Technology Implications to Achieve Information Superiority for NATO in 2010

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Abstract

This paper describes the operational environment for NATO in 2010 along with the associated technology implications. It will discuss coalition interoperability in a network-centric environment that achieves information superiority. The environment for NATO in 2010 must change because technology will allow NATO to implement a System of Systems approach that will satisfy Joint Vision 2010. Information technology in 2010 will enable NATO nations to work together in a seamless fashion. Technology will facilitate the transition of NATO nations into fast, agile, empowered members, fully integrated into a cohesive task force. The fusion of a plethora of systems and data can cause a huge information overload problem that technology must solve. The proper handling of this information will support consistent battlespace awareness, coordinated planning, and coordinated action. In addition, technology will provide a means for coalitions to work in a proactive fashion, even in stochastic environments with unexpected actions by the adversaries. The result will be a radically different way of doing business for NATO in 2010.

The focus of the paper is to forecast the technology evolution and the associated technology capabilities that will be available for NATO in 2010. The environment in 2010 will feature petabytes/second communications with petaflop computing. This will require new processes to ensure information assurance, information superiority, and decision-making superiority. Technology cannot be used merely to speed up existing processes because this will result in major disruptive inefficiencies.

1. Introduction

The NATO in 2010 will be characterized by the following three features with the associated implications:

- Reduced Manpower
  - Implies a need for productivity improvement
  - Dr. Michael Dertouzos of MIT predicts productivity increases of 300% are possible

- Funding Constraints

  - Will force an increased reliance on sophisticated integration of COTS products

- Information Battlespace Environment that will look like a Greek Agora

  - Billions of computers that facilitate the free exchange of information and services throughout NATO

  - Results in a "connected" and empowered warrior that knows the current situation and can act on it

Figure 1
A View of the Future Technology Picture

Figure 1 shows how NATO will operate in 2010. NATO will be able to collaborate in virtual space and develop new R&D capabilities in virtual coalition laboratories. NATO will depend on a Distributed Virtual Environment (DVE) that will facilitate true collaboration throughout the coalition.

This will be possible because ubiquitous broadband communications will seamlessly integrate wire, fiber, terrestrial wireless, and satellite channels. This will support real-time distributed collaboration for decision making, information distribution, and virtual R&D labs using the DVE concept. Satellite-based "Internet-in-the-sky" will provide at least 64 megabits per second of two-way links. Project Oxygen's 275,000 Km of fiber will provide 1.92 terabits/sec and global connectivity at about 1.5% of current satellite circuit prices, and less than 1% of previous submarine cable prices. The future military decision maker should expect computing power to be 100 times that of today's 600 MHz Pentium III for the same price. Computing will be embedded everywhere, and will be "invisible" because it is in the fabric of military life, just like electricity is today.

The technology environment will include:

- Ubiquitous access
- Low cost Low Elevation Orbit (LEO) satellites
- Nanosatellites will fill space. This concept encompasses softball-sized satellites, weighing around 1 kilogram. They will be 3-dimensional substrates, utilizing Micro-Electro Mechanical Systems (MEMS) technology. These nanosatellites will be capable of sensing a wide spectrum of the electromagnetic energy, thus allowing more accurate depictions of the battlespace.
- The communication environment will include optical backbone and optical wireless.
- 100 to 1000 wavelengths on a single fiber using Dense Wave Division Multiplex (DWDM) by 2005

