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Table of Contents

1. Introduction 1
1.1. Scope 1
2. Far-Term Emerging Technologies 3
2.1. Networking 3
2.1.1. Mobile Ad-hoc Network (MANET) 3
2.1.2. Knowledge Based Networking 6
2.2. Data Strategies 7
2.2.1. Situation-Dependent Information Extraction 7
2.2.2. Mega-Scale Data Management 7
2.2.3. Application Vulnerability Description Language (AVDL) 7
2.2.4. Common Alerting Protocol (CAP) 8
2.2.5. Emergency Data Exchange Language, Distribution Element (EDXL DE) 9
2.3. Nanotechnology 9
2.3.1. Carbon Nanotube Computers 9
2.3.2. Flexible Silicon 9
2.3.3. Microphotonic Devices 10
2.3.4. Invisible Transistors 11
2.4. Human-Computer Interface 12
2.4.1. Hand Controlled Computers 13
2.4.2. Head Moving Tracking Technology 13
2.4.3. Eye Tracking Movements 13
2.4.4. Brain-Computer Interface 14
2.4.5. Tactile Feedback 15
2.4.6. Three Dimensional Displays 16
2.4.7. Automated Language Processing 17
2.5. Portable Power 19
2.5.1. Fuel Cells 21
2.5.2. Methanol Fuel Cells 21
2.6. Computing 22
2.6.1. Quantum Computing 22
2.6.2. Data Storage 22
3. Standards 25
3.1. Introduction 25
3.2. Operational Mission/Activities/Tasks 25
3.2.1. List of Standards 25
3.3. User Information Services 25
3.3.1. List of Standards 25
3.4. Technical Services 25
3.4.1. List of COI Standards 26
3.4.2. List of Information Integration Standards 27
3.4.3. List of Communications Standards 28
3.5. Information Assurance 29

3.5.1. List of Standards 29
3.6. Service Management and Control 29
A. Acronyms 31
References 33

1. INTRODUCTION

001. This document has been developed and agreed (AC/322(SC/1-WG/4)N(2010)0002-AS1, 24 Mar 10) by the NATO Open Systems Working Group (NOSWG) under the authority of the NATO Consultation, Command and Control Board (NC3B). Under AC/322-N(2010)0038-AS1, the NATO Consultation, Command and Control Board noted ADatP-34(D) and approved the standards and profiles in Volume 2 as mandatory for use in NATO common funded systems in accordance with the NATO networked C3 Interoperability Policy.

002. Volume 4 of the NATO Interoperability Standards & Protocols (NISP) will continue the evolution from the platform based NATO C3 Common Operation Environment (NCOE) to the loosely coupled Network Enabled Capabilities environment. Within this part of the document, the focus is on the long-term's perspective. The long-term perspective has a time frame of 7 to 10 years into the future from the publication of this version of the NISP. This is the concluding step to the realization of a fully network enabled NATO coalition environment.

1.1. SCOPE

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

004. The long-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.

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2. FAR-TERM EMERGING TECHNOLOGIES

2.1. NETWORKING

2.1.1. Mobile Ad-hoc Network (MANET)

005. 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.

006. 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.

