store and access them on centralised server nodes. Object names can be numbers or character strings; whichever is appropriate for the applications. Once stored in the system, any node can access a named object just by knowing its name. This means that a P2P system can have a global shared state that does not depend on any centralised node.

111. While in principle avoiding a centralised solution, many early P2P systems, such as the Napster file sharing system actually relied on some central functions in order to implement the mapping from object names to object locations. However, in later generations of P2P decentralisation has been taken another step further, by the introduction of overlay networks, earlier in this report mentioned as a form of virtual networks.

112. With an overlay network, a distributed means of finding the node that is responsible for storing an object with a given name is provided. Typically the set of all possible object names, called the name space, is divided into subsets such that each node becomes responsible for one subset of the name space. This means that the need for centralised resources is completely avoided. For a node to become part of a P2P system, i.e. To join the overlay network, all that is needed is knowledge of any other node already part of the system. As nodes join and leave the system, the responsibility for name space subsets is automatically redistributed.

113. The development of overlay network based P2P systems has been driven by a striving to improve scalability, guarantees, and robustness. Today, a logarithmic logical scalability can be achieved, which means that to find a given node from any other node in the system requires at most logk(N) node-to-node messages to be sent, where k is some constant and N is the maximum number of nodes in the system. Note, however, that this scalability measure does not automatically translate into an exact measure of the actual time it takes to send a message between two nodes as this time will depend also on the distribution of nodes on the underlying physical network.

114. The scalability issue has been addressed by a number of proposed P2P implementation techniques developed within academic research projects such as Chord [13], Pastry [14], and Tapestry [15]. However, scalability has been taken yet another step further by the DKS system developed at the Swedish Institute of Computer Science (SICS. In DKS, the amount of administrative traffic required to keep track of nodes in the overlay network is significantly reduced, and dimensioning parameters of the system can be fine-tuned in a very general framework (that actually treats the other mentioned techniques as special cases) so as to improve the practical scalability.

115. Another important aspect of P2P systems is also the guarantees that can be given that any named object stored in the systems also can found. Such guarantees have improved over the P2P technology generations, and 100% guarantees can now be given by the DKS system assuming that there are no errors such as physical communication failures that make nodes unreachable. As intermittent or lasting communication failures must be expected in any practical system, techniques for improving the fault tolerance by means of replication of data have been investigated and are now being included into the general frameworks of P2P technologies.

116. However, practical applications of new P2P technologies like DKS in distributed systems need to be investigated in order to determine how well scalability and robustness functions in practise given the impact of underlying infrastructure and application properties. An example of an ongoing such project investigates the properties of a DKS based implementation of central service in the OpenSIS standard [16].

117. To summarise, P2P technologies have matured into a practical way of organising distributed systems in a decentralised way that is both highly scalable and reliable. Excellent reviews and descriptions of P2P technologies can be found in [1], [2], and [3].

118. **Status**: Currently the advantages of P2P technologies (pooling computing power, pooling bandwidth of the participants, and elimination of the server/client distinction) don't outweigh the disadvantages (legal obstacles, and security vulnerabilities)

1.4. SERVICE DELIVERY PLATFORM (SDP)

119. Service Delivery Platform (SDP) is an architecture that enables the quick development, deployment and integration (convergence) of broadband, video, wireless and wire-line services can cater to many technologies including VoIP, IPTV, HSD (High Speed Data), Mobile Telephony, Online Gaming, etc.

120. Examples of a converged architecture:

- A user can see incoming phone calls (Wire-line or Wireless), IM buddies (PC) or the location of friends (GPS Enabled Device) on their television screen.
- A user can order VoD (Video on Demand) services from their mobile phone or watch streaming video that they have ordered as a video package for both home and mobile phone.

121. SDPs in the converged services world need to be designed and engineered using information and identity engineering techniques as a core discipline because a is supporting online users their services. A needs to be a real time multi function system that interfaces to the back office systems for billing and to the network infrastructure systems. From an information engineering perspective there could be 20-100 information items associated with a user, their devices and their content and if there are 10 million users on the system, it means that the needs scale up to associate with a billion pieces of information used in random ways. SDPs also need to address the issues of converged services management, account control, self care, and entitlements as well as presence based event type services. Service Delivery Platform, identity engineering and white papers on presence based services can be found at *www.wwite.com.

1.4.1. Composite Adaptive Directory Services

122. Data bases have been with the IT industry for 30 years and traditional directories for the last 20 years and they will be with us in the future. However, with the larger scale, converged services and event driven (presence) systems now being developed world wide (e.g. 3G-IMS), information, identity and presence services engineering and the technologies that support it will require some evolution. This could take the form of CADS (Composite Adaptive Directory Services) and CADS supported Service Delivery Platforms. CADS is an advanced directory service and contains functions for managing identity, presence, content and adaptation algorithms for self tuning and with its unique functions, greatly simplifies and enhances the design of converged services SDPs. See Service Delivery Platform

1.5. NETWORKED COMPUTING

123. Networked computing is a set of technologies that treats the network as a computing platform, enables machine to machine communication, and offer efficient new ways to help networked computers organise and draw conclusions from online data.

124. **Implications**: Reusable, repurposable, and reconnectable data/services will promote the convergence of Service Oriented Architecture and the Semantic Web.

1.5.1. Web Services

125. Web Services are software systems that enable machine to machine interaction over a network. The Web Services present themselves as web based Application Programming Interfaces (API) that use XML messages to communicate. The core standards are covered in Volume 2 and this section covers emerging extentions.

- **WS-Security** - Defines how to use XML Encryption and XML Signature in SOAP to secure message exchanges, as an alternative or extension to using HTTPS to secure the channel.
- **WS-Reliability** - An OASIS standard protocol for reliable messaging between two Web services.
- **WS-ReliableMessaging** - A protocol for reliable messaging between two Web services, issued by Microsoft, BEA and IBM it is currently being standardised by the OASIS organisation
- **WS-Addressing** - A way of describing the address of the recipient (and sender) of a message, inside the SOAP message itself.
- **WS-Transaction** - A way of handling transactions.

1.5.1.1. Web Service Specifications

Technology	**Description**
WS-BPEL	Process composition
WSCI	Process composition
OASIS WS-Business Activity 1.1	Management and infrastructure
WS-Eventing	Management and infrastructure
WS-Notification	Management and infrastructure
WS-Federation	Management and infrastructure
JBI	Process composition

SCA	Process composition
Java-EE	Management and infrastructure
Java-RMI	Distributed systems
.NET	Management and infrastructure
Jini	Distributed systems, Service selection, Management and infrastructure
Rio	Distributed systems, Service selection, Process composition, Management and infrastructure

Table 1.5. Summary of Emerging Web Services Technologies

1.5.1.1.1. Business Process Execution Language for Web Services (WS-BPEL or BPEL4WS)

126. The Business Process Execution Language (BPEL) originally proposed by Microsoft, and Siebel Systems. It is XML-based and is designed as a layer on top of WSDL that allows a standardised way of describing business process flows in terms of web services. A BPEL process can be used either to describe an executable work flow in a node (orchestration), or to describe the protocol for interaction between participants in a business process (choreography). **Status**: As of January 2007, BPEL4WS is now an OASIS standard also referred to as WS-BPEL version 2.0. [4].

1.5.1.1.2. Web Service Choreography Interface (WSCI)

127. Other Web service based standards for Web service orchestration and choreography are , developed by Sun, , BEA, and Intalio, and BPML, initiated by Intalio, Sterling Commerce, Sun, and through the non-profit (Business Process Management Initiative) corporation. (Web Services Choreography Interface) extends WSDL (rather than being built on top of WSDL like BPEL) and focuses on the collaborative behaviour of either a service user or a service provider. **Status**: The WSCI specification is one of the primary inputs into the W3C's Web Services Choreography Working Group which published a Candidate Recommendation on WS-DSL version 1.0 on November 2005 to replace WSCI.

1.5.1.1.3. Web Service Distributed Management (WSDM)

128. Web Services Distributed Management (WSDM) [22] is an OASIS [17] standard that specifies infrastructure support for the integration of web service management aspects across heterogeneous systems. This is done through management specific messaging via web services. It consists of main parts:

- WSDM-MUWS. Deals with Management Using Web Services (MUWS), i.e., the fundamental capabilities required to manage a resource.

- WSDM-MOWS. Deals with Management of Web Services (MOWS), and builds on MUWS to specify how web services (as a kind of resource) are managed.

1.5.1.1.4. Java Business Integration (JBI)

129. Java Business Integration (JBI) is a Java Specification Request (JSR 208) [24] that aims to extend Java (including Java EE) with an integration environment for business process specifications like , BPEL4WS and those proposed by the W3C Choreography Working Group [23]. It is an example of a technology that implements Enterprise Service Bus (ESB) concepts.

1.5.1.1.5. Java Remote Method Invocation (JRMI)

130. Java Remote Method Invocation (JRMI), is a Java specific standard for access to Java objects across a distributed system [12].

1.5.1.1.6. Jini

131. Jini network technology [6] [7] [8] is an open architecture that enables developers to create network-centric services that are highly adaptive to change. An architecture based on the idea of a federation rather than central control, Jini technology can be used to build adaptive networks that are scalable, evolvable and flexible as typically required in dynamic computing environments. Jini technology provides a flexible infrastructure for delivering services in a network and for creating spontaneous interactions between clients that use these services regardless of their hardware or software implementations.

132. The Jini architecture specifies a discovery mechanism used by clients and services to find each other on the network and to work together to get a task accomplished. Service providers supply clients with portable Java technology based objects that implements the service and gives the client access to the service. The actual network interaction used can be of any type such as Java [27], CORBA [11], because the object encapsulates (hides) the communication so that the client only sees the Java object provided by the service.

133. The Rio Project [8] extends the Jini technology [6] [7] to provide dynamic adaptive network architecture and uses a nomadic SOA approach. In a nomadic SOA services can migrate and self optimise their architectural structure to respond to the changing service environment.

134. A fundamental tenet of distributed systems is they must be crafted with the reality that changes occur on the network. Compute resources have assets diminished or fail and new ones are introduced into the network. Applications executing on compute resources may fail, or suffer performance degradation based on diminishing compute resource capabilities and/or assets. Technology used must provide distributed, self-organizing, network-centric capabilities. Enables a dynamic, distributed architecture capable of adapting to unforeseen changes on the network.

135. **Importance**: This architecture can facilitate the construction of distributed systems in the form of modular co-operating services.