2. NATO Needs

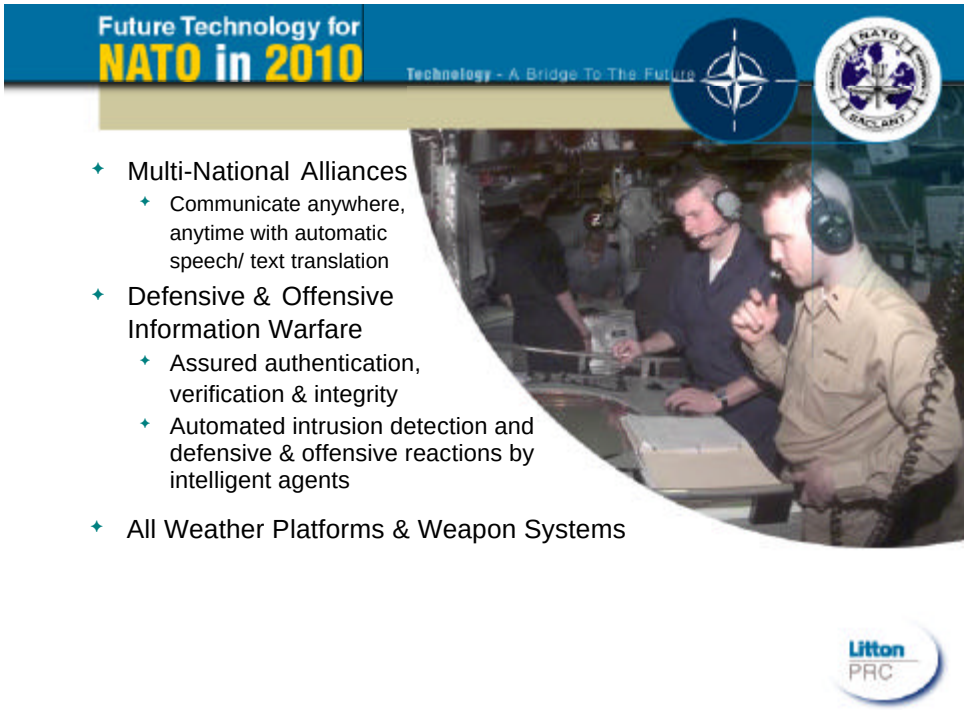

Figure 2
Needs for the NATO of 2010

Coordination of multi-national forces will be facilitated by real-time automatic text understanding and, to a lesser degree, speech understanding and automated language translation. (See Figure 2). In any conflict, information dominance will be critical, requiring sophisticated Information Operations (IO) for the NATO forces and the ability to deny the adversaries' ability to communicate. Intelligent agents will provide autonomous intrusion detection as well as provide offensive IO. The information assurance environment will have adaptive firewalls and countermeasures, including insider threat detection and automated reconfiguration that will allow:

- Complete security trust among allies
- Automated and adaptive reconfiguration after computer raids

The platforms and weapon systems must not allow weather to be a deterrent to NATO operations, including munitions effectiveness and intelligence gathering.

