COMITÉ #4

Building Partnerships with Eastern European Scientists

Concerning the future of scientists and technologists in Eastern Europe, what is the best approach to improving "in place" support to the scientific and technological communities to enhance regional security?

EXECUTIVE SUMMARY

In a joint effort, students from the French CHEAr and the US ICAF undertook a shared research project examining issues and opportunities for mutually beneficial science and technology (S&T) collaboration between the nations of the historic Euro-Atlantic alliance and the emerging democracies of the former Eastern Bloc. The French Ministry of Defense (MoD), the U.S. Department of Defense (DoD) and the emerging democracies of Eastern Europe all stand to gain from increased partnering of S&T capabilities between the Eastern Europe and the West. Historically, scientists in Eastern Europe have demonstrated excellent capabilities in academic and defense-related research and this expertise has the potential to provide new insights into defense research challenges facing the entire Euro-Atlantic alliance. Also, building strong relationships with scientists in newly emerging democracies can assist in keeping these nations on a positive pathway to economic and societal reforms, inducing a better framework for global security, while increasing our mutual dependence and thus assuring peace and stability in the region.

This report explains the strategic motivation for pursing S&T collaboration with Eastern European nations, including an explanation of the choice of Romania, Ukraine and Moldova as foci for the study. We analyzed the following essential question through a joint research project:

Concerning the future of scientists and technologists in Eastern Europe, what is the best approach to improving "in place" support to the scientific and technological communities to enhance regional security?

As a result of this analysis there were a short series of recommendations to enhance current R&D activities, participating to develop global security in Europe. These recommendations are based on our study of Romania, Ukraine and Moldova as representative examples of the broader reality of Eastern Europe.

The first recommendation is to "Make rapid and widespread information technology (IT) infrastructure development in Eastern Europe the number one priority of Western investment activities." This was deemed a key enabler for all other actions. Secondly, "Establish a "Team of Leaders" to aggressively pursue coordination between and expand upon existing initiatives for S&T collaboration between the US/EU/NATO and the Eastern European technical community". This is an effort not to create a new structure but to coordinate

actions already underway. Third, "Support the establishment of special development zones" is a proposal to create special zones aimed at stimulation and growth of armaments industry and finally, a proposal to "Reverse the flow of students to the West by supporting "in place"" which aims to exchange professors rather than students.

We hope that with these recommendations the West can act quickly to take advantage of the window of opportunity offered. There is currently a strategic pause in the environment and these nations could shift into either the western or the eastern camp. This paper lays out the actions required to move them closer to the west and achieve western goals of security and stability. The West must act rapidly to achieve success while the opportunity is presented.

INTRODUCTION

Overview

In a joint effort, students from the French Centre for Higher Armament Studies (CHEAr) and the United States Industrial College of the Armed Forces (ICAF) undertook a research project examining issues and opportunities for mutually beneficial science and technology (S&T) collaboration between the nations of the historic Euro-Atlantic alliance and the emerging democracies of the former Eastern Bloc.

For many reasons, both the Western alliance and the emerging democracies of Eastern Europe stand to gain from such an initiative. First, shared S&T expertise has the potential to provide new insights into defense research challenges facing the entire Euro-Atlantic alliance. Moreover, building strong relationships with the scientific and technical communities of newly emerging democracies can assist in keeping these nations on a positive pathway to economic and societal reforms, while helping to reduce the likelihood of research advances occurring which are contrary to Euro-Atlantic interests.

The report first explains the strategic landscape within which the project occurs. Chapter "Strategic Landscape" provides the motivation for pursuing the vision of expanding collaborative activities in science and technology between the Euro-Atlantic alliance and the emerging democracies of the former Eastern Bloc. It provides a short discussion of the geopolitical history of Eastern Europe, a justification for the choice of Romania, Ukraine, and Moldova as study foci, and an explanation of the logic behind pursing S&T collaboration as an important initiative for integrating nascent democracies with the West.

Chapter "Background On Countries Studied" provides background material on each of the former Eastern Block countries selected for inclusion in the study.

Chapter "Strategy For S&T Collaboration" presents a concrete strategy for S&T collaboration with Eastern European scientists and technologists. It focuses on two domains for potential collaboration: technical research initiatives and educational initiatives in Science, Technology, Engineering, and Mathematics (STEM) with a

particular emphasis on the potential of social networking methodologies and infrastructures as a practical means of enabling broader S&T collaboration. This chapter also presents various funding sources and regulatory issues related to collaboration. Each subsection of this chapter includes recommendations to decision-makers for actions that would have positive impacts on both Eastern European scientists and the Western interests in the realm of S&T collaboration[1].

An Appendix is included containing in-depth information on many of the topics covered in the report. Subsections of the annex provide details on the countries studied, organizations devoted to the vision of collaboration with scientists in Eastern Europe, STEM education initiatives, and background material on the growing impact of social networking on societies around the world.

Subject Analysis and Research Approach

Just after the fall of the Berlin Wall, the subject of developing mutually beneficial science and technology collaboration between the Euro-Atlantic alliance and former Eastern Bloc nations was a hot topic. At that time, Western leaders were concerned about the re-employment of highly talented scientists and technologists from former military institutes, principally as it related to a WMD[2] non-proliferation mission. Many initiatives and foundations[3] were created in North America or Western European countries to re-employ WMD experts in alternative activities.

At the beginning of the twenty first century, the situation has evolved. Many Eastern European S&T experts now live in Western countries. The scientists and technologists who remain find the economies of their countries cannot sustain their talents, and many have had to accept jobs beneath their intellectual capacities. As a consequence, their contribution to S&T within their own nations is limited. As Eastern European nations work to improve the quality of life in their societies, a critical factor to global stability and security, their native science and technology experts must not be under-employed.

[1] The Agenda, The White House, http://www.whitehouse.gov/agenda/technology

[2] WMD : Weapons of Mass Destruction.