136. **Implications**: Can provide a more stable, fault-tolerant, scalable, dynamic, and flexible solution. Jini also provide the ability to do a better job at upgrading systems, keeping everything running including old clients.

137. **Status**: Originally developed and maintained by Sun Microsystems, but now that responsibility is being transferred to the Apache Software Foundation under the project name of River. There are many initiatives that are based on the Jini technology such as various grid architectures and [8].

1.5.1.2. Web Service Frameworks

138. A list of Frameworks:

Name	Platform	Destination	Specification	Protocols
Apache Axis	Java/C++	Client/Server	WS-ReliableMessaging, WS-Coordination, WS-Security, WS-AtomicTransaction, WS-Addressing	SOAP, WSDL
JSON RPC Java	Java	Server	-	JSON-RPC
Java Web	Java	Client/Server	WS-Addressing, WS-Security	SOAP
Services Development Pack	Java	Client/Server	-	WSDL
Web Services Interoperability Technology	Java	Client/Server	WS-Addressing, WS-ReliableMessaging, WS-Coordination, WS-AtomicTransaction, WS-Security, WS-Security Policy, WS-Trust, WS-SecureConversation, WS-Policy, WS-MetadataExchange	SOAP, WSDL, ATOM

Web Services Invocation Framework	Java	Client	-	SOAP, WSDL
Windows Communication Foundation	.Net	Client/Server	WS-Addressing, WS-ReliableMessaging, WS-Security	SOAP, WSDL
XFire	Java	Client/Server	WS-Addressing, WS-Security	SOAP, WSDL
XML Interface for Network Services	Java	Server	-	SOAP, WSDL
gSOAP	C/C++	Client/Server	WS-Addressing, WS-Discovery, WS-Enumeration, WS-Security	SOAP, XML-RPC, WSDL
NuSOAP	PHP	Server	-	SOAP, WSDL

1.5.1.3. Web Services Platforms

1.5.1.3.1. Java 2 Edition (J2EE)

139. Java Enterprise Edition (formerly known as Java 2 Platform, Enterprise Edition or J2EE up to version 1.4) [9] is a specification of a platform and a code library that is part of the Java Platform. It is used mainly for developing and running distributed multi-tier Java applications, based largely on modular software components running on a platform (application server). The platform provides the application with support for handling of transactions, security, scalability, concurrency and management of deployed applications. Applications are easily ported between different Java EE application servers. Applications developed for the Java EE can easily support Web Services. Java EE is often compared to Microsoft .Net [10], a comparison that is beyond the scope of this document. But it shall be noted that .Net is a product and framework closely related to development for the Windows operating system whereas Java EE is a specification that is followed by many product vendors.

1.5.1.3.2. Microsoft .NET

140. Microsoft .NET framework [10] is a Microsoft product closely related to application development for the Windows platform [10]. The framework includes the closely related C# programming language (even if it is a formal ISO standard) and the Common Language Runtime (CLR), which simplified is Microsoft's response to JAVA. Programs written for the NET. Framework execute in which provides the appearance of an application virtual machine, so that program-

mers need not consider the capabilities of the specific CPU that will execute the program. The framework also includes libraries for development of web service applications.

1.5.2. Semantic Web

141. The Semantic Web initiative will make searches more accurate and enable increasingly sophisticated information services like intelligent agents that can find products and services, schedule appointments and make purchases. The initiative includes a sort of grammar and vocabulary that provide information about a document's components; this information will enable Web software to act on the meaning of Web content. Semantic Web software and Web services promise to shift the nature of the Web from a publishing and communications medium to an information management environment.

142. Semantic Web software includes a special set of Extensible Mark-up Language (XML) tags that includes Uniform Resource Identifiers (URL), a Resource Description Framework (RDF), and a Web Ontology Language (OWL).

143. Semantic Web software makes it possible for an intelligent agent to carry out the request "show me the Unmanned Aerial Vehicles (UAV) operating in the current area of responsibility" even if there is no explicit list, because it knows that "area of responsibility" has the property "location" with the value "Kandahar", and in searching a directory of UAVs it knows to skip UAVs belonging to the United States, whose location value is "Kabul", but include German UAVs, whose location value is "Kandahar".

144. Semantic Web software organises Web information so that search engines and intelligent agents can understand properties and relationships. A university, for example, could be defined as an institution of higher education, which is a class of objects that has a set of properties like a population of students.

145. The World Wide Web Consortium released standards in February 2004 that define the two foundation elements of the Semantic Web initiative: the Resource Description Framework (RDF), which provides a structure for interpreting information, and the Web Ontology Language (OWL), which provides a means for defining the properties and relationships of objects in Web information.

146. Web services provide a way for software to communicate with each other over the Web, enabling a form of distributed computing in which simple services can be combined to carry out complicated tasks like financial transactions.

147. Our most fundamental sensors are our senses themselves. They are quite sophisticated, the product of a complex evolutionary design. And yet we've improved on them as time has passed: telescopes and microscopes extend our eyes, thermometers extend our touch, and satellite dishes extend our ears. In addition, virtual sensors have been used for many years to monitor our computing environments. Smaller and more powerful computer processors allow sensors to be small and inexpensive enough that they can be everywhere. And with the advent of trillions and trillions of IPv6 addresses, they can all be networked.

148. Networks, human or technological, are designed to communicate information from one point to others. But the value of a network is entirely dependent on the information it contains. And so the sensors that feed information into a network play a crucial role in maximising a network's value. Simply put, the better the sensors and the better the information they provide, the more valuable the network becomes.

149. Advanced sensors that report directly about their physical environment will enable truly revolutionary applications. Already there are sensors that can detect, measure, and transmit any physical quality such as temperature, pressure, colour, shape, sound, motion, and chemical composition. And, as sensors are becoming more sophisticated, they are also shrinking in size. Some are so tiny that they are difficult to detect.

150. Emerging sensor network technologies will be autonomous, intelligent, and mobile. These sensors will reconfigure themselves to achieve certain tasks. These requirements will provide rigid requirements for the computing, and delivery systems of the future. The networks and computing systems must reorganise themselves to serve the distributed agents with needs to communicate and exchange decisions, actions, and knowledge to other agents in secured environment.

1.5.3. Service Component Architecture

151. Service component architecture (SCA) [25] is a technology development initiative driven by a group of middle-ware vendors. SCA extends and complements existing standards for service implementation and for web services; the goal is to simplify application development and implementation of SOA.

152. SCA components operate at a business level and are decoupled from the actual implementation technology and infrastructure used. SCA uses Service Data Objects (SDO) [26] to represent the business data that forms parameters and return value between the services. SCA thus provides uniform Service access and uniform Service data representation.

153. **Status**: The current SCA specifications are published in a draft version (1.0) at the vendor's web sites [25].

1.6. SECURITY

154. There is an explosion of protocols and standards dealing with identities. These range from identity, authentication, access control, compliance, workflow, policy, storage, etc. From these protocols and standards we are seeing infrastructure that is being developed to support them. There is a growing trend to provide security infrastructure openly so that there is interoperability and collaboration in the "Security Environment". From this infrastructure many applications will be written, such as signal sigon.

155. **Implication**: For an enterprise, this means a lower cost of password and account management, and lower user frustration by allowing users to control of their login.

1.6.1. Authentication

1.6.1.1. OpenID

156. OpenID is a decentralised single sign-on system. Websites using OpenID allow web users to abandon the need to remember traditional authentication tokens such as user name and password. Instead, they only need to be previously registered on a website with an OpenID "identity provider", sometimes called an i-broker. Since OpenID is decentralised, any website can employ OpenID software as a way for users to sign in; OpenID solves the problem without relying on any centralised website to confirm digital identity.

157. **Status**: OpenID is increasingly gaining adoption among large sites, with organisations like AOL acting as a provider. In addition, integrated OpenID support has been made a high priority in Firefox 3 and Microsoft is working on implementing OpenID 2.0 in Windows Vista. A non-profit organisation,OpenID Europe, was created in 2007 to support and promote the OpenID framework in Europe.

1.6.1.2. Bandit Project

158. The Bandit project is a worldwide open source community that enables open yet secure enterprise computing through an Open Identity System. Bandit's components will create an environment where, the right people get the right access to the right IT systems at the right time. The Bandit project is sponsored by Novell, which contributes significant engineering, management and infrastructure resources. Novell, in consultation with the Bandit community, sets the project engineering goals and retains ultimate responsibility for the project.