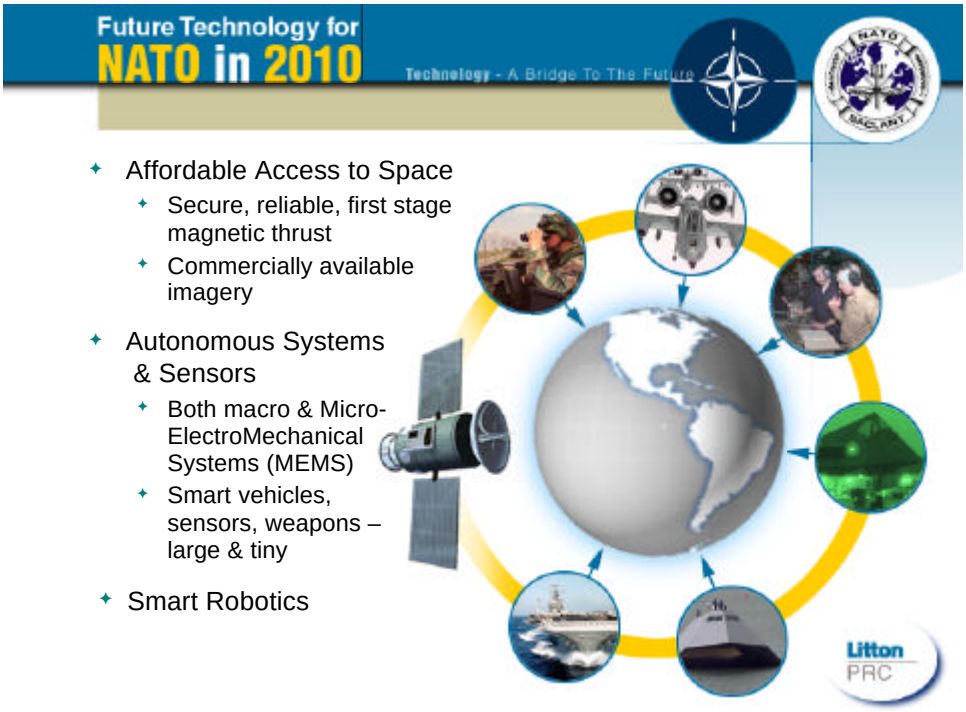

Figure 3
Additional Needs for the NATO of 2010

3. Technology Environment

Low-cost launch capability will include nanosatellites and alternative launch mechanisms, such as magnetic thrust for phase 1 launch. Figure 3 provides a view of this new environment. Achieving a clear and consistent battlespace understanding, as well as agile dominant force projection, will require affordable access to space, plus many autonomous systems and sensors, ranging from large platforms to tiny mobile systems using MEMS technology. MEMS capabilities include signal processors, filters, motors, pumps, and sensors with features on the order of 1 micron. Future MEMS will be smart and autonomous, and will be able to interact with the external environment. Nanosatellites can "see" earth and space with special emphasis on "full measurement" for early chem-bio detection, economic unrest analysis, improved BDA, detection of decoys and early warning of covert troop movements. This will require improvements in hyperspectral analysis

Figure 4
Trends & Capabilities for the NATO of 2010

Major technology components and capabilities for NATO in 2010 are depicted in Figure 4. The seamless communications will need to be combined with advanced, 3-D models and simulations to provide DVEs driven by fusion of information from multiple sources, resulting in consistent situation understanding, ranging from space down to the foxhole. There will be a need for "see-through walls" capability for urban operations. The battlespace understanding displays must provide not only clear views of the operational environment, but also the determination of enemy intent. Modeling and simulation must provide the capability to perform dynamic "What if" alternative analysis to see what different ranges of enemy capabilities and tactics will affect the likely outcome of NATO tactics and capabilities.

Figure 5
Trends & Capabilities for the NATO of 2010 Technology Needs

4. NATO Technology Trends & Capabilities

Further NATO needs are shown in Figure 5. NATO must be able to deal with different languages and customs. The warrior needs intuitive interfaces, ubiquitous (anywhere, any time) broadband secure links and spontaneous adaptive computing (based on the warrior's current needs). These capabilities will provide a clear real-time view of the battlespace to allow coordinated actions that will satisfy the mission. DWDM will allow hundreds of different wavelengths to carry different transmissions on a single tunable fiber by 2010. Spontaneous computing will allow adaptive computing that is always available and just like electricity today.

Figure 6
Trends & Capabilities for the NATO of 2010

NATO will also need improved means to work together in a coalition environment to accomplish the complex needs shown in Figure 6. Rapid technological change, along with the demise of the Soviet Union, will present NATO with types of threats that are too complex for any individual or small group to manage. These threats include multiple civil wars, ethnic strife, cyber terrorism, and biological warfare.

Distributed collaboration will be critical for future system design, development, testing, and manufacturing. NATO planners will be able to produce sophisticated new designs via collaborative processing on a global basis. This will allow for new platforms, creative designs, novel concepts, and future information and command and control centers. Effective operation with reduced manpower and rapid force projection will require remote diagnostics and telemedicine, as well as trans-national logistics. Troops will be supplied via a global “no warehouse” approach.