[3] ISTC(International Science and Technology Centre), STCU(Science and Technology Centre in Ukraine), CRDF(Civilian Research and development foundation), OSCE(Organisation for Security and co-operation in Europe).

In order to provide the greatest benefit to Eastern European nations and to global security at large, the issue in today's context must be restated. This report thus analyzes the following essential question:

Concerning the future of scientists and technologists in Eastern Europe, what is the best approach to improving "in place" support to the scientific and technological communities to enhance regional security?

Classification of Eastern European Countries

Several definitions of Eastern Europe exist today, but they often lack precision or are extremely general. Definitions vary across cultures and among experts and political scientists, recently becoming more imprecise. Usually, Eastern Europe is understood as a region between Central Europe and the Ural Mountains. The United Nations Statistics Division considers Eastern Europe to consist of ten countries: Belarus, Bulgaria, Czech Republic, Hungary, Moldova, Poland, Romania, Russia, Slovakia, and Ukraine. A broader United Nations' definition encompasses the 21 states in Europe that were once under the Soviet Union's influence or were part of the Warsaw Pact. Russia itself is defined as a transcontinental country (Asia and Europe), and Azerbaijan, Kazakhstan, Armenia and Georgia belong to Asia.

For the purposes of this paper, the broader U.N. definition for Eastern Europe will be applied, with the exception of East Germany, which is now unified. The remaining 20 countries can be grouped in three categories:

1. Eastern European countries that are now EU and/ or NATO members (10):
- Estonia – Latvia – Lithuania – Poland – Czech Republic – Slovakia – Hungary – Slovenia – Romania – Bulgaria

2. Eastern European countries now under Western influence or leaning toward the West (8):
- Croatia – Bosnia and Herzegovina – Albania – Kosovo – Republic of Macedonia – Montenegro – Serbia – Ukraine

3. Eastern European countries still strongly under Russian influence (2):
- Belarus – Moldova

Countries Chosen for Analysis

All of the countries noted above were evaluated in political, economical, educational and military domains and it was decided to choose only three strategic countries, one from each category with very different human, economical and military conditions. Such a choice allows us to possibly transpose any recommendations for one country to similar countries in the same category. In addition, NATO and EU nations consider that the eastern bound of Europe should move towards the Black Sea, as this part of the world is seen as very crucial for global stability[4]. For all of these reasons, this paper will focus on the European Black Sea Arch or more precisely Romania, Ukraine, and Moldova.

– Romania is a new EU/NATO country, with strong economic growth, needing help developing infrastructure and educational systems.
– Ukraine is presently a non-EU/NATO country with historically strong Russian influence. It is now publicly pursuing membership, and leans more and more toward western prosperity and security. Ukraine has a strategic role in Europe energy supply.
– Moldova is the poorest European country, and is strongly dependent on Russia. It has not joined NATO or EU, but may wish to enter in the future to develop its own security and prosperity.

STRATEGIC LANDSCAPE

Historical Geopolitics

After two world wars and decades of global nuclear standoff, the 20th century closed with an unexpected surge of freedom to the eastern half of the European Continent. The sacrifice of generations of Europeans and Americans made this outcome possible. However, twenty years after the end of the Cold War, not all potential gains in freedom have been secured. Many Eastern European societies have had a difficult time reconciling the pull of East and West, working to define themselves as separate entities from the Soviet framework without antagonizing

[4] OSCE annual report 2008.

their large and powerful neighbor to the East. Moving from centrally planned histories to futures based on strong civil societies and vibrant private sectors requires simultaneous progress on many levels.

Whether the West ultimately succeeds in expanding the family of open and democratic societies to Eastern Europe, or sees nations revert to a model of closed autocracies, is extraordinarily important. Eastern Europe, at the crossroads of two continents, rich in natural resources, the focal point of key historical traditions, with an advanced industrial and technological history, has inherent strategic importance. The world needs little instruction on the geopolitical consequences of autocratic rule in a major, strategic country in Europe. Indeed, failing to do everything possible to secure the gains of freedom in this region denotes blindness to the extraordinary cost already endured bringing Eastern Europe out of its Cold War stupor, and to the price of regaining ground once lost in security and stability.

In addition to the down side risk, there is an opportunity cost associated with failing to maintain reform progress in Eastern Europe. Bringing the significant human capital and natural wealth of the region into unfettered circulation with the free world creates new opportunities for both Eastern Europeans and their trading partners to the West. Moreover, if reforms can succeed in Eastern Europe, then both figuratively and literally a bridge remains open between the West and Russia. At a minimum, if key Eastern European nations remain in the Western sphere, it creates a zone of shared East-West interests. Ideally, the influence of successful and democratic societies with historic ties to Russia might yet persuade Moscow to embrace reforms.

S&T Collaboration as a Method for Building East-West Relations

This project is rooted in the visions of the Euro-Atlantic alliance and European Union finding effective ways to integrate the emerging democracies of the former Eastern Bloc into the family of free and open societies. Science and technology initiatives provide a unique framework for collaboration between the West and Eastern European societies, with several characteristics that make success likely.

First, S&T initiatives can be fashioned as "win-win" for all nations involved. This is a marked change for nations who faced off against each other during the Cold War. In that era, the West and the Eastern Bloc engaged in a competitive regime of scientific research, technical application, and production, particularly in the area of defense. This competition enabled both sides to develop world-class scientists and researchers; however, at the end of the Cold War, the former Eastern Bloc countries saw a drastic decline in financial capacity. Funding was cut drastically, laboratories fell into disrepair, and salaries for scientists and technologists became inadequate to sustain them and their families.