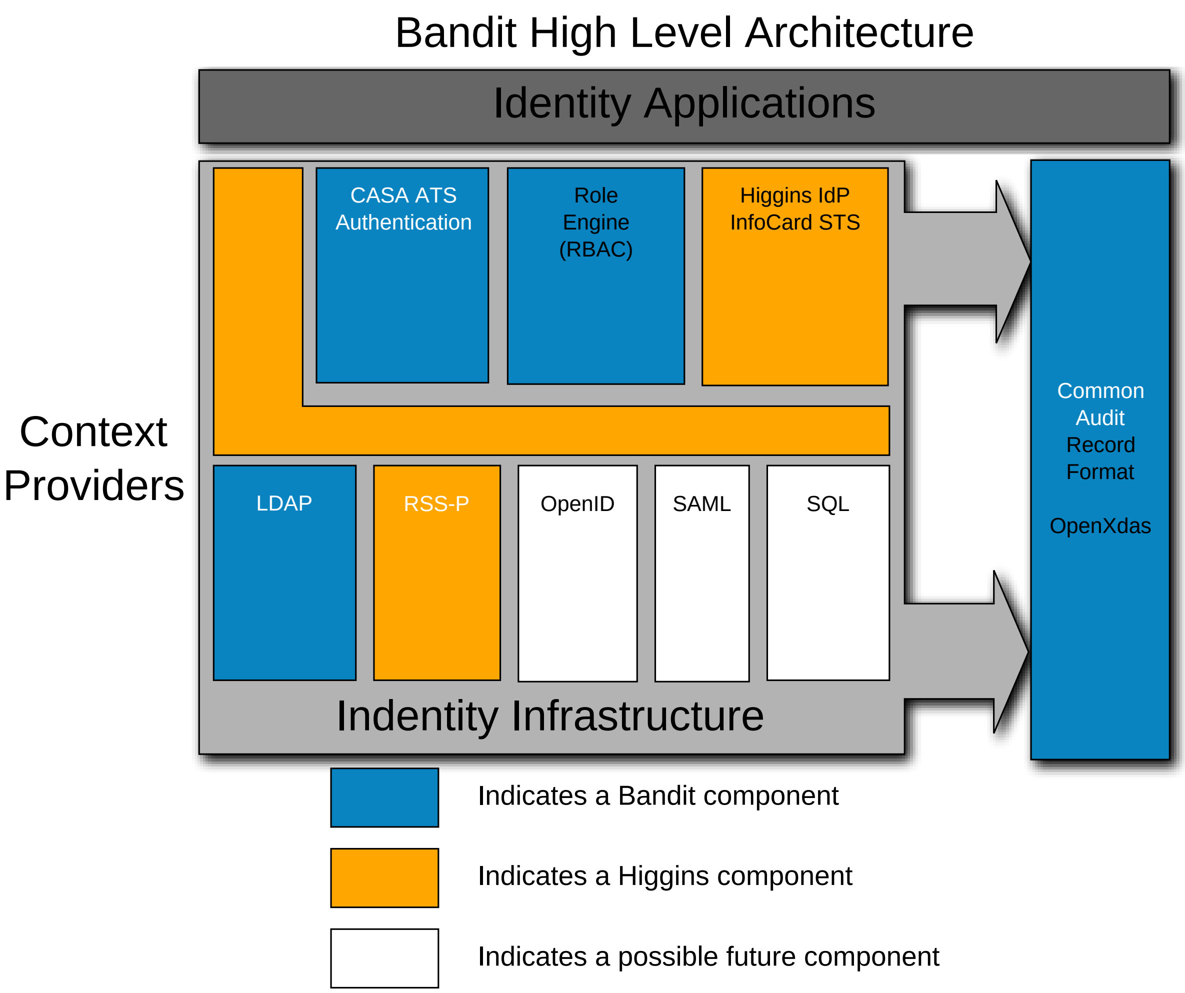

Figure 1.7. Bandit High Level Architecture

159. Bandit's current emphasis is in the following areas:

- Provide simple application access to multiple identity stores
- Support multiple and pluggable authentication methods to provide consistent application access
- Provide a simple application interface to unify system access based on roles
- Allow applications to easily participate in a common compliance system

160. **Status**:Work is being done on version 2 of the Common Identity component and the Role Engine component.

1.6.2. Risk Analytical Engines

161. Risk Analytical Engines are used predict risk based on models. Risk assessments are done real-time.

162. **implications**: Risk Analytical Engines are used in a variety of industries such as financial, health, and customer service. But it is the potential use in enterprise identity management and network intrusion detection that makes it an attractive technology category.

1.6.2.1. Predictive Model Markup Language (PMML)

163. Predictive Model Markup Language (PMML) describes predictive analytical models that are conventionally used to analyse data in a data warehouse. PMML provides a method for systems, or computer programs to access an analytical model by providing a web services abstraction of the analytical model. This allows the invocation of the analytical model hosted by an analytic engine through a web services interface to the analytic engine. Invocation of the analytical model through the web services interface may be independent of the analytic engine hosting the analytical model.

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2. MID TERM EMERGING STANDARDS

164. This purpose of this chapter is to specify the NISP mid term emerging standards. The document organises these standards into five service areas. These service areas are listed in volume 2.

165. This section presents all associated standards in tabular form. The tables refine each service area into one or more service categories, with service components mapping to the emerging mid term category (see NISP vol. 1). A remarks column provides optional supplementary information on each standard plus CCEB-specific information. The NISP Rationale Document (RD) provides further explanation on why service and standards categories have been selected.

2.1. OPERATIONAL MISSION/ACTIVITIES/TASKS

166. This service area is detailed in the corresponding section of volume 2.

2.1.1. List of Standards

SUBAREA / SERVICE CATEGORY	CATEGORY / SUBCATEGORY	EMERGING MID TERM	Remarks

2.2. USER INFORMATION SERVICES

167. This service area is detailed in in the corresponding section of volume 2.

2.2.1. List of Standards

SUBAREA / SERVICE CATEGORY	CATEGORY / SUBCATEGORY	EMERGING MID TERM	Remarks

2.3. TECHNICAL SERVICES

168. This service area is detailed in in the corresponding section of volume 2.

2.3.1. List of COI Standards

2.3.2. List of Information Integration Standards

SERVICECATEGORY / CATEGORY / SUBCATEGORY	**EMERGING MID TERM**	**Remarks**
Core Enterprise Services		
Discovery		
Service Discovery Services		
Information Discovery Services		
	OWL-S	
Repository		
Metadata Registry Services		
Enterprise Directory Services		
Mediation		
	OMG Systems Modeling Language (OMG SysML) Version 1.1, November 2008. SysML is a Systems Engineering standard.	
Composition Services		
Translation Services		
Interaction		
Messaging Services		
Publish/Subscribe Services		
Transaction Services		
Collaboration Services		
Infrastructure		

SERVICECATEGORY / CATEGORY / SUBCATEGORY	**EMERGING MID TERM**	**Remarks**
Application Services		
	HTML 5.0	
Storage Services		
Web Services		
Device Independent Console		
Content Mgmt		

2.3.3. List of Communications Standards

SERVICECATEGORY / CATEGORY / SUBCATEGORY	**EMERGING MID TERM**	**Remarks**
Network and Transport Services		
Mixed DISA standards		
	ZigBee 1.0	
	WiBree	
	W-USB	
	6LoWPAN	
	5G	
	Mobile WiMax	
	Mobile-Fi	
	WiBro	
	HIPERMAN	
	Flash-OFDM	
	UWB	
	OGSA	
	OSGi	
	SCTP	
Data Link and Connection Service		

SERVICECATEGORY / CATEGORY / SUBCATEGORY	EMERGING MID TERM	Remarks
External Networks		
Tactical Area Comms		
Transmission		
	VDSL2	VDSL2 is the next generation of Super Broadband DSL. Ericsson has demonstrated 500-Mbits/s transmission rates over copper cabling by using new crosstalk cancellation or vectorized VDSL2 based modems. The data rate is over 20 times faster than the fastest ADSL2 services currently on offer in most countries.
VLF		
HF		
VHF		
UHF		
UHF SATCOM		
SHF SATCOM		
EHF SATCOM		
QoS		

2.4. INFORMATION ASSURANCE

2.4.1. List of Standards

SUBAREA / SERVICE CATEGORY	CATEGORY / SUBCATEGORY	EMERGING MID TERM	Remarks
SMI Service			
Confidentiality			
Encryption			
Integrity			
Authentication			
		Common Biometric Exchange Formats Framework (CBEFF)	

SUBAREA / SERVICE CATEGORY	CATEGORY / SUBCATEGORY	EMERGING MID TERM	Remarks
Detection			
Transsec			

2.5. SERVICE MANAGEMENT AND CONTROL

SUBAREA / SERVICE CATEGORY	CATEGORY / SUBCATEGORY	EMERGING MID TERM	Remarks
Mgmt Info Publisher			
Mgmt Info Subscriber			
Mgmt Info Collector			
Mgmt Info Provider			
Asset Mgmt			
User Mgmt			
System Mgmt			

2.6. EVOLUTION TO A FEDERATED NNEC

169. This section of Volume 3 of the NATO Interoperability Standards & Protocols (NISP) will continue the evolution from the legacy platform based systems to a federated Network Enabled Capabilities environment. Within this part of the document, the focus is on the far-term perspective of 7 to 10 years into the future from the publication of this version of the NISP. This should encompass the realization of a fully network enabled NATO federated environment.

2.7. SCOPE

170. The scope of this section will cover that final transitional period when NATO transforms its environment to one that follows the approach of a NATO Network-Enabled Capability (NNEC). This section will identify the emerging technologies.

171. The far-term period will mark the migration from separate wired and wireless technologies and applications, and more about service portability between various networks and seamless

service mobility. The NATO network of the future will leverage both smart devices and network intelligence to delivery services in this seamless fashion.

2.8. NETWORKING

2.8.1. Mobile Ad-hoc Network (MANET)

172. MANET can be set up to connect military groups that need to maintain communications while on the move. Wireless sensor networks, on the other hand, are stationary. They are often deployed in areas hostile to humans and relay on a variety of observational data that are passed onto military personnel stationed at safer vantage points.

173. The potential integration of these two network types can provide the cornerstone of a truly 'network-centric' communications infrastructure. However, in order for NATO to fully utilize wireless technology, future technology should be focused on addressing the current deficiencies in wireless technology. These include:

- Improvements in extending wireless range capabilities
- Increasing transfer rates
- Technology that will create more resilient/reliable links
- Evolving routing protocols to better secure wireless networks
- Technology that will not only choose the best path for routing packets but will also choose the best frequency as well.

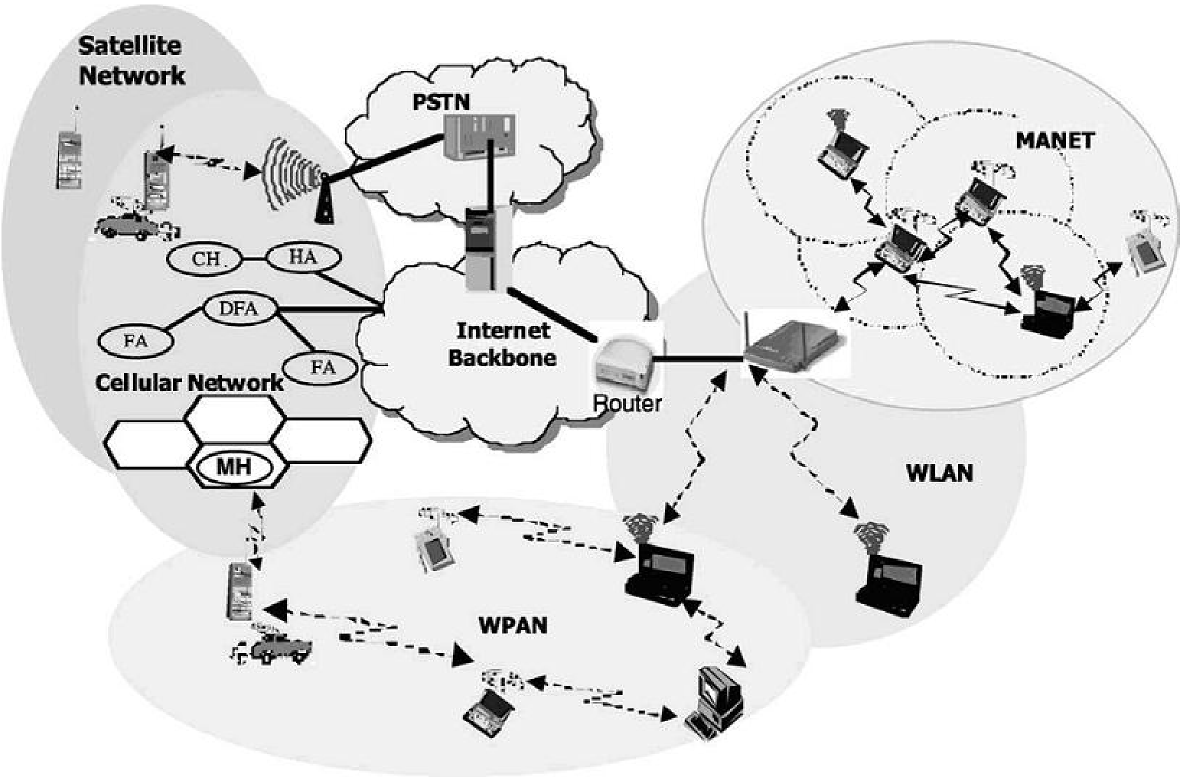

Figure 2.1. Mobile AdHoc Network

2.8.1.1. Ad Hoc On-Demand Distance Vector (AODV)

174. The Ad Hoc On-Demand Distance Vector routing protocol is intended for use by mobile nodes in an ad hoc network. It offers quick adaptation to dynamic link conditions, low processing and memory overhead, low network utilization, and establishment of both unicast and multicast routes between sources and destinations. It uses destination sequence numbers to ensure loop freedom at all times (even in the face of anomalous delivery of routing control messages), solving problems (such as ``counting to infinity") associated with classical distance vector protocols.