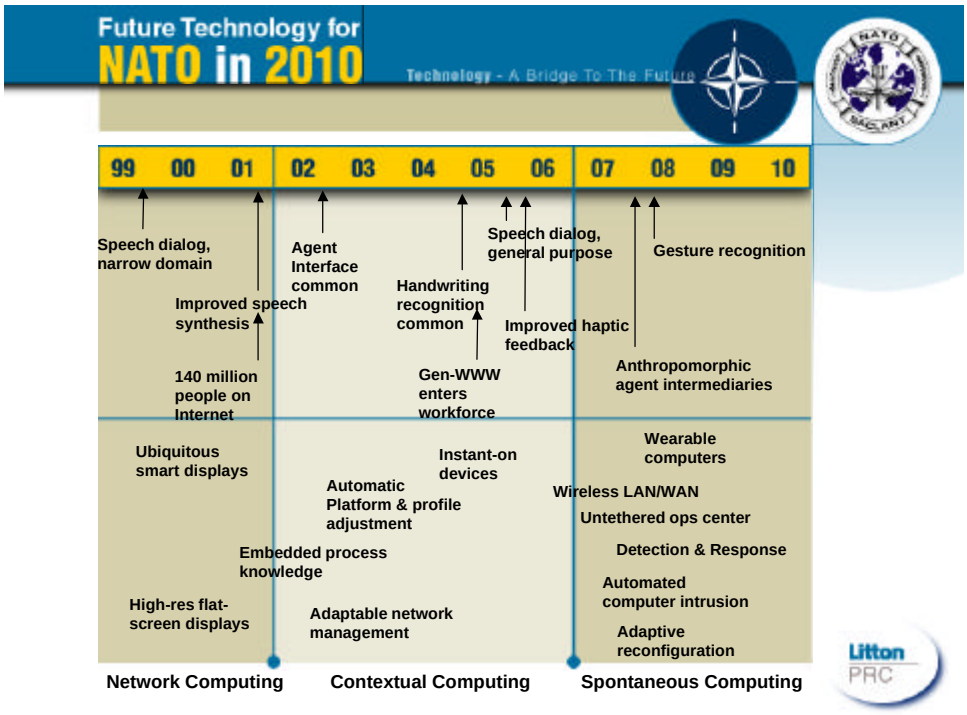

Figure 7
Specific IT Trends

5. Future Technologies

Figure 7 shows a panoply of technology capabilities as a function of time. Note that biotechnology is a wild card and may speed up the process and increase the capabilities within a shorter time. In the view of the Gartner Group and others, we're now in the era of *Network Computing*, with widespread connection of people and smart devices over the Internet, Niprnet, etc. Human-computer interfaces are improving, with high-resolution, flat-screen displays and speech dialog emerging.

We hear a lot of talk about intelligent agent interfaces now, but they won't be a significant factor until around 2001. Then, combined with other advances in interface technologies and with embedded processes, the computing environment will automatically adjust to the user's current needs, bringing us into the era of *Contextual Computing.*

Further along, starting around 2007, we'll have *Spontaneous Computing (Follow Me Computing)*, with anytime, anywhere access to information through portable, wearable computers, and broadband low-cost wireless access on a worldwide basis. This accessibility will be enhanced through improved speech understanding capabilities, smarter intelligent agents, and gesture recognition. Spontaneous computing will likely be a disruptive technology that will change the way people and organizations operate because the computer will provide an ubiquitous environment that adapts to the users' needs.