This lack of funding and support to the scientific community became particularly alarming when it was discovered that some scientists of the former Soviet block were offering their "services" to the highest bidder, representing a potential threat to Western interests. A summit was held in 1992 with U.S. Secretary of State George Baker, German Foreign Minister Genschler and Russian Foreign Minister Kozyrev that resulted in a call for a center for international science and technology that would support former USSR scientists and engineers. This initiative was established to ease the transition to life in a market economy, and provided scientists and engineers with opportunities "to redirect their talents to non-military endeavors, and in particular, minimize any incentives to engage in activities that would result in proliferation of nuclear, biological and chemical weapons and missile delivery systems.[5]"

Circumstances have changed slightly since that period for the scientists, researchers and engineers of Eastern Europe. Analysis completed for this report revealed that these countries still have reasonably well equipped university laboratories although the equipment is often dated. The researchers in these countries are highly-experienced and skilled and their equipment shortfalls have often driven them to develop more efficient and original approaches to solving problems than the more technologically intensive approaches used in the West.

The Eastern European science and technology community is underutilized and is seeking new partnership opportunities with the West, where the need for skilled workers in S&T is increasing due to the advancement of technology. Human

[5] Anonymous, "Proposed Center to Help Scientists of the Former USSR," http://www.fas.org/spp/starwars/offdocs/w920218.htm, accessed March 23, 2009.

resources for S&T are the vital element to innovation and economic growth and there is a known shortage of science, technology, engineering, and mathematics (STEM) expertise within the United States and in Western Europe to fill positions in private sector industry and in government. It is therefore a logical segue to both dilemmas to consider using the expertise developed in Eastern Europe as a means to supplement the S&T shortage in Europe and the United States. Despite differing levels of development among Eastern European countries, scientists in these nations have demonstrated excellent capabilities in academic and defense-related research in such areas as material science, hydrodynamics, and photonics. This expertise has the potential to provide new insights into the defense research challenges facing both MoD and DoD. Additionally, strong relationships with the Euro-Atlantic scientific community, coupled with adequate research funding and direction, would tend to discourage these eastern European scientists from participating in research contrary to Western strategic interests.

S&T initiatives also have a high chance for success as a means of collaboration because they are based on strong civil society and private sector influences, rather than purely governmental activities. Professional scientific societies are a long-standing presence within the civil society framework of Western nations. Through peer-review and academic debate, these societies enforce a merit-based culture that rewards ethical and progressive behaviors. The capital investment decisions by the private sector, which move the innovations of the technical community into the marketplace, are based on the merit an innovation possesses in meeting popular needs rather than by political considerations.

These civil society and private sector influences on S&T initiatives provide several other advantages. Given the geopolitical reality of Russian sensitivity toward overt Western governmental initiatives in the nations of the former Eastern Bloc, a focus on the civil society and private sector level helps moderate Russian concerns. Also, since initiatives with strong civil society and private sector influence help guarantee merit-based outcomes, S&T collaborations in academia and industry can serve as a catalyst to root out political corruption in transitioning societies. This, in turn, can further encourage openness and collaboration between East and West, creating a virtuous cycle of growth.

BACKGROUND ON COUNTRIES STUDIED

A combination of differing geopolitical histories and pragmatic facts create contextual differences that impact S&T collaboration strategies for various Eastern European nations. In order to refine the picture, this section provides a fuller background on each of the countries included in this study.

As mentioned previously, the choice of Romania, Ukraine and Moldova fulfills the objective of including a representative cross-section of the Eastern European sphere in this project. In many ways, these three nations traversed similar paths in the 20th century. All three experienced brief moments of independence early in the 1900s and after the Second World War, and all experienced decades of Soviet control. All three developed advanced scientific and technical communities during their Communist eras, with notable academic scholarship and fundamental research activities and all three developed important industrialized manufacturing activities. However, the aftermath of the Kremlin's age of centrally planned economies left deep voids, which were revealed as they gained independence from Moscow.

Although they have many similarities, the strides that they each have made since the fall end of the Cold War are very diverse and include the spectrum of realities that now face all of the former Eastern Bloc countries. Romania, with its westward leaning history, has ascended into the EU and achieved NATO membership. Ukraine, with its more eastward leaning history, has elements that aspire toward a westward vision, but has not yet fully committed to the values of the EU or NATO. Moldova is a very small country with an uncertain future within Eastern or Western Europe. All three nations have robust science and technology histories, but each has a different level of progress and experience with free market concepts and democratic reforms.

Romania

Romania represents a medium-size, and historically westward-looking nation in Eastern Europe. Its lack of close cultural and ethnic ties to Russia led to a level of disfavor and distance from the Kremlin, resulting in a stunting of Soviet initiatives in the nation. By 1990, economic vitality was weak, and the manufacturing sector had become antiquated. However, when the Cold War ended, Romania's westward bent worked to its advantage, quickening the pace of its embrace of European

reform initiatives. Since Romania did not strongly depend on Moscow like some other countries within the Eastern Bloc, and since its citizens were united in terms of a future vision, Romania as a nation has strongly progressed in its democratic and economic reforms, and has already succeeded in joining the EU and NATO. Moreover, in recent days as Russia has demonstrated a desire to exercise greater control over its former Eastern Bloc neighbors, its power politics agenda has not included Romania.

Ukraine

Ukraine is the second largest[6] of the non-Russian former republics of the Soviet Union, and is an Eastern European nation that clearly shows the challenges of moving from a past dominated by an authoritarian Russia to a future characterized by a westward looking vision of a free and democratic society. Internal to Ukraine, a profound East-West divide manifests itself as an important feature of the national structure. The eastern half of the country has a strong affinity for Russia. Here, a large fraction of the populace are ethnic Russians, and the ethnic Ukrainians who reside there share with the Russians an Eastern Orthodox heritage and culture[7]. By contrast, Catholics and autonomous Orthodox who distance themselves from the Moscow church are concentrated in the west of Ukraine[8].

In the Soviet era, this variation in identities led the Kremlin to deal with the two halves of Ukraine in very different fashions. Eastern Ukraine became highly industrialized and strongly dependent on Moscow. Western Ukraine remained agricultural, and much more ready to look westward. In today's independent Ukraine, the populace remains deeply conflicted about a future vision for the nation. In the momentous Presidential elections of 2004, a clear East-West distribution of votes occurred, with the heavily populated eastern districts favoring the Kremlin-backed candidate, and the western districts backing the pro-Western opposition candidate[9].