175. **Importance:** Designed for ad hoc mobile networks and is capable of both unicast and multicast routing.

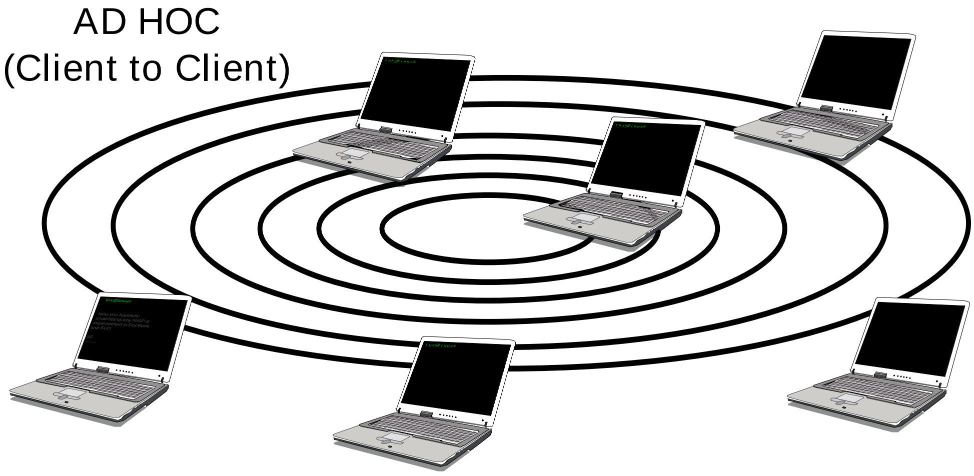

Figure 2.2. Ad Hoc Networking

2.8.1.2. Dynamic Source Routing (DSR)

176. The Dynamic Source Routing (DSR) is a routing protocol for wireless mesh networks. It is similar to AODV in that it forms a route on-demand when a transmitting computer requests one. However, it uses source routing instead of relying on the routing table at each intermediate device.

177. Determining source routes requires accumulating the address of each device between the source and destination during route discovery. The accumulated path information is cached by nodes processing the route discovery packets. The learned paths are used to route packets. To accomplish source routing, the routed packets contain the address of each device the packet will traverse. This may result in high overhead for long paths or large addresses, like IPv6. To avoid using source routing, DSR optionally defines a flow id option that allows packets to be forwarded on a hop-by-hop basis.

178. This protocol is truly based on source routing whereby all the routing information is maintained (continually updated) at mobile nodes. It has only 2 major phases which are Route Discovery and Route Maintenance. Route Reply would only be generated if the message has reached the intended destination node (route record which is initially contained in Route Request would be inserted into the Route Reply).

179. To return the Route Reply, the destination node must have a route to the source node. If the route is in the Destination Node's route cache, the route would be used. Otherwise, the node will reverse the route based on the route record in the Route Reply message header (symmetric links). In the event of fatal transmission, the Route Maintenance Phase is initiated whereby the Route Error packets are generated at a node. The erroneous hop will be removed from the node's route cache; all routes containing the hop are truncated at that point. Again, the Route Discovery Phase is initiated to determine the most viable route.

180. **Importance:** The protocol allows multiple routes to any destination and allows each sender to select and control the routes used in routing its packets. Also allows for a very rapid recovery when routes in the network change.

181. **Status:** IETF DSR Draft- version 1.0 has had many successful implementations. One of which is the open source DSR-UU that can run on Linux. DSR-UU implements most of the basic DSR features specified in the DSR draft (version 10). One big exception is flow extensions.

2.8.2. Knowledge Based Networking

182. A Knowledge Based Network would make decisions about the wireless spectrum and have intelligent nodes that could automatically optimize the network. If a connection spans reliable and unreliable parts of a network, there could be performance issues: if a packet makes it through the reliable region but is dropped in the unreliable part, it would have to be resent through the entire connection. A Knowledge Based Network would automatically break this connection into two smaller connections, one across the reliable region and one across the unreliable region. Then, if data is lost across the unreliable part, it would only need to be re-sent along that region of the network. This technique could increase bandwidth tenfold.

183. Also, in a knowledge based network it would take note of frequently accessed data and save copies on the edge of the network for quick access: the idea is If one soldier needs a piece of map data, then the guys around him will need it too. Artificial intelligence could even decide which protocols to use.

184. Such an intelligent network would not only understand how to move data; it would also be able to understand what the data meant to users. This idea is based on this concept of the Semantic Web, which called for Web pages to include machine-readable data in addition to content intended to be read by people. Software agents would use this data to understand the meaning of documents instead of simply searching for keywords.

2.9. DATA STRATEGIES

2.9.1. Situation-Dependent Information Extraction

185. Situation-dependent information extraction uses advanced algorithms to support situation associative processing and improve human systems collaboration. Tools are needed to go beyond static data filtering and template matching. Early work has shown that Bayesian networks, statistical analysis, and hidden Markov models can be used to extract meaning and context from complex and cluttered data streams. Application of the se techniques for disparate sensors that are not temporally or specially matched would enable NATO to detect, discern, analyze, and understand the actions of stealthy adversaries embedded in complex domains.

186. **Importance:** Effective implementation and utilization of these tools in conjunction with better understanding of the operational environment and adversary activities will improve performance of NATO forces across the decision-making spectrum from tactical to strategic, and

cross the pre- to post-conflict timeline. Improvements in link analysis and intent inference will result in faster and more complete understanding of options leading to better decisions.

2.9.2. Mega-Scale Data Management

187. Future operations can be expected to require the contextual exploitation capability to handle exabytes of data at transfer rates of terabytes per second, coupled to decision timelines in seconds to minutes. As the threat base evolves, there will be a greater dependence on integrated, multiple-domain sensors with much greater dynamic range, spatial reach, sample rate, and temporal history. Mega-scale data management will apply an integrated, federated, and scalable data framework to link disparate information sources and provide robust knowledge management to permit conclusions based on contextual relationships. It will also incorporate a robust security and access in a timely manner. Advanced automated decision tools will increase the war fighter's ability to make timely decisions with an explicit evidential basis and reduced the level of information overload often experienced in answering prioritized information requests. User-defined knowledge sharing will minimize catastrophic errors due to cognitive biases and other limitations.

188. **Importance:** Member nations must take a look at the private sector and emulate data management tools being explored in this area. Member nations must become more agile and responsive adapters of commercial advances in this and related fields in order to achieve the anticipated operational demands of future data management requirements.

2.9.3. Application Vulnerability Description Language (AVDL)

189. Application Vulnerability Description Language (AVDL) is a security interoperability standard for creating a uniform method of describing application security vulnerabilities using XML. With the growing adoption of web-based technologies, applications have become far more dynamic, with changes taking place daily or even hourly. Consequently, enterprises must deal with a constant flood of new security patches from their application and infrastructure vendors.

190. To make matters worse, network-level security products do little to protect against vulnerabilities at the application level. To address this problem, enterprises today have deployed a host of best-of-breed security products to discover application vulnerabilities, block application-layer attacks, repair vulnerable web sites, distribute patches, and manage security events. Enterprises have come to view application security as a continuous life-cycle. Unfortunately, there is currently no standard way for the products these enterprises have implemented to communicate with each other, making the overall security management process far too manual, time-consuming, and error prone.

191. **Importance:** AVDL will create a uniform way of describing application security vulnerabilities. This information may be utilized by application security gateways to recommend the optimal attack prevention policy for that specific application. Remediation products could use AVDL files to suggest the best course of action for correcting problems, while reporting tools could use AVDL to correlate event logs with areas of known vulnerability.

192. **Status:**The AVDL 1.0 specification was approved by OASIS in May 2004.

2.9.4. Common Alerting Protocol (CAP)

193. The Common Alerting Protocol is a simple but general format for exchanging all-hazard emergency alerts and public warnings over all kinds of networks. CAP is a XML-based data format for exchanging public warnings and emergencies between alerting technologies. CAP allows a warning message to be consistently disseminated simultaneously over many warning systems to many applications. CAP increases warning effectiveness and simplifies the task of activating a warning for responsible officials. Individuals can receive standardized alerts from many sources and configure their applications to process and respond to the alerts as desired.

- Flexible geographic targeting using latitude/longitude boxes and other geospatial representations in three dimensions;
- Multilingual and multi-audience messaging;
- Phased and delayed effective times and expirations;
- Enhanced message update and cancellation features;
- Template support for framing complete and effective warning messages;
- Digital encryption and signature capability; and,
- Facility for digital images, audio and video.

194. **Importance:** The Common Alerting Protocol will enhance organizations 'situational awareness' at all levels by providing a continual real-time database of all warnings, even local ones. It will extend the reach of warning messages and enhance the effectiveness of those messages by providing timely corroboration of warnings from several sources. This system will also simplify the work of alerting officials by giving them a write-it-once method for issuing warnings over multiple dissemination systems without duplicate effort.