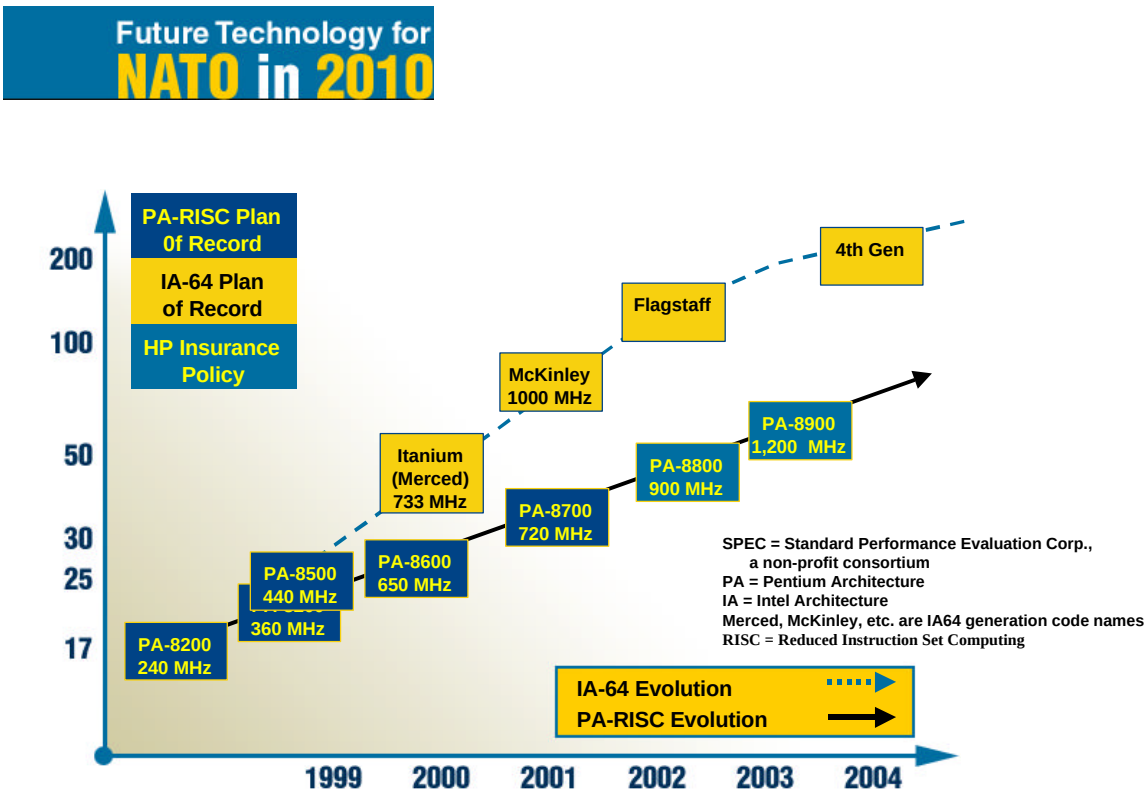

Figure 8
Examples of Processor Trends

Figure 8 portrays the evolution of processing power as a function of time. Using one measure of CPU performance, SPECint, we see that Moore's Law shows no sign of abating soon, based on Intel's plans. For comparison, a Pentium III at 600 MHz comes in at a SPECint of 24. If Intel's 64-bit architecture goes as planned, we should expect a performance increase factor of 8 to 10 times over the next 4 to 5 years. Moore's Law will last until 2005 to 2010 when transistor devices will have cross-sections of several atoms.

Figure 9
Make or Buy? …Make

6. NATO Make or Buy

NATO should invest in technology that it will need and that it can't expect the commercial sector to develop adequately (See Figure 9). The current explosion of Internet-related technologies, especially electronic commerce, is driving significant commercial investment in communications infrastructure, information management, computing, and software technology. Therefore, NATO can rely on COTS for these areas. While there is commercial investment in collaborative technologies, intelligent agents, information assurance, and modeling and simulation, the resulting capabilities will not likely be adequate for NATO's mission. So, for example, NATO members need to invest in the development of distributed collaboration environments and in computer security technology to support information operations and offensive information warfare.

The Make or Buy decision will be driven by the fact that NATO will suffer the pain of not being able to respond to their mission and needs if they do not invest in "The Make." Further, the global threat requires a global cooperative, collaborative NATO that can focus the necessary logistics, platforms, and personnel on a given threat within a few hundred hours or less.