[6] After Kazakhstan.

[7] Central Intelligence Agency. March 2009. https://www.cia.gov/library/publications/the-world-factbook/geos/up.html (accessed March 8, 2009).

[8] GlobalSecurity.org. GlobalSecurity.org. Edited by John Pike. April 2005. http://www.globalsecurity.org/military/world/ukraine/geography.htm (accessed March 8, 2009).

[9] *Ibid*

External pressures on Ukraine from Moscow, and tensions between Kiev and the Kremlin are also very real and ongoing. Ukraine must import three-fourths of its oil and natural gas, leaving it heavily dependent on Russia for energy supplies[10]. Just as important, Ukraine is a major transit country for energy supplies from Russia to a host of European nations further west. These realities have provided openings for Moscow to exert external pressure on its neighbor. In 2006 and 2009, Russia shut off natural gas supplies to Ukraine over pricing disputes, in the latter case causing multiple countries to go without heat for several days in the dead of winter. Managing this issue has become a major test of Ukrainian leaders' ability to successfully navigate its role as intermediary between Russia and Europe. Given the East-West pressures on the country, democratic and economic reforms in Ukraine have been much more tentative in the past two decades. To this point, Ukraine is a nation that has not yet entered into the EU or NATO, but which still aspires to move in a more western direction.

Moldova

Moldova represents a very small Eastern European nation whose future is uncertain. It has historically been a territory, which oscillated between Eastern and Western dominance, with little power to control its own destiny. For much of its history it was dominated from the West, by the Lithuanian-Polish Empire or the Austro-Hungarian Empire. Much of the time, it has been dominated from the East, by Moscow Russian power. Its culture and heritage reflect this complex, mixed past. Today, as a tiny independent state, it remains dependent on Russia in many practical ways. It is not yet strongly inclined to join the EU and NATO, but does have within its national psyche a hope for greater Western integration.

STRATEGY FOR S&T COLLABORATION

Given the benefits and opportunity for S&T collaboration between the West and the Eastern European technical community, it is important to develop a concrete plan. Using four subsections, Chapter "STRATEGY FOR S&T COLLABORATION" of this report discusses four factors related to a successful S&T collaboration strategy. The first section discusses educational collaboration. The second section then covers

[10] *Ibid*

various funding sources and regulatory impediments to collaboration. The third section focuses on identifying the best technical areas for research collaboration between the West and the Eastern European technical communities. The fourth section covers the potential of social networking methodologies and infrastructures to serve as a practical means for enabling broader S&T collaboration.

Each of the four sections in this chapter concludes with a set of recommendations. The intent is to provide a set of concrete steps for implementation in each of the four areas of potential collaboration: education, legal and funding, technical research, and networking opportunities.

Educational Collaboration

This section discusses the role education plays in the utilization of scientists and engineers in Eastern European countries, specifically in Ukraine, Moldova, and Romania with respect to the use of partnerships and alliances, specialized skill development, the current and potential areas for establishing distance learning, and enabling communication development.

Strategic Educational Environment

The joint ICAF/CHEAr research group identified education as one of the four critical focus areas for improving research and technology capabilities in Eastern Europe and integrating these capabilities to the benefit of the Western defense community. A study published in August 2007 by the National Center for Education Statistics comparing the education system in the U.S. with systems in other G-8 countries revealed that the United States has the highest number of foreign students enrolled in colleges and universities. The study found that G-8 countries hosted about two-thirds of the 2.7 million students attending college or university outside their country of citizenship. The majority (22 percent) were enrolled in the United States, followed by the United Kingdom (11 percent), Germany (10 percent), and France (9 percent)[(11)].

[(11)] Miller, David C. , Education Statistics Services Institute - American Institutes for Research, Sen, Anindita, Education Statistics Services Institute - American Institutes for Research, Malley, Lydia B. Education Statistics Services Institute ,Child Trends, "Comparative Indicators of Education in the United States and Other G-8 Countries: 2006" http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2007006 , August 2007.

The U.S. and these other countries clearly benefit from the inflow of talented students and many countries now actively seek to recruit and attract foreign students. Students are increasingly mobile and this mobility of students and researchers is an important benefit to the S&T community. A particular issue with such students is the high numbers that choose to remain permanently in the United States. While it is easy to understand the benefits the U.S. and EU countries obtain with the inflow of talented students, it is often difficult to understand and acknowledge that students that study abroad and gain knowledge and experience in another country do in fact contribute to the creation and diffusion of knowledge in their country of origin. These contributions may not be immediate in the home country, and may only be realized when/if students and researchers return after extended periods away, nonetheless, they do in many cases continue to contribute to their country of origin.

For the purposes of this particular study, our focus is on programs that take place in the native country and not those using an "educate and return" model. Our desire to improve the intellectual capital of the region as well as the physical and business infrastructures mandates this approach. There are many existing programs for students and executives to attend training abroad; our focus is on the development of internal programs. We seek to avoid a repetition of past "brain drains" from developing economies.

Educational Environment by Country

Romania: The educational attainment levels in Romania are similar to those of other countries in the region, with a 97.3% literacy rate. The education system is comprised of eight mandatory years and four non-mandatory years. Four years are in primary education and four in lower secondary education. Upper secondary education is not required but adds another four years. Twenty-five percent of pupils leave the education system after the eight years, largely represented in the urban poorer areas of the country. There have been significant changes made in the education system in recent years to include increasing institutional capacity, modernization of curriculums, evaluation and certification, and international recognition of diplomas and certificates. The number of teaching staff has doubled because of these changes; however, a problem still exists with recruiting and retaining teaching professionals. Qualified teachers are turning to private educational institutions or are leaving the profession in search of higher pay and

better working conditions. In 2005, the percentage of GDP spent for education was 3.5% down from 4.0% in 2000. There are 64 public institutions of higher education, which include universities, academies, polytechnics, institutes, and colleges. Most institutions of higher education are administered under the Ministry of Education and Research[12].