195. **Status**: The 1.0 specification was approved by OASIS in, 2004. Based on experience with 1.0, the OASIS Emergency Management Technical Committee adopted an updated 1.1 specification in October 2005. At a meeting in October, 2006 the 1.1 specification was taken under consideration by the International Telecommunications for adoption as an ITU recommendation.

2.9.5. Emergency Data Exchange Language, Distribution Element (EDXL DE)

196. Emergency Data Exchange Language, Distribution Element (EDXL-DE), facilitates emergency information sharing and data exchange across local, regional, tribal, national, and international organizations in the public and private sectors. This standard has the ability to transmit any content, from files to technical data exchange information.

197. **Importance:** Same as CAP.

198. **Status:** 20 June 2006 - The OASIS international standards consortium approved the Emergency Data Exchange Language Distribution Element (EDXL-DE) version 1.0 as an OASIS Standard.

2.10. NANOTECHNOLOGY

2.10.1. Carbon Nanotube Computers

199. For decades, the size of silicon-based transistors has decreased steadily while their performance has improved. As the devices approach their physical limits, though, researchers have started looking to less conventional structures and materials. Single-walled carbon nanotubes are one prominent candidate -- already researchers have built carbon nanotube transistors that show promising performance. According to estimates, carbon nanotubes have the potential to produce transistors that run 10 times faster than even anticipated future generations of silicon-based devices, while at the same time using less power.

200. *Importance:* Could help make large-scale integrated circuits built out of carbon nanotubes possible, leading to ultrafast, low-power processors. The need to power IT equipment becomes less of a factor in planning military operations.

201. *Status:* Researchers at have overcome an important obstacle to building computers based on carbon nanotubes, by developing a way to selectively arrange transistors that were made using the carbon molecules.

2.10.2. Flexible Silicon

202. Most flexible electronics, such as those used in e-paper and roll-up displays for mobile devices, rely on transistors made of either organic polymers, printed directly on a plastic substrate, or amorphous, or noncrystalline, silicon. However, transistors made of these materials can't perform at the gigahertz speeds needed for complex circuitry or antennas.

203. People have for some time been able to make slow flexible electronics, but the speed of the transistors has been limited. The next step has been to make the transistors out of high-quality, single-crystal silicon instead of organic polymers and amorphous silicon because electrons simply move faster in single-crystal silicon.

204. **Importance:** This technology opens possibilities to new flexible electronics that can be implemented in a wide variety of military applications. Imagine you are an infantry soldier and you look to your wrist computer to get your bearings, known positions of friend and foe and even a weather report. Flexible electronics has the potential to revolutionize the way in which information is disseminated on the battlefield.

205. **Status:** Researchers have made ultra thin silicon transistors that operate more than 50 times faster than previous flexible-silicon devices. The advance could help make possible flexible high-end electronics that would be useful in a variety of applications, from computers to communication.

2.10.3. Microphotonic Devices

206. Optical fibers can quickly transmit huge amounts of data. But the technology for sorting and sending photons lags far behind the microelectronics that generates and process the data, putting a crimp on bandwidths. In the past few years, scientists and engineers have made great strides in miniaturizing photonic devices and integrating them onto a single chip. Such advances allow for cheaper manufacturing, smaller sizes, and higher performance. Along the way they've developed techniques for working with materials common to the semiconductor industry, which is a step toward integrating photonics and electronics on the same chip. And these researchers have made structures with phenomenal precision, in some cases down to distances smaller than those that separate atoms.

207. Even with these successes, however, a major obstacle remained. Light delivered via cylindrical fiber optics breaks into different polarizations, or orientations of light waves. In devices at the microscale, the outputs change depending on if the waves are oriented vertically or horizontally so they're suited to processing only certain polarizations, which can lead to weakened signals. If researchers are limited to using horizontally polarized light, for example, they end up throwing away vertically polarized light and lose half the signal strength. That's a problem particularly when sending signals over long distances, such as between continents.

208. One approach to this problem is to run light through more than one device, each specifically designed to process one polarization. Researchers at MIT's Research Laboratory of Electronics took a different approach. Rather than building separate devices for different light polarizations, they invented a device for converting vertically polarized light into horizontally polarized light. First, the device splits light into its horizontally and vertically polarized components, directing these into separate channels. Then it gradually rotates the vertically polarized light to make it horizontal. At this point, the light in both channels has the same polarization. This makes it possible to use identical devices to process that light. As a result, all of the light is processed in the same way, allowing clear, strong signals.

209. The current advance pertains only to those photonic applications that involve light with multiple polarizations and those communications applications that involve fiber optics. There hasn't been much economic pressure in the past couple of years to develop technology for these applications because of a glut in bandwidth, but now communications demands are increasing again.

210. **Importance:** Paves the way to cheaper, more complex, and higher-performance optical networks. When you integrate things like this, the complexity and the performance of the kinds of filtering we can do are a little more advanced than the methods that are used today. For example, sensor assemblies using photonic components are immune to electromagnetic interference and electrical component failure in adverse environments.

211. **Status:** Researchers at MIT's Research Laboratory of Electronics report in the current issue of Nature Photonics that they have developed a method for overcoming a fundamental problem in using photonics in communications.

2.10.4. Invisible Transistors

212. Researchers have fabricated high performance, transparent thin-film transistors (TFTs) using a low-cost, low-temperature method. They use indium oxide as both a semiconductor and a conductor, combining the inorganic material with organic insulators on top of a transparent substrate. The resulting transistors perform nearly as well as the much more expensive polysilicon transistors used to control pixels in high-end TVs and computer monitors.

213. On glass that's been coated with a transparent electrode, the researchers deposit the organic insulating materials, which form a multilayered lattice. To deposit the indium oxide, the researchers use a standard technique called ion-assisted deposition, in which an ion beam controls the crystallization and adhesion of the oxide. Changing the oxygen pressure during the process varies the conductivity of the indium oxide, which can thus be used as a semiconductor in one part of the device and as a conductor in other parts.

214. **Importance:** The new TFTs could replace the opaque transistors used to control pixels in digital displays. Because the low-temperature method can deposit transistors on flexible plastics, it could lead to see-through displays affixed to curved surfaces such as windshields and helmet visors. The method is also cheap enough, and easy enough to adapt for large-scale manufacturing, that it could make such displays affordable. Imagine a vehicle windshield that displays a map to your destination, military goggles with targets and instructions displayed right before a soldier's eyes.

215. **Status:** Negotiations for licensing the technology have begun. Prototype displays could be ready within 18 months. The researchers hope to improve the performance of the transistors so that they could serve as processors or memory cells.

2.11. HUMAN-COMPUTER INTERFACE

216. The idea of eliminating the gap between human thought and computer responsiveness is an obvious one, and a number of companies are working hard on promising technologies. One of the most obvious such technologies is voice recognition software that allows the computer to type as you speak, or allows users to control software applications by issuing voice commands.

217. Even the most advanced and accurate software in this category has an accuracy that is impressive, and the technology is far ahead of voice recognition technology from a mere decade ago, but it's still not at the point where people can walk up to their computer and start issuing voice commands without a whole lot of setup, training, and fine tuning of microphones and sound levels. Widespread, intuitive use of voice recognition technology still appears to be years away.

218. And yet our interface with the Internet remains the lowly personal computer. With its clumsy interface devices (keyboard and mouse, primarily), the personal computer is a makeshift bridge between the ideas of human beings and the world of information found on the Internet. These interface devices are clumsy and simply cannot keep pace with the speed of thought of which the human brain is capable.

219. Consider this: a person with an idea who wishes to communicate that idea to others must translate that idea into words, then break those words into individual letters, then direct her fingers to punch physical buttons (the keyboard) corresponding to each of those letters, all in the correct sequence. Not surprisingly, typing speed becomes a major limiting factor here: most people can only type around sixty words per minute. Even a fast typist can barely achieve 120 words per minute. Yet the spoken word approaches 300 words per minute, and the speed of 'thought' is obviously many times faster than that.

220. Pushing thoughts through a computer keyboard is sort of like trying to put out a raging fire with a garden hose: there is simply not enough bandwidth to move things through quickly enough. As a result, today's computer / human interface devices are significant obstacles to breakthroughs in communicative efficiency.

221. The computer mouse is also severely limited. I like to think of the mouse as a clumsy translator of intention: if you look at your computer screen, and you intend to open a folder, you have to move your hand from your keyboard to your mouse, slide the mouse to a new location on your desk, watch the mouse pointer move across the screen in an approximate mirror of the mouse movement on your desk, then click a button twice. Thats a far cry from the idea of simply looking at the icon and intending it to open.

222. Today's interface devices are little more than rudimentary translation tools that allow us to access the world of personal computers and the Internet in a clumsy, inefficient way. Still, the Internet is so valuable that even these clumsy devices grant us immeasurable benefits, but a new generation of computer/human interface devices would greatly multiply those benefits and open up a whole new world of possibilities for exploiting the power of information and knowledge.

2.11.1. Hand Controlled Computers

223. Another recent technology that represents a clever approach to computer / human interfaces is the iGesture Pad by a company called Fingerworks (http://www.FingerWorks.com). With the iGesture Pad, users place their hands on a touch sensitive pad (about the size of a mouse pad), then move their fingers in certain patterns (gestures) that are interpreted as application commands. For example, placing your fingers on the pad in a tight group, then rapidly opening and spreading your fingers are interpreted as an Open command.

224. For more intuitive control of software interfaces, what is needed is a device that tracks eye movements and accurately translates them into mouse movements: so you could just look at an icon on the screen and the mouse would instantly move there.

225. **Importance:** This technology represents a leap in intuitive interface devices, and it promises a whole new dimension of control versus the one-dimensional mouse click. Keystrokes and mouse clicks limit a soldier's degree of freedom.

226. **Status:** It's still a somewhat clumsy translation of intention through physical limbs. Interestingly, some of the best technology in this area comes from companies building systems

for people with physical disabilities. For people who can't move their limbs, computer control through alternate means is absolutely essential.

2.11.2. Head Moving Tracking Technology

227. One approach to this is tracking the movement of a person's head and translating that into mouse movements. One device, the Head Mouse (Origin Instruments), does exactly that. You stick a reflective dot on your forehead, put the sensor on top of your monitor, and then move your head to move your mouse.

228. Another company called Madentec (http://www.Madentec.com) offers a similar technology called Tracker One. Place a dot on your forehead, and then you can control the mouse simply by moving your head.

229. In terms of affordable head tracking products for widespread use, a company called NaturalPoint (http://www.NaturalPoint.com) seems to have the best head tracking technology at the present: a product called SmartNav. Add a foot switch and you can click with your feet.