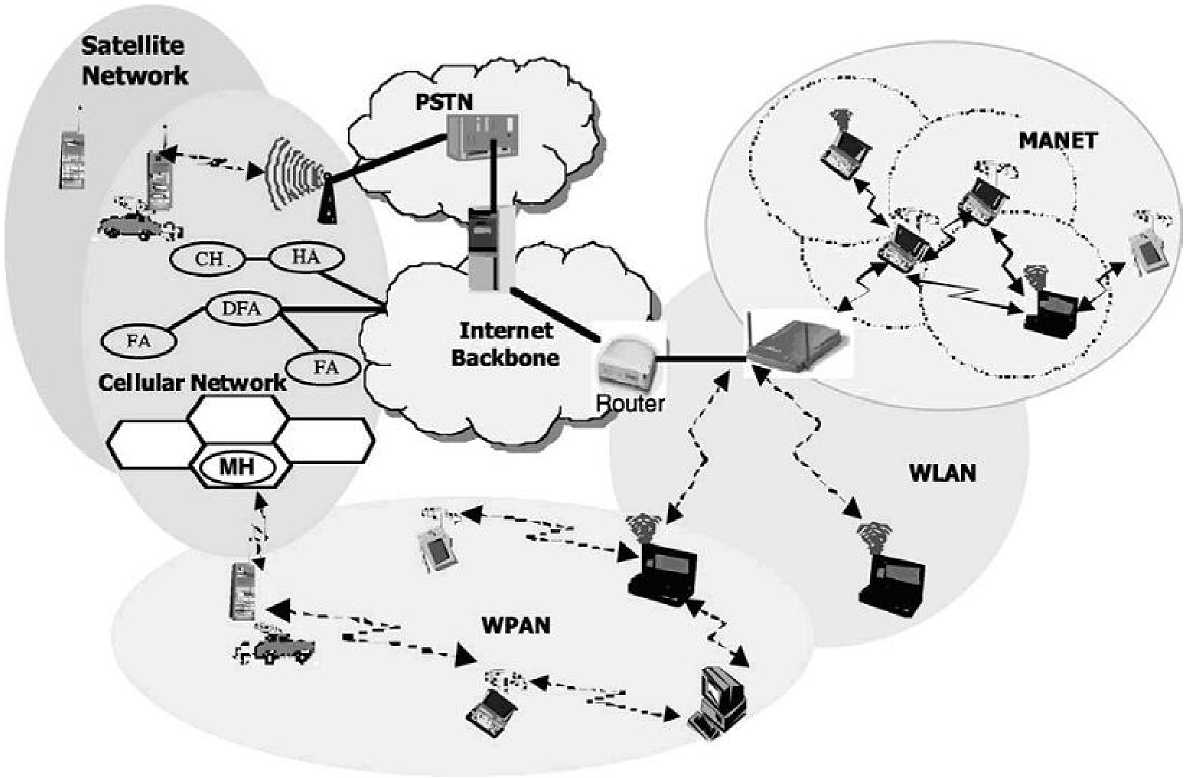

Figure 2.1. Mobile AdHoc Network

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

007. 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.

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

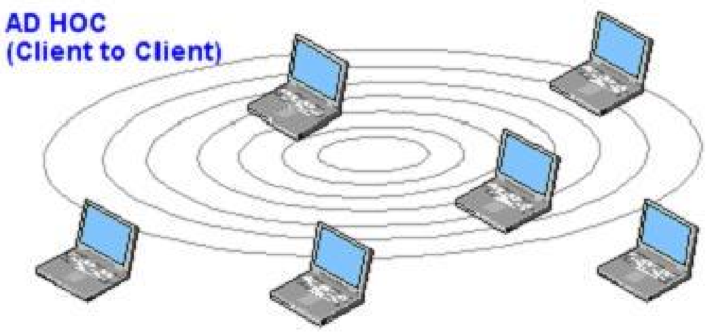

Figure 2.2. Ad Hoc Networking

2.1.1.2. Dynamic Source Routing (DSR)

009. 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.

010. 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.

011. 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).

012. 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.

013. **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.

014. **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.

2.1.2. Knowledge Based Networking

015. 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.

016. 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.

017. 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.

2.2. DATA STRATEGIES

2.2.1. Situation-Dependent Information Extraction

018. 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.

019. **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.

2.2.2. Mega-Scale Data Management

020. 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.

021. **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.

2.2.3. Application Vulnerability Description Language (AVDL)

022. 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.

023. 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.

024. **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.

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

2.2.4. Common Alerting Protocol (CAP)

026. 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.

027. **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.

028. **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.

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

029. 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.

030. **Importance:** Same as CAP.

031. **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.

2.3. NANOTECHNOLOGY

2.3.1. Carbon Nanotube Computers

032. 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.

033. *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.

034. *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.

2.3.2. Flexible Silicon

035. 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 sub-

strate, or amorphous, or noncrystalline, silicon. However, transistors made of these materials can't perform at the gigahertz speeds needed for complex circuitry or antennas.

036. 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.

037. **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.

038. **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.

2.3.3. Microphotonic Devices

039. 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.

040. 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.

041. 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.

042. 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.

043. **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.

044. **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.

2.3.4. Invisible Transistors

045. 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.

046. 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.

047. **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.

048. **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.

2.4. HUMAN-COMPUTER INTERFACE

049. 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.