Ukraine: Ukraine has almost a 99.4% literacy rate with 15% of the adult population having completed higher education. The education system is comprised of nine mandatory years and three non-mandatory years. Four years are in elementary education and five are in lower secondary education. Upper secondary is not required but adds another three years. In 2006, 6.3% of GDP were spent on education. Education problems are focused on establishing a national context for education. Curriculum changes have focused on removing ideological material and "Ukrainization" of the humanities and social sciences. Secondary education curriculum has not been adapted to lifelong learning. In addition, the curriculum is relatively theoretical and methodology is skewed towards memorization of factual knowledge vice developing learning skills and broad competencies. There are approximately 300 higher education institutions, 70 are privately owned. The Ministry of Education and Science is responsible for the planning of curricula and financing. Many universities have to acquire 30% of their budget from tuition and sponsorships. Due to a high demand for entering the universities and shortages in some teaching areas, some large institutions have moved away from being predominantly specialized in science and technology to less specialized degrees in areas of management, economics, and international relations[13].

Moldova: Moldova has a literacy rate of 99%. The education system is comprised of eleven mandatory years: four years in primary education, five years in lower secondary education, and two or three years in upper secondary education. In 2006, 7.6% of GDP was spent on education. Russian and Romanian are the principal mediums of instruction in the schools. There are sixteen state and fourteen private institutions of higher education. The reform of higher education is focused on

[12] Dreyfus, Alfred, A Cancelled Voyage in French Guiana, 45th National Edition, edited by N. Guilloux, 2009.
[13] http://ec.europa.eu/education/programmes/tempus/countries/higher/ukraine.pd.f

modernization of the curriculum, the diversification of study programs and course offerings, and their synchronization with the needs of the national economy and labor market. A major objective is to integrate Moldavian higher education into the European higher education area by introducing the European Credit Transfer system into Moldavian higher education. In addition, the modernization of the teaching process through the introduction of information and communication technologies and evaluation and assessment systems for higher education are parts of the strategic plan for Moldavian higher education[14].

Educational Collaboration Programs

Existing Partnerships

All countries have a varied degree of technical expertise based on current educational institutions of excellence and types of projects currently researched and developed. Upon review, it appears that overall Ukraine, Romania, and Moldova demonstrate westward-leaning scientific approaches. This may indicate their openness towards collaboration with the U.S. and the EU. Within the North Atlantic Treaty Organization (NATO) Science for Peace and Security (SPS) Program, several collaborative projects are underway for all these countries, all of which have EU involvement and some of which have U.S. involvement.

A primary U.S. means for collaboration with Eastern Europe exists within the U.S. Civilian Research & Development Foundation (CRDF), authorized by the Congress and under the direction of the National Science Foundation. The foundation is actively engaged in scientific and technical collaboration with Ukraine and Moldova. Activities include research partnerships, conferences, and project funding. Despite its access to federal funding, CRDF is a non-governmental organization (NGO). There is opportunity for additional partnering with the EU and other NGOs via joint ventures with government, industry, and academia.

Romania: Working under their National Agency for Scientific Research, Romanian scientists demonstrate levels of expertise in varied areas of laser, plasma, and

[14] Stefan Tiron, Valenti, Arion, Mihai, Paiu, Vitalie ,Scalnîi, and Victor Stan, Higher Education in the Republic of Moldova, http://www.erisee.org/downloads/library_moldova/higher%20Education%20in%20the%20Republic%20of%20Moldova%202003.pdf, accessed 3 May, 2009.

radiation physics. This scientific expertise resides within those conducting research in laser optics. In addition, the "Petru Poni" Institute of Macromolecular Chemistry, conducts extensive polymer research connected to "hot" scientific areas within the medical/biotechnology areas associated with the third priority of sixth Framework Program[15]. The European SME National Center for Program Management recognizes Romania's technology strengths within production technologies, information technologies, and material sciences[16]. The European Commission's Joint Research Centre (JRC) collaborates with over 30 Romanian scientists while over 300 of their scientists participate in the JRC workshops annually.[17]

Ukraine: Possessing nuclear technologies, scientists from Ukraine maintain vast experience within the scientific areas of nuclear weapons, power, and environmental remediation of nuclear disasters. One of Ukraine's research areas for NATO SPS focuses on nuclear risk assessment related to Chernobyl's environmental effects. Other research projects by a Joint Working Group of Ukrainian and NATO scientists were awarded in 2008. Defense applications center on the use of nanomechanics to rapidly detect bioagents and atmospheric monitoring for detection of chemical agents. Ukrainian expertise is vital for both the US and EU in chemical and biological detection. Scientists from the Institute of Single Crystals in Ukraine are working jointly on another SFP project regarding lightweight and transparent armors, dramatically reducing armor plate thickness while maintaining required protection from armor piercing ammunition.[18]

Moldova: The Academy of Science of Moldova (ASM) houses the country's top research institution that actively promotes international collaboration with the NATO Scientific Committee[19]. Under the National Indicative Programme 2007-2010, the European Neighborhood and Partnership (ENP) Instrument adopted an EU-Moldova

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[15] European Comission, The Sixth Framework Programme in brief, http://ec.europa.eu/research/fp6/pdf/fp6-in-brief_en.pdf, accessed march 2009.

[16] Europeer SME RP6: National Center for Programme Management, http://www.europeer-sme-rp6.org/147.0.html. Under this program, Romania's National Authority for Scientific Research concentrates on international cooperation and partnership, biotechnology, information society, and development of infrastructures for technology transfers and innovation.

[17] European Commission Joint Research Centre, http://www.jrc.ec.europa.eu/. The JRC research focuses on the following from the EU's 7th FP: biotechnology, chemical safety, natural disasters, energy and transport, nuclear energy and its safety and security, along with rural development, just to name a few.

[18] Nicole Casey and Dr. Susanne Michaelis, NATO Science for Peace and Security (SPS) Programme: Update for Cooperative Activities with Ukraine, 29 January 2009.