230. **Importance:** Allows for hands-free control via head movement.

231. **Status:** Current implementations present a learning curve for new users, but it works as promised.

2.11.3. Eye Tracking Movements

232. While tracking head movement is in many ways better than tracking mouse movement, a more intuitive approach, it seems, would be to track actual eye movements. A company called LC Technologies, Inc. is doing precisely that with their EyeGaze systems (http://www.lctinc.com/products.htm). By mounting one or two cameras under your monitor and calibrating the software to your screen dimensions, you can control your mouse by simply looking at the desired position on the screen.

233. This technology was originally developed for people with physical disabilities, yet the potential application of it is far greater. In time, I believe that eye tracking systems will become the preferred method of cursor control for users of personal computers.

234. Eye tracking technology is quickly emerging as a technology with high potential for widespread adoption by the computing public. Companies such as Tobii Technology (http://www.tobii.se), Seeing Machines (http://www.SeeingMachines.com), SensoMotoric Instruments (http://www.smi.de), Arrington Research (http://www.ArringtonResearch.com), and EyeTech Digital Systems (http://www.eyetechds.com) all offer eye tracking technology with potential for computer / human interface applications. The two most promising technologies in this list, in terms of widespread consumer-level use, appear to be Tobii Technology and EyeTech Digital Systems.

235. **Importance:** Allows for hands-free control via eye movement.

2.11.4. Brain-Computer Interface

236. Moving to the next level of human-computer interface technology, the ability to control your computer with your thoughts alone seems to be an obvious goal. The technology is called Brain Computer Interface technology, or BCI.

237. Although the idea of brain-controlled computers has been around for a while, it received a spike of popularity in 2004 with the announcement that nerve-sensing circuitry was implanted in a monkey's brain, allowing it to control a robotic arm by merely thinking. Brain activity produces electrical signals that are detectable on the scalp or cortical surface or within the brain. BCIs translate these signals from mere reflections of brain activity into outputs that communicate the user’s intent without the participation of peripheral nerves and muscles. BCIs can be non-invasive or invasive. Non-invasive BCIs derive the user’s intent from scalp-recorded electroencephalographic (EED) activity. While invasive BCIs derive the user’s intent from neuronal action potentials or local field potentials recorded from within the cerebral cortex or from its surface. Researchers have studied these systems mainly in nonhuman primates and to a limited extent in humans. Invasive BCIs face substantial technical difficulties and involve clinical risks. Surgeons must implant the recording electrodes in or on the cortex. The devices must function well for long periods and they risk infection and may pose other damage to the brain.

238. **Importance:** Imagine the limitless applications of direct brain control. People could easily manipulate cursors on the screen or control electromechanical devices. They could direct software applications, enter text on virtual keyboards, or even drive vehicles on public roads. Today, all these tasks are accomplished by our brains moving our limbs, but the limbs, technically speaking, don't have to be part of the chain of command.

239. **Status:** The lead researchers in the monkey experiment are now involved in a commercial venture to develop the technology for use in humans. The company, Cyberkinetics Inc. hopes to someday implant circuits in the brains of disabled humans and then allow those people to control robotic arms, wheelchairs, computers or other devices through nothing more than brain behaviour.

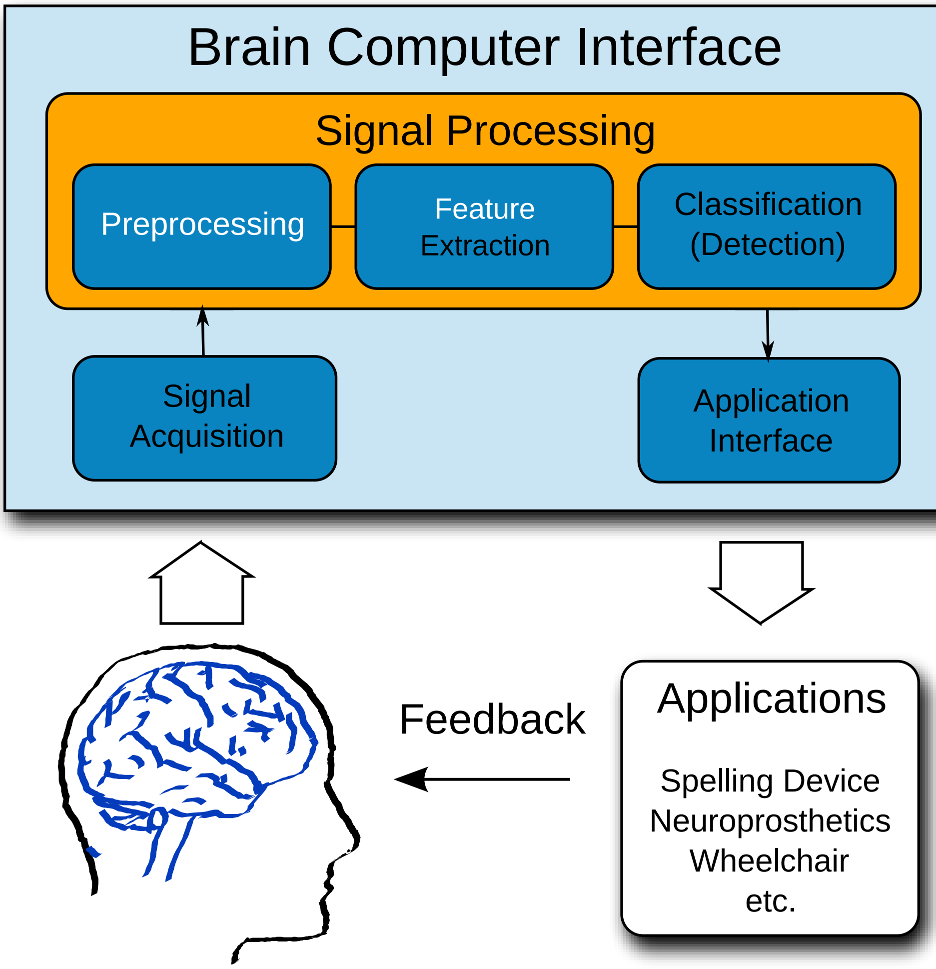

Figure 2.3. Brain Computer Interface

2.11.5. Tactile Feedback

240. Another promising area of human-computer interface technology is being explored by companies like Immersion Corporation (http://www.Immersion.com), which offers tactile feedback hardware that allows users to 'feel' their computer interfaces.

241. Slide on Immersion's CyberGlove, and your computer can track and translate detailed hand and finger movements. Add their CyberTouch accessory, and tiny force feedback generators mounted on the glove deliver the sensation of touch or vibration to your fingers. With proper software translation, these technologies give users the ability to manipulate virtual objects using their hands. It's an intuitive way to manipulate objects in virtual space, since nearly all humans have the natural ability to perform complex hand movements with practically no training whatsoever.

242. Another company exploring the world of tactile feedback technologies is SensAble Technologies. Their PHANTOM devices allow users to construct and feel three-dimensional objects

in virtual space. Their consumer-level products include a utility for gamers that translate computer game events into tactile feedback (vibrations, hitting objects, gun recoil, etc.).

243. On a consumer level, Logitech makes a device called the IFeel Mouse that vibrates or thumps when your mouse cursor passes over certain on-screen features. Clickable icons, for example, feel like bumps as you mouse over them. The edges of windows can also deliver subtle feedback.

244. **Importance:** Key technology for modeling & simulation, and simulated training. Tactile feedback has potential for making human-computer interfaces more intuitive and efficient;even if today's tactile technologies are clunky first attempts. The more senses we can directly involve in our control of computers, the broader the bandwidth of information and intention between human beings and machines.

245. **Status:** Hasn't seen much success in the marketplace.

2.11.6. Widget Framework for Desktop and Portable Devices

246. Widgets are software with small footprint designed to pull in a particular kind of information (often from multiple sources). An emerging standard that supports such combination of data from multiple sources is Enterprise Mashup Markup Language (EMML) 1.0 (www.openmashup.org).

2.11.7. Automated Language Processing

247. Foreign language speech and text are indispensable sources of intelligence, but the vast majority of this information is unexamined. Foreign language data and their corresponding providers are massive and growing in numbers daily. Moreover, because the time to transcribe and translate foreign documents is so labor intensive, compounded by the lack of linguists with suitable language skills to review it all, much foreign language speech and text are never exploited for intelligence and counterterrorism purposes. New and powerful foreign language technology is needed to allow English-speaking analysts to exploit and understand vastly more foreign speech and text than is currently possible today.

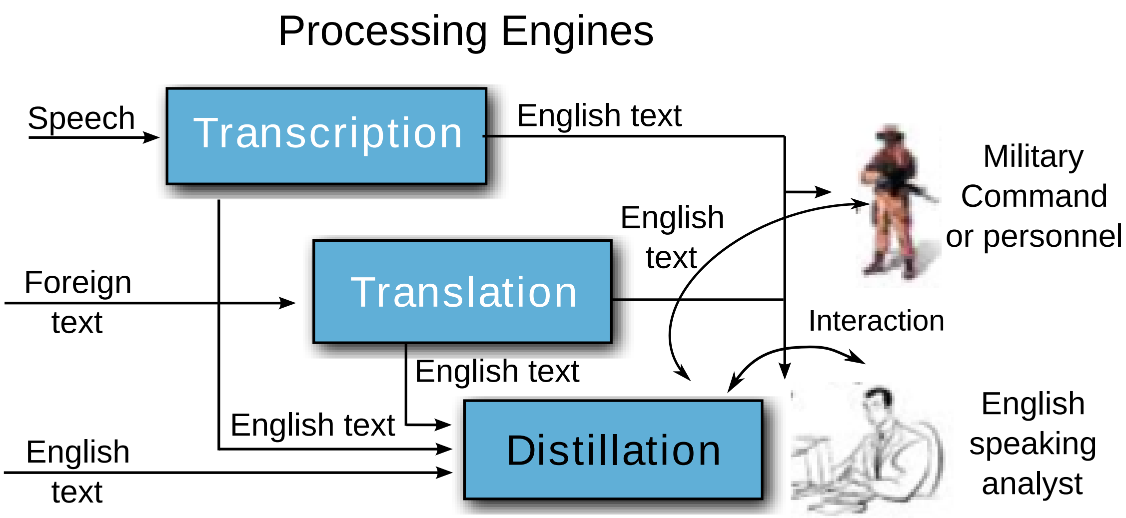

Figure 2.4. Language Processing

2.11.7.1. Speech-to-Text Transcription

248. Automatic speech-to-text transcription seeks to produce rich, readable transcripts of foreign news broadcasts and conversations (over noisy channels and/or in noisy environments) despite widely-varying pronunciations, speaking styles, and subject matter. Goals for speech-to-text transcription include: (1) providing high accuracy multilingual word-level transcription from speech at all stages of processing and across multiple genres, topics, speakers, and channels (such as, Arabic, Chinese, the Web, news, blogs, signals intelligence, and databases); (2) representing and extracting "meaning" out of spoken language by reconciling and resolving jargon, slang, code-speak, and language ambiguities; (3) dynamically adapting to (noisy) acoustics, speakers, topics, new names, speaking-styles, and dialects; (4) improving relevance to deliver the information decision-makers need; (5) assimilating and integrating speech across multiple sources to support exploration and analysis to enable natural queries and drill-down; and (6) increased portability across languages, sources, and information needs.