050. 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.

051. 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.

052. 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.

053. 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.

054. 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.

055. 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.

2.4.1. Hand Controlled Computers

056. 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.

057. 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.

058. **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.

059. **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.

2.4.2. Head Moving Tracking Technology

060. 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.

061. 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.

062. 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.

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

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

2.4.3. Eye Tracking Movements

065. 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 com-

pany 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.

066. 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.

067. 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.

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

2.4.4. Brain-Computer Interface

069. 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.

070. 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.

071. **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.

072. **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.

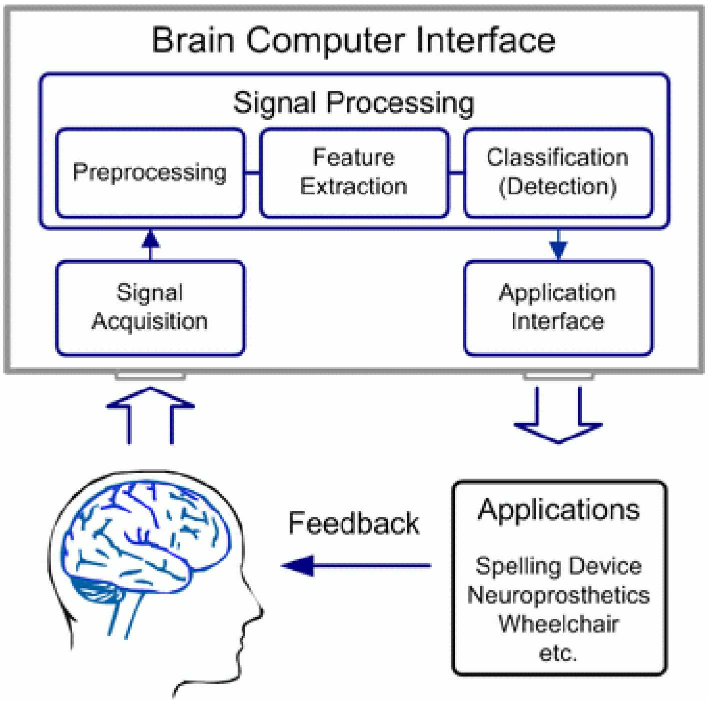

Figure 2.3. Brain Computer Interface

2.4.5. Tactile Feedback

073. 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.

074. 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.

075. 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.).

076. 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.

077. **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.

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

2.4.6. Three Dimensional Displays

079. The long-promised 3D computer monitor finally seems to be close to reality. Manipulating complex windows, documents and virtual objects on a two-dimensional display -- as is standard today -- is rather limiting. With a 3D monitor, we could work in layers or position documents and objects in 3D space rather than squeezing them down to a tiny toolbar at the bottom of one screen.

080. For human beings, 3D space is intuitive. We get it without training. That's because we live in a world of 3D objects and space, and our perception is hard-wired to understand spatial relationships. That's why gamers who play first-person shooters like Quake can mentally retrace their way through enormous maps (levels) in their heads, eyes closed, without even trying: the human brain was built to remember and navigate 3D space.

081. Recent breakthroughs in 3D display promise to make computing more intuitive and powerful. Companies like LightSpace Technologies (http://www.lightspacetech.com) are already selling desktop 3D display monitors that display true 3D images without the need for special glasses.

082. The trouble is, Windows and Mac operating systems weren't written with 3D displays in mind. So there's no capability to stack windows or view the depth of objects. It's a classic chicken-and-egg conundrum: who's going to buy 3D displays if the software can't support them, and why would software makers write 3D layering logic if nobody owns the displays?

083. In time, thanks to the cool factor of 3D displays, the technology will eventually receive enough attention to warrant the necessary R&D investment by operating system developers like Microsoft and Apple. No doubt, future generations will conduct all their computing with the aid of 3D displays, and the very idea of 2D displays will seem as outdated as black & white movies do to us today.

084. Another new 3D display device is the Perspecta Spatial 3D globe, seen at: http://www.actuality-systems.com/index.php/actuality. This device displays 3D objects or animations inside a globe. Users can walk around the globe and view the objects from any angle. It's a rather expensive item, of course, so early applications for this product focus on medical and research tasks. In time, however, the technology will drop in price, bringing it within reach of more consumers.