[19] Academy of Science of Moldova, http://www.utm.md/master/en/parteneri/asm/html.

ENP Action Plan. Under this plan, the objective exists to upgrade educational and exchange programs to improve Moldova's integration into the European Research Area[20]. At the Technical University of Moldova, the only higher technical educational institution, the potentially defense education focus areas are energetics, machine engineering and mechanics, microelectronics, computers, and telecommunications. As Moldova prepares their engineers for support of the national economy, the modernization of their education ensures linguistic training.[21] Their combined technical training within foreign language proficiencies could lead to employment as technical manual translators. Without a well-documented technical expertise area, this would be the most prudent initial utilization of their scientific talent.

Future Wave - Distance Learning, Networking and Web 2.0

An alternative for students who might otherwise travel and study abroad, and an alternative that may provide an immediate benefit to the Science and Technology community in the student's country of origin is Distance Learning (DL). This topic is in depth in Section "Social Networking and Collaboration". What follows is a brief discussion in the context of educational development opportunities. DL involves the ongoing efforts of universities to develop the appropriate and most effective of the available technologies to deliver education to students. Distance learning exists in one of three modes:

- Web supplemented distance learning - Participation online is optional for the student.
- Web dependent distance learning - Participation on-line is a compulsory requirement although some traditional on-campus component is retained.
- Full on-line delivery of distance learning - There is no on-campus direct contact. All interactions are integrated and delivered online.

In the developing crescent of Eastern Europe, once the internet capability exists, full on line delivery is the best option for sustained growth and development to support defense needs. With the continued growth, worldwide, in distance learning, a number of universities have recognized the opportunities offered by globalization and formed international consortia to help them develop and market their educational programs. Some of these consortia are:

[20] European Neighborhood and Partnership Instrument, Republic of Moldova, National Indicative Programme 2007-2010.
[21] Technical University of Moldova, http://www.utm.md/master/en/parteneri/utm.html.

- The International Network of Universities (http://www.inunis.net/about/index.htm) which plans to allow students to undertake e-learning with partner universities
- The Santander Group (http://sgroup.be/glowna.html)
- The Worldwide Universities Network (http://www.wun.ac.uk/)
- Universities 21 (http://www.u21global.edu.sg/Education/home) which has an agreement with Thompson Learning to develop and deliver its e-learning
- The Global University Alliance (http://www.universityalliance.com/info) is a worldwide leader in interactive professional education provides unprecedented access to the top universities in U.S.

While distance learning is certainly important, the attainment of such degrees will be useless without a full investment in a pan-European process such as the Bologna Process. In short, the Bologna Process seeks to set all educational institutions on a common footing using similar academic terms, credits and levels. One major goal will be to have all institutes of higher learning adopt easily readable and comparable degrees organized in a three-cycle structure (e.g. bachelor-master-doctorate). Full attainment of the Bologna Process will allow for US and European partners to easily validate skill sets, determine qualifications, and hire qualified researcher to assist in defense needs.

Enabling Communication Development

One significant area in an assessment of the factors affecting educational collaboration must be the ability of a country to meet the underlying requirements for advanced education, research and development, and communications. Since the goal of this research is to discover a means to build and grow the Eastern European science and technology community without exporting the human capital of these countries, education and development must take place on site. While there are many opportunities to improve the education system and the delivery of information, there are significant hurdles to overcome. One of the major areas that must be addressed is the lack of capacity of the communications infrastructure in Eastern Europe to connect individuals and provide the needed educational and developmental opportunities.

Section "Recommendations: Technical Research Collaboration" of this report provides details on the state of Eastern European information technology infrastructure, as well as recommendations for overcoming the deficiencies that exist there.

Recommendations: Educational Collaboration

Based on the discussion in this section, several near term possibilities offer further development of educational collaboration between the West and Eastern European scientists and technologists in order to improve the access to their skills for western defense needs.

Recommendation #1

Establish an International Consortium for Technology and Innovation.

Led by an organization such as the National Science Foundation, or others, the consortium should have members from U.S./EU/Eastern Europe defense research institutions, defense industry research partners, and academia research partners. Non-profit partners could include the U.S. Civilian Research and Development Foundation. The consortium will identify opportunities for partnering in basic research and key technology development areas with strong potential for use in the defense sector. The target audience for participation in research opportunities will include current research scientists and high performing students enrolled in science, technology, engineering, and mathematics degree programs at targeted universities.

Recommendation #2

Utilize the Bologna Process to promote Distance Learning as an effective alternative to educate and train skilled workers, such as researchers and scientist within the country of origin. The Bologna Process' 46-country cooperative arrangement includes Moldova, Romania, and Ukraine, and aims to create a common European Higher Education Area by 2010[22]. The Bologna Process provided the reforms needed to make European higher education more compatible, comparable, competitive, and attractive for students and scholars from European countries and from other continents.

[22] European Commission, "The Bologna Process – Towards the European Higher Education Area", http://ec.europa.eu/education/policies/educ/bologna/bologna_en.html.

In addition to the possibilities listed above, we suggest using the following broad-based programs, relevant to educational development, and modeled for application to Eastern Europe.

- Institutional and Policy Development for Science in Moldova (Civilian Research and Development Foundation): Moldovan Research and Development Association - Non-weapons research partnerships between Moldovan and U.S. scientists. Transferring electronics and aviation expertise of defense industry to commercial sector. CRDF-MRDA Moldova Travel Fellowship Program enables junior researchers to conduct research at American universities. Moldovan-U.S. Bilateral Grants Program allows research partnerships in key technology areas such as energy.
- Supporting Science Achievement in Ukraine (CRDF) – Programs to bolster scientific achievement, CRDF grants, collaborative research between U.S. and Ukraine through meetings and project funding. International Select Conference on Ukrainian Science, Intel sponsorship to discus future of science, technology, and higher education, national priorities for building research and development infrastructure. CRDF Industry programs
- Stanford School of Engineering Partnerships
- International Research Fellowship Program (National Science Foundation) – offers 9 to 24 months research fellowships at foreign host universities.