249. **Importance:** Examples of critical technologies include: improved acoustic modeling; robust feature extraction; better discriminative estimation models; improved language and pronunciation modeling; and language independent approaches that are able to learn from examples by using algorithms that exploit advances in computational power plus the large quantities of electronic speech and text that are now available. The ultimate goal is to create rapid, robust technology that cab be ported cheaply and easily to other languages and domains.

2.11.7.2. Foreign-to-English Translation

250. Goals for foreign to English translation include: (1) providing high accuracy machine translation and structural metadata annotation from multilingual text document and speech transcrip-

tion input at all stages of processing and across multiple genres, topics, and mediums (such as, Arabic, Chinese, the Web, news, blogs, signals intelligence, and databases); (2) understanding or at least deriving semantic intent from input strings regardless of source; (3) reconciling and resolving semantic differences, duplications, inconsistencies, and ambiguities across words, passages, and documents; (4) more efficient discovery of important documents, more relevant and accurate facts while decreasing the amount of time required to do it, and passages for distillation; (5) providing enriched translation output that is formatted, cleaned-up, clear, unambiguous, and meaningful to decision-makers; (6) eliminating the need for human intervention and minimized delay of information delivery; and (7) fast development of new language capability, swift response to breaking events, and increased portability across languages, sources, and information needs.

251. **Importance:** Examples of critical technologies include: improved dynamic language modeling with adaptive learning; advanced machine translation technology that utilizes heterogeneous knowledge sources; better inference models; language-independent approaches to create rapid robust technology that can be ported cheaply and easily to any language and domain; syntactic and semantic representation techniques to deal with ambiguous meaning and information overload; and cross- and mono- lingual, language-independent information retrieval to detect and discover the exact data in any language quickly and accurately, and to flag new data that may be of interest.

2.12. PORTABLE POWER

252. It seems that no matter how advanced notebook computers get, their battery life remains at a standstill: 2-3 hours from most models, regardless of price. From electric vehicles to portable electronics, today's battery capacity lags far behind the steady improvements in other areas of technology. Despite the hype and advertising from battery manufacturers, today's chemical batteries are virtually identical to ones sold three decades ago.

253. It's not that battery manufacturers aren't trying to develop something better: efforts to improve battery capacity and power density have been underway for years. Despite the research, arguably the best technology they have produced yet is the ingenious battery testing strip that you can use to check how quickly your batteries have gone dead.

254. Today's battery technology is simply outdated. The chemicals are extremely hazardous to the environment (Nickel-Cadmium, for example, is made from two heavy metals that are toxic to practically all forms of life on the planet), dangerous to nearby users (risk of explosions), heavy (standard car batteries can weigh 70+ pounds) and unreliable. They charge slowly, their output voltage wavers, and their size becomes a major limiting factor when designing portable electronics like digital cameras.

255. Portable power is a crucial enabling technology for a vast array of applications. Some of these applications include:

- **Wearable Computers** - Smaller batteries will make wearable computers more comfortable and convenient. A power pack the size of a matchbox might power a wearable computer for an entire day.
- **Robotics** - Autonomous robots require an enormous amount of electrical power for the operation of motors, artificial muscles and CPUs. Today's chemical batteries just don't deliver the horsepower. AIBO, Sony's robotic pet, only barks for 2-3 hours on a typical charge, and the working prototypes of humanoid robots from Japan only have enough juice for brief public performances.
- **Medical Devices** - The miniaturization of medical devices depends heavily on increasing the power density of batteries. From portable monitoring systems to handheld diagnostic devices, the battlefield medicine would benefit greatly from a breakthrough in power density and portability.
- **Electric Vehicles** - To date, total electric vehicles have not succeeded in military applications primarily due to their lack of range (power density). That's the fault of the battery technology: it requires a thousand pounds of batteries to drive a vehicle the same distance delivered by four gallons of gasoline. While hybrid vehicles are finding tremendous success in the marketplace by packing both batteries and combustion engines under the same hood, tomorrow's vehicles could run off batteries alone if high density power storage systems were available.
- **Space Exploration** - The limitations of portable power are critical when it comes to space exploration. Battery requirements shape the scope of entire missions. The primary factor limiting the life and utility of the 2004 Mars rovers, for example, was battery life. With the help of higher density power systems, space exploration takes a quantum leap forward and unleashes spectacular new possibilities in remote sensing vehicles and manned missions.
- **Solar Power Systems** - Solar power is clean, renewable, safe, reliable and environmentally friendly. Unfortunately, it's expensive to install, and the single greatest cost often comes from the batteries, not the solar panels. Batteries for solar systems are typically large, heavy, dangerous (risk of explosions), expensive and short-lived (many need replacing in a mere five years). A breakthrough in power density and storage costs could revolutionize the solar industry, making residential and commercial solar systems far more affordable. If battery costs could be halved, it would subtract five years from the average twenty-year return on solar systems.

256. These are just a few of the many important applications of high density portable power. Remember, though, it's not just the density that matters: it's the cost as well. To herald a genuine breakthrough, the next wave of technology needs to be better on all counts: size, weight and cost.

2.12.1. Fuel Cells

257. The most promising candidate technology that meets this requirement is fuel cell technology. Fuel cells are clean, small and lightweight, and will eventually be cheap to produce. The choice of fuels for those fuel cells, however, remains undecided.

258. One of the promising contenders is zinc -- one of the most abundant minerals in the planet. With the help of fuel cell membranes, zinc particles release electricity when oxidized by exposing them to air. Once all the zinc is oxidized, the zinc particles can be quickly "recharged" (reversing the oxidation process with the help of electricity) and used again. This process can be endlessly repeated, since the zinc never wears out.

259. Zinc is promising because it offers high density portable power (far greater power density than chemical batteries), a widely-available element, and outstanding safety (zinc won't explode if exposed to flames or high temperatures). The industry leader in portable zinc power is Metallic Power (http://www.metallicpower.com)

2.12.2. Methanol Fuel Cells

260. Zinc power isn't seeing many headlines these days. Much of the news about portable fuel cells seems focused on methanol. These so-called Direct Methanol Fuel Cells (DMFCs) convert methanol (a common alcohol that can be derived from corn, among other renewable sources) into electricity. NEC, Samsung, and already have working prototypes of DMFCs for notebook computers or portable electronics.

261. The problem with methanol is its combustibility: methanol ignites easily and has a flash point ranging from room temperature to 130 degrees (F), depending on the concentration of water in the mixture. That makes it an illegal explosive according to the laws of many countries, meaning that DMFCs would not be allowed on airplanes unless existing regulations are changed.

262. Methanol also has the drawback of not being easily renewed by consumers. Few people have the know-how to distill methanol in their own garage, meaning that consumers would be dependent on DMFC manufacturers for methanol recharge kits. Like ink jet printer refill kits, this is where DMFC manufacturers will probably make the bulk of their profits.

263. In the end, however, the choice of fuel isn't as important as the widespread adoption of a fuel cell battery standard. Today's chemical batteries are holding back promising applications for emerging technologies, and only a breakthrough in portable power can overcome those limitations. Fuel cells can make the leap, and their adoption by consumers and manufacturers alike is all but assured.

264. **Importance:** Fuel cells are very useful as power sources and offer significant savings of loads, in weight and volume, compared to conventional power sources. Because fuel cells have no moving parts and do not involve combustion, in ideal conditions they can achieve up to 99.9999% reliability. This equates to less than one minute of down time in a six year period.

2.13. OPTICAL COMPUTING

265. Optical computing would provide much higher computing speeds. Developments have centered on devices such as VCSELS (Vertical Cavity Surface-Emitting Lasers) for data input, SLMs (Spatial Light Modulators) for putting information on light beams and high speed APDs

(Avalanche Photo-Diodes) for data output. More work remains before digital optical computers will be available commercially.

2.13.1. Data Storage

266. Data storage media will need to improve to keep pace with computer processing power, and may be achieved via optical disk technologies and applications of parallelism. Promising areas involve the use of holographic memory, offering 64 billion bits storage capacity on a laser activated crystal the size of a compact disk. Holographic data storage captures information using an optical inference pattern within a thick, photosensitive optical material. Light from a single laser beam is divided into two separate beams, a reference beam and an object or signal beam; a spatial light modulator is used to encode the object beam with the data for storage. An optical inference pattern results from the crossing of the beams' paths, creating a chemical and/or physical change in the photosensitive medium; the resulting data is represented in an optical pattern of dark and light pixels. By adjusting the reference beam angle, wavelength, or media position, a multitude of holograms (theoretically, several thousand) can be stored on a single volume.

267. **Importance:** The theoretical limits for the storage density of this technique are approximately tens of per cubic centimeter. In addition, holographic data storage can provide companies a method to preserve and archive information. The write-once, read many (WORM) approach to data storage would ensure content security, preventing the information from being overwritten or modified. Manufacturers believe this technology can provide safe storage for content without degradation for more than 50 years, far exceeding current data storage options.

3. FAR TERM EMERGING STANDARDS

268. This purpose of this chapter is to specify the NISP far term emerging standards. The document organises these standards into five service areas. These service areas are listed in volume 2.

3.1. QUANTUM COMPUTING

269. A quantum computer would store information, not as strings of ones and zeros as in a ‘classical’ computer, but as a series of quantum mechanical states. Quantum physics allows particles to be in more than one state at a time, so that it is possible for a particle in a quantum computer to hold more than one bit of information, referred to as a ‘qubit’. The quantum computer would allow very fast parallel computing capability. A functional quantum computer is still beyond the grasp of current technology, and many obstacles must be overcome before a usable computer can be built. A major problem is that slight outside disruption, e.g. heat or light, will cause a system to lose its quantum coherence, while the very process of retrieving results would also upset the coherence.