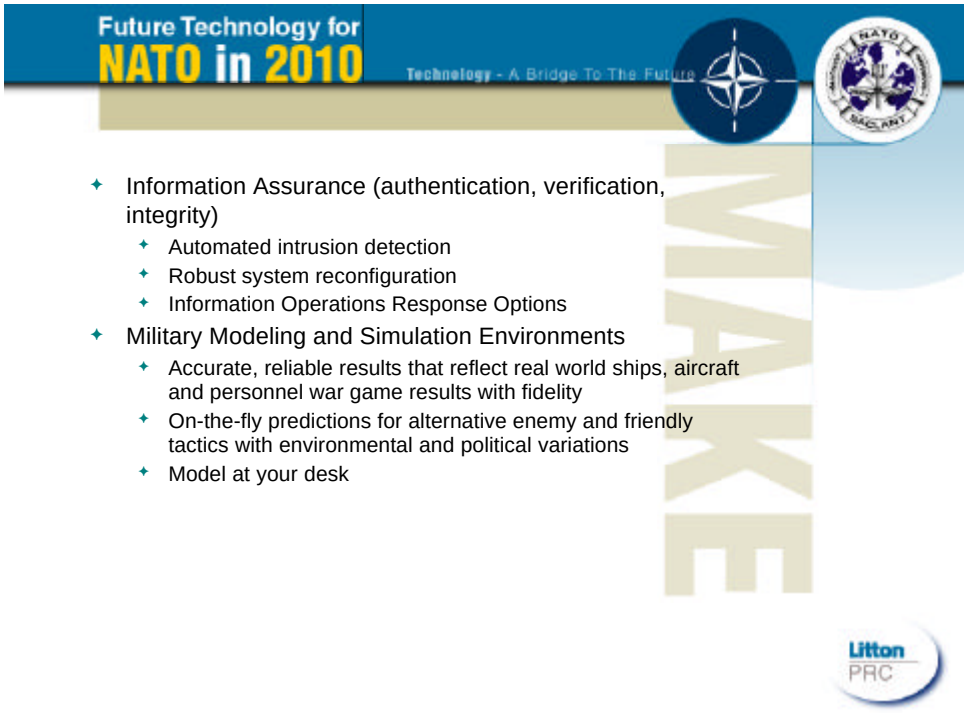

Figure 10
Make or Buy? …Make (continued)

Figure 10 indicates further areas in which NATO must invest. This will allow:

- Automated reconfiguration and response after an IO attack
- Offensive information operations and information warfare
- Modeling and Simulation that is accurate and fast to support Make/Buy/Go/No Go Decisions
- On-the-fly training
- Accurate life cycle costs that model true cost of ownership

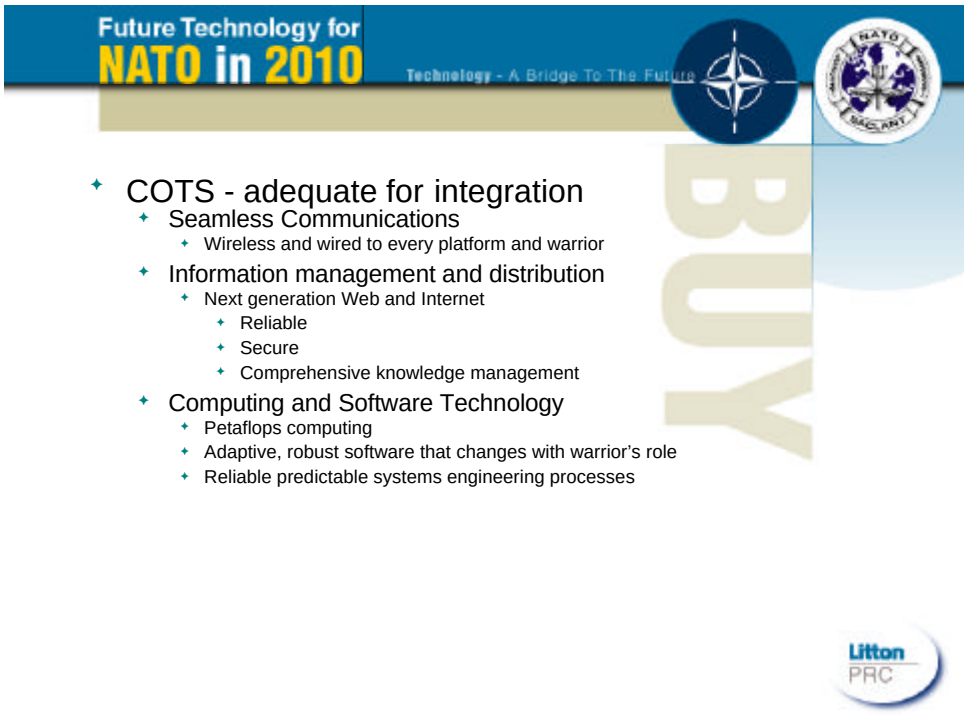

Figure 11
Make or Buy? …Buy

Figure 11 shows the areas in which NATO should invest. Technology changes will support the ability for true continuous collaboration among NATO allies, and this will allow greatly expanded functionality for NATO. This, in turn, will have a strong influence on NATO policy and will make a true System of Systems a reality. NATO needs to transition from the bureaucracy model of interaction to a dynamic network model, with distributed virtual teams crossing space, time, and organizational boundaries and applying diverse knowledge and capabilities to a common mission. This will produce results greater than the sum of the individual contributions. NATO policy needs to be pro-active and needs to focus on the projected capabilities of NATO in 2010.

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