International Research Experience for Students (NSF) – International research experiences graduate and undergraduate.

Legal and Funding Framework

While exploring methods to increase the productive use of scientists and engineers for civil society and military requirements in Eastern European countries, it is imperative to understand the status of the legal environment and quality of governance that exits within these countries. These highly qualified individuals, and the contractual vehicles that are established to take advantage of their expertise, will have to coexist with any limitations that their respective governmental systems impose. Accessible, sufficient and adequately structured legal systems that protect not only the safety of the individuals, but also the rights of the parties who have entered into a development or contractual arrangements, are critical to development in industrial democracies.

While there are many methods that could be used to measure the suitability of engaging in the use of Eastern European resources, the internationally recognized World Bank Institute has established a significant database of governance indicators that have been measured for over a decade. The following is a comparative table of governance indicators that provides a quick view into the status of legal systems within Romania, Moldova, and Ukraine as compared to the whole of Eastern Europe and the Organization for Economic Cooperation and Development (OECD). While this table is somewhat subjective, it is intended to provide a snapshot of the indicators and their current trending.

Comparative Governance Indicators and Trends for Moldova, Romania, and Ukraine

Goverance Indicator	Moldova	Romania	Ukraine	East Europe & Baltics	OECD
Voice and Accountability	→	→	→		
Political Stability	→	↘	↗		
Government Effectiveness	→	↗	↘		
Regulatory Quality	↗	→	→		
Rule of Law	→	→	→		
Control of Corruption	→	↗	↘		

Percentile

- 90th - 100th
- 75th - 90th
- 50th - 75th
- 25th - 50th
- 10th - 100th
- 0th - 10th

Source: Governance Matters VII: Aggregate and individual Governance, 1996-2007 (June24 2008). World Bank Policy Research Working Paper N° 4654.

As Figure indicates, Romania's indicators are consistent with Eastern Europe writ large. Moldova and the Ukraine are both grappling with establishment of basic governance systems that are necessary to be successful in the global community.

The governance within each country will affect that country's ability to participate in the development of intellectual assets for international partners. Protection of intellectual property rights that is underpinned by a strong judicial system for dealing with both civil and criminal offenses to enforce those rights is critical if the

industrial property is to have value. The judicial system must also be staffed with competent experienced personnel. Without the adequate protection mechanism that both grants rights but also protects them, an intellectual assets developed will have no value[23].

Each country has its own patent and trademark office. These are typically organized to protect the resources that evolve from the creation of intellectual property of the country. This is especially true in developing economies of Eastern Europe. The protection of the science and technology resources that facilitates economic benefit for each of these countries motivates the government investment in the human resources required to operate intellectual property systems.[24]

The following section discusses the status of the intellectual property systems of Romania, Ukraine, and Moldova.

Status of Intellectual Property Rights by Country

Romania: The Romanian government established the State Office for Inventions and Trademarks. The office was established in the 1800's to prepare and propose the main laws in the field of industrial property protection. Since 1990, the office has focused on modernizing Romanian intellectual protection laws to be consistent with the international provisions in patents and trademarks.[25]

Romania is party to several important international treaties, agreements, and conventions: among which are: the Paris Convention for the Protection of Industrial Property (1920), the WIPO Convention (1970), the Patent Cooperation Treaty (1978), and European Patent Convention. While it is clear that the Romanian government understands the need and value of intellectual property controls, significant improvement are required to meet international standards for intellectual property rights controls.[26]

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[23] International Bureau of WIPO, WIPO Intellectual Property Handbook: Policy, Law and Use, WIPO Publication No.489 (E):207.
[24] *Ibid*, 163.
[25] Romanian State Office for Inventions and Trademarks (OSIM), "General Information", About us, http://www.osim.ro/index3_files/about/about.htm#general, (February 23, 2009).
[26] European Union, "European Commission, Romania - 2005 Comprehensive Monitoring Report, 25 October 2005," SEC (2005) 1354, http://www.unhcr.org/refworld/docid/43956435b.html, (February 24, 2009).

The Romanian government has indicated that raising awareness of the importance of the protection of intellectual property for both the government and the population is needed. Additionally, recognition of intellectual property rights by private firms and the enforcement of those rights by civil authorities require improvement.[27] Any government or private firm acting on behalf of the government that intends to use the science and technology resources of Romania should evaluate the importance of any intellectual assets that might be developed as a result of that investment. Caution must be maintained until such time that the Romanian government can reasonably protect the intellectual assets developed.

Moldova: Moldova is a member of the World Intellectual Property Organization as well as a signatory of the 1967 International Convention on Intellectual Property and the World Trade Organization's 1994 Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS). Under these regimes, the Moldovan government has taken measures to comply with the expected standards for regulation, and have established the State Agency for Intellectual Property for enforcement.

The enforcement of these agreements is sporadic however. Corruption haunts the country and has not been improving. Moldova was tied for 109th place out of 180 countries in Transparency International's Corruption Perception Index[28]. This places it well behind all of the European Union countries but narrowly ahead of Ukraine. Bribes are an expected part of doing business in Moldova and are reportedly an increasing problem[29]. Additionally, the Moldovan justice system is weakened by influence from government officials. Payments of judicial salaries are reportedly delayed as a means to influence the courts[30].

Ukraine: Ukraine has a mixed, but generally improving record on intellectual property rights. The Ukraine inherited a weak intellectual property structure from the Soviet Union; however, over the last ten years it has been working to develop a more internationally acceptable framework.

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[27] International Bureau of WIPO, Advisory Committee on Enforcement: Romanian Efforts to Improve Awareness of Decision Makers and Public on Issues Related to the Enforcement of Intellectual Property by Ion Codescu, WIPO/ACE/3/7 (E):3.
[28] Transparency International, 2008 Corruption Perceptions Index.
[29] The Tiraspol Times, "Corruption breaks new records in Moldova", http://www.tiraspoltimes.com/node/1753.
[30] The Heritage Foundation, http://www.heritage.org/index/country/Moldova.