270. **Importance:** Integer factorization is believed to be computationally infeasible with an ordinary computer for large integers that are the product of only a few prime numbers (e.g., products of two 300-digit primes). By comparison, a quantum computer could efficiently solve this problem using Shor's algorithm to find its factors. This ability would allow a quantum computer to "break" many of the cryptographic systems in use today.

271. This chapter presents all associated standards in tabular form. The tables refine each service area into one or more service categories, with service components mapping to the emerging far term category (see NISP vol. 1). A remarks column provides optional supplementary information on each standard plus CCEB-specific information. The NISP Rationale Document (RD) provides further explanation on why service and standards categories have been selected.

3.2. OPERATIONAL MISSION/ACTIVITIES/TASKS

272. This service area is detailed in the corresponding section of volume 2.

3.2.1. List of Standards

SUBAREA / SERVICE CATEGORY	CATEGORY / SUBCATEGORY	EMERGING FAR TERM	Remarks

3.3. USER INFORMATION SERVICES

273. This service area is detailed in in the corresponding section of volume 2.

3.3.1. List of Standards

SUBAREA / SERVICE CATEGORY	**CATEGORY / SUBCATEGORY**	**EMERGING FAR TERM**	**Remarks**

3.4. TECHNICAL SERVICES

274. This service area is detailed in in the corresponding section of volume 2.

3.4.1. List of COI Standards

SERVICECATEGORY / CATEGORY / SUBCATEGORY	**EMERGING FAR TERM**	**Remarks**
Generic COI Services		
Meteo		
Map View		
Map Mgmt		
Spatial Geography Visualisation		
Document Management		
Specific COI Services		
Communicate and Inform		
Battlespace Mgmt		
Orbat Mgmt		
Overlay Mgmt		
Meteo Svc		
Symbol Mgmt		
Tracking		
Synchronisation		
Distribution		

SERVICECATEGORY / CATEGORY / SUBCATEGORY	**EMERGING FAR TERM**	**Remarks**
Notification		
Aggregation		
Collaborate and Plan		
Plan Workspace		
Plan Analysis		
Plan Briefing		
Plan Replay		
Plan Synchronisation		
Plan Collaboration		
Simulation		
Collaboration analysis		
Sense and Respond		
Tasking		
Plan Deviation Monitor		
JCOP		
Logistics Svcs		
Supply Chain Svcs		

3.4.2. List of Information Integration Standards

SERVICECATEGORY / CATEGORY / SUBCATEGORY	**EMERGING FAR TERM**	**Remarks**
	AVDL	
	EDXL-DE	
Core Enterprise Services		
Discovery		
Service Discovery Services		

SERVICECATEGORY / CATEGORY / SUBCATEGORY	EMERGING FAR TERM	Remarks
Information Discovery Services		
Repository		
Metadata Registry Services		
Enterprise Directory Services		
Mediation		
Composition Services		
Translation Services		
Interaction		
Messaging Services		
Publish/Subscribe Services		
Transaction Services		
Collaboration Services		
Infrastructure		
Application Services		
Storage Services		
Web Services		
Device Independent Console		
Content Mgmt		

3.4.3. List of Communications Standards

SERVICECATEGORY / CATEGORY / SUBCATEGORY	EMERGING FAR TERM	Remarks
Network and Transport Services		
Mixed DISA standards		

SERVICECATEGORY / CATEGORY / SUBCATEGORY	EMERGING FAR TERM	Remarks
	AODV	
	DSR	
	CAP	
Data Link and Connection Service		
External Networks		
Tactical Area Comms		
Transmission		
VLF		
HF		
VHF		
UHF		
UHF SATCOM		
SHF SATCOM		
EHF SATCOM		
QoS		

3.5. INFORMATION ASSURANCE

3.5.1. List of Standards

SUBAREA / SERVICE CATEGORY	CATEGORY / SUBCATEGORY	EMERGING FAR TERM	Remarks
SMI Service			
Confidentiality			
Encryption			
Integrity			
Authentication			
Detection			
Transsec			

3.6. SERVICE MANAGEMENT AND CONTROL

3.6.1. List of Standards

SUBAREA / SERVICE CATEGORY	CATEGORY / SUBCATEGORY	EMERGING FAR TERM	Remarks
Mgmt Info Publisher			
Mgmt Info Subscriber			
Mgmt Info Collector			
Mgmt Info Provider			
Asset Mgmt			
User Mgmt			
System Mgmt			

A. ACRONYMS

Standards organisations	
IETF	Internet Engineering Task Force
IEEE	International Electronics and Electrical Engineering Society
INCITS	International Committee for Internet Technology Standards
IEC	International Electrotechnical Commission
ISO	International Standards organisation
ITU	International Telecomunications Union
OASIS	organisation for the Advancement of Structured Information Standards
OMG	Object Management Group
TTA	
W3C	World Wide Web Consortium
WS-I	Web Services Interoperability Organisation

Table A.1. Standards organizations

Terms	
1xRTT	2.5G CDMA data service up to 384 kbps
AMPS	Advanced mobile phone service
AODV	Ad Hoc On-Demand Distance Vector
AVDL	Application Vulnerability Description Language
BICES	Battlefield Information Collection and Exploitation
BPIF	Business Process Infrastructure Framework
BRAN	Broadband Radio Access Network
C3	Command, Control, and Communications
CAP	Common Alerting Protocol
CDMA	Code division multiple access
CIS	Computer Information System
COI	Community of Interest
COTS	Commerical-of-the-Shelf
CPP	Collaboration Protocol Profile
DHCP	Dynamic Host Configuration Protocol
DISA	Defense Information Systems Agency [US]
DSR	Dynamic Source Routing
EARS	Effective Affordable Reusable Speech-to-text

EDGE	Enhanced data for global evolution
EDXL DE	Emergency Data Exchange Language, Distribution Element
ETSI	European Telecommunications Standards Institute
FDMA	Frequency division multiple access
GPRS	General packet radio system
GSI	Grid Security Infrastructure
GSM	Global system for mobile
HTTP	HyperText Transfer Protocol
IEG	Information Exchange Gateway
IP	Internet Protocol
LAN	Local Area Network
MAC	Media Access Control
MANET	Mobile Ad-hoc Network
MBWA	Mobile Broadband Wireless Access
NATO	North Atlantic Treaty organisation
NC3TA	NATO Command, Control, and Communications Technical Architecture
NCOE	Net Centric Operational Environment
NCOW	Net Centric Operations and Warfare
NGO	Non-Government organisation
NMT	Nordic mobile telephone
NNEC	NATO Network Enabled Capability
NNEC-DS	NNEC Data Strategy
NRF	NATO Reaction Force
OASIS	Organization for the Advancement of Structured Information Standards
OGSA	Open Grid Services Architecture
OSGi	Open Services Gateway Initiative
P2P	Peer-to-Peer
PDC	Personal digital cellular
PSTN	Pubic switched telephone network
QoS	Quality of Service
RHQ AFNORTH	Regional Headquarters Allied Forces North Europe
SHAPE	Supreme Headquarters Allied Powers Europe
SLA	Service Level Agreements

SOA	Service Oriented Architecture
SOA-RM	SOA Reference Model
SOAP	Simple Object Access Protocol
TACS	Total access communications system
TDMA	Time division multiple access
TFT	Thin-Film Transistors
UDDI	Universal Description and Discovery Interface
W3C	World Wide Web Consortium
WCDMA	Wideband CDMA
XML	Extensible Modelling Langauge

Table A.2. Terms

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References

[1] *Toward Internet distributed computing, web services, peer-to-peer, grid computing, ad hoc networks*. IEEE Computer, Vol 36, Number 5, May 2003. Copyright © 2003. IEEE Computer Society Publications.

[2] *Theme Issue On Peer-to-Peer Computing*. Communications of the ACM, Vol 46 number 2, February 2003. Copyright © 2003. ACM Publications Office.

[3] *Discusses Peer-to-Peer Computing*. Communications of the ACM, Vol 46 number 9, September 2003. Copyright © 2003. ACM Publications Office.

[4] *OASIS BPEL working group*. http://www.oasis-open.org/committees/tc_home.php?wg_abbrev=wsbpel .

[5] *The OSGi Standard Forum*. http://www.osgi.org .

[6] *Sun's Jini Description*. Sun Microsystems. http://java.sun.com/developer/products/jini/index.jsp .

[7] *Jini Community resource*. Apache Projects. http://www.jini.org/ .

[8] *Jini Project*. http://www.rio-project.org/ .

[9] *Java EE*. Sun Microsystems. http://java.sun.com/javaee/index.jsp .

[10] *Microsoft .NET Developer Homepage*. Microsoft Inc.. http://msdn.microsoft.com/net-framework/ .

[11] *Homepage (CORBA, IDL)*. The Object Management Group (OMG). http://www.omg.org/spec/CORBA/3.1/ .

[12] *Java Remote Method Invocation Specification*. Sun Microsystems. http://java.sun.com/j2se/1.5/pdf/rmi-spec-1.5.0.pdf .

[13] *Chord*. MIT. http://pdos.csail.mit.edu/chord .

[14] *Pastry*. Microsoft Inc.. http://research.microsoft.com/~antr/pastry .

[15] *Tapestry*. http://oceanstore.cs.berkeley.edu/tapestry .

[16] *DKS*. http://dks.sics.se .

[17] *OASIS*. organisation for the Advancement of Structured Information Standards (OASIS). http://www.oasis-open.org .

[18] *Globus Alliance*. http://www.globus.org .

[19] *Globus Toolkit*. http://www.globus.org/toolkit .

[20] *Global Grid Forum*. http://www.ggf.org .

[21] *OGSA*. http://forge.gridforum.org/projects/ogsa-wg .

[22] *OASIS WSDM technical committee*. http://www.oasis-open.org/committees/tc_home.php?wg_abbrev=wsdm .

[23] *W3C Choreography Working Group*. http://www.w3.org/2002/ws/chor .

[24] *Java Business Integration (JBI)*. Java Specification Request (JSR 208). http://www.jcp.org/en/jsr/detail?id=208 .

[25] *Service Component Architecture (SCA)*. http://www.osoa.org/display/Main/Service+Component+Architecture+Specifications .

[26] *Service Data Objects (SDO)*. http://dev2dev.bea.com/pub/a/2005/11/sdo.html .

[27] *Java*. http://www.oracle.com/us/technologies/java/index.html .

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