085. **Importance:** For that, we will ultimately need a tabletop 3D display system that lays flat on your desk (like an LCD monitor laying down) and projects 3D images into the space above the panel. This would be a true volumetric 3D display system, and it's here that the technology truly represents a breakthrough. Program application windows could literally be stacked from the rear to the front, and if you peeked around the side of the display, you could see a side view of all the windows at once. With proper software control, objects or documents could be placed in true 3D space: desktop icons, for example, could be lined up along the very back row. Games could display true 3D scenes as if you're actually in them, and CAD engineers would have the ability to observe their designs in true 3D space. Better yet, if coupled with a motion tracking glove or similar technology, users could use their hands to grasp, move, resize or otherwise manipulate elements in 3D space. This, of course, opens up an unlimited universe of possibilities for computer / human interaction.

2.4.7. Automated Language Processing

086. 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.

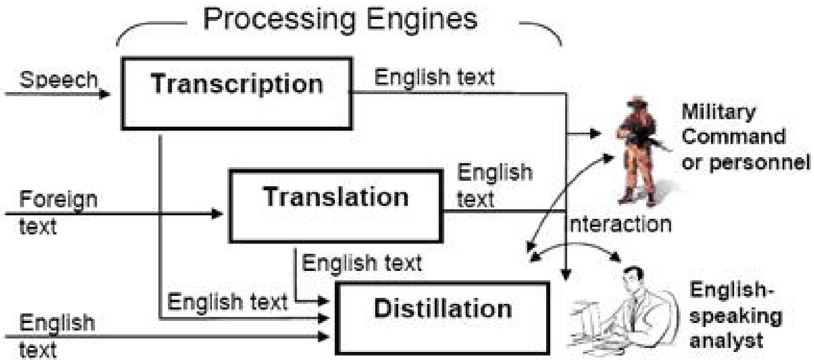

Figure 2.4. Language Processing

2.4.7.1. Speech-to-Text Transcription

087. 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.

088. **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.

2.4.7.2. Foreign-to-English Translation

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

090. **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.

2.5. PORTABLE POWER

091. 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.

092. 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.

093. 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.

094. 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.

095. 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.

2.5.1. Fuel Cells

096. 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.

097. 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.

098. 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)

2.5.2. Methanol Fuel Cells

099. 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.

100. 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.

101. 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.

102. 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.

103. **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.

2.6. COMPUTING

104. 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.

2.6.1. Quantum Computing

105. 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.

106. **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.

2.6.2. Data Storage

107. 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.

108. **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.

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3. STANDARDS

3.1. INTRODUCTION

109. 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.

110. This section presents all associated standards and profiles 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

111. 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

112. 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

113. 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		
Specific COI Services		
Communicate and Inform		
Battlespace Mgmt		
Orbat Mgmt		
Overlay Mgmt		
Symbol Mgmt		
Tracking		
Synchronisation		
Distribution		
Notification		
Aggregation		
Collaborate and Plan		
Plan Workspace		
Plan Analysis		
Plan Briefing		
Plan Replay		
Plan Synchronisation		
Plan Collaboration		
Simulation		
Collaboration analysis		
Sense and Respond		

SERVICECATEGORY / CATEGORY / SUBCATEGORY	EMERGING FAR TERM	Remarks
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		
Information Discovery Services		
Repository		
Metadata Registry Services		
Enterprise Directory Services		
Mediation		
Composition Services		
Translation Services		
Interaction		
Messaging Services		
Publish/Subscribe Services		

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

SERVICECATEGORY / CATEGORY / SUBCATEGORY	EMERGING FAR TERM	Remarks
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

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			

SUBAREA / SERVICE CATEGORY	CATEGORY / SUBCATEGORY	EMERGING FAR TERM	Remarks
System Mgmt			

A. ACRONYMS

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
DSR	Dynamic Source Routing
EARS	Effective Affordable Reusable Speech-to-text
ebXML	electronic business Extensible Mark-up Language
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 Organization
NC3TA	NATO Command, Control, and Communications Technical Architecture
NCOE	Net Centric Operational Environment
NCOW	Net Centric Operations and Warfare
NGO	Non-Government Organization
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 Language

Table A.1. Acronyms

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