The United States established sanctions against Ukraine in 2001 largely in response to copyright violations of music and video properties. While this provides a concern, there have been few complaints filed in regard to technological property rights violations. In order to address this issue and to facilitate the lifting of U.S. sanctions, in 2006 Ukraine passed legislation that changed its criminal code increasing the punishments for software piracy.

The Ukrainian government established the State Department of Intellectual Property (SDIP) within the Ministry of Science and Education in April of 2000[31]. The SDIP is the primary institution responsible for policy development and management of legal positions. Ukraine is also a member of the World Intellectual Property Organization (WIPO) as well as a signatory of numerous other IPR-related international agreements[32]. As part of its ongoing efforts to negotiate accession to the WTO, Ukraine has adopted a series of laws to bring its IPR regime into compliance with the WTO Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS).

Legal and Regulatory Barriers to the Transfer of Technical Information

United States: The transfer of S&T information between U.S. citizens, organizations (private, governmental, or quasi-governmental) or companies, and non-U.S. entities is governed primarily by three sets of Federal government regulations. For information and material pertaining to defense and military-related technologies, the governing rules can be found in Title 22, sections 120-130 of the Code of Federal Regulations (22 C.F.R. §§ 120-130), commonly known as the International Traffic in Arms Regulations (ITAR). Since these rules implement the provisions of the Arms Export Control Act, they carry the force of federal law in controlling the export and import of defense-related articles and services that are identified on the U.S. Munitions List. The ITAR, including the Munitions List, can be found at http://www.access.gpo.gov/nara/cfr/waisidx_99/22cfrv1_99.html. The State Department's Directorate of Defense Trade Controls (DDTC) administers the ITAR for the federal government. In general, ITAR prohibits sharing information or material pertaining to defense and military-related technologies with other than U.S.

[31] State Department of Intellectual Property, http://www.sdip.gov.ua/en/history_.html.

[32] Ukraine Legislative Profile, World Intellectual Property Organization (WIPO), www.wipo.int/about-ip/en/worldwide/pdf/ua.pdf.

persons unless licensed by DDTC or unless the information is otherwise exempted (e.g., certain categories of information or equipment provided to Canadian citizens or entities). Violations of ITAR can result in heavy penalties[33].

The export of information or material that is not directly defense-related but could be dual-use (items or data that could have applications in both commercial and military or proliferation spheres) is governed by the Export Administration Regulations (EAR), administered by the Commerce Department's Bureau of Industry and Security (BIS). EAR also covers the disclosure of U.S. technology to foreign nationals. The EAR implements the Export Administration Act of 1979, annually extended by the President under the provisions of the International Emergency Economic Powers Act. The list of dual use technologies can be found in the Commerce Control List, part of the EAR. BIS maintains a "Dummy's Guide to Export Controls" at http://www.bis.doc.gov/licensing/exportingbasics.htm. The EAR can be found at http://www.access.gpo.gov/bis/index.html[34].

The exchange of basic or applied scientific information is governed by National Security Decision Directive 189 (NSDD-189), which declares, "the products of fundamental research [should] remain unrestricted"[35]. The NSDD defines fundamental research as "…basic and applied research in science and engineering, the results of which ordinarily are published and shared broadly within the scientific community, as distinguished from proprietary research and from industrial development, design, production, and product utilization, the results of which ordinarily are restricted for proprietary or national security reasons"[36]. For fundamental research funded by the federal government, publication and broad dissemination are usually required by the funding agency[37].

France: In France, the principle constraints that could limit exchanges with foreign countries, including the Eastern European countries, relate to import/export controls

[33] Wei Luo, "Research Guide to Export Control and WMD Non-Proliferation Law," International Journal of Legal Information 35 (Winter, 2007), (February 17, 2009), 447-448, 457, 497.
[34] *Ibid*., 456.
[35] National Security Decision Directive-189, (1985).
[36] *Ibid*.
[37] Dana A. Shea, Balancing Scientific Publication and National Security Concerns: Issues for Congress, Congressional Research Service (Washington, DC: 2006), http://wikileaks.org/wiki/CRS-RL31695, (February 16, 2009), 8-9.

of the war equipment business[38] for the full definition of "war equipment" and related authorizations.

The decree-law of April the 18th of 1939 declares[39] that "the export…without authorization, of war or classed as war equipments is prohibited." To be authorized to produce or sale war equipment, French companies require specific authorization (AFC: "Autorisation de Fabrication, Commerce et/ou Intermédiation"). Any information exchange or transaction related to war equipment is thus controlled by a panel of prior agreements (AP: "Agrément Préalable", AEMG: "Autorisation d'Exportation de Matériel de Guerre") that are delivered by the Commission Interministérielle pour l'Etude des Exportations de Matériels de Guerre (CIEEMG).

Mutual development of national defense industries through increased cooperation with potential foreign partners could be sped up by an improvement of current control processes between European nations. A report from a parliament deputy[40], completed with a number of critiques from French armament companies (SMEs[41] or larger companies) initiated a change to the AEMG processes to facilitate war equipment business in France, with the goal of simplifying and reducing the authorization cycle of export procedures needed to achieve compliance; e.g., to meet foreign military equipment IT schedules or to make the authorization processes more achievable by SMEs.

In parallel, many contacts made during the preparation of this report, stressed the importance that any prospective approach from Western to Eastern European countries must initiate concrete exchanges and collaboration. These contacts could be supported through organization of relevant workshops, conferences or exchange opportunities, and through facilitation of early, pre-procurement contacts made during prospective research of the defense industry companies. This would require the simplification of the defense equipment export procedures for early contacts, in the prior agreements part of the process.

[38] http://www.legifrance.gouv.fr/texteconsolide/RIHBQ.htm
[39] French Defense Code, art L2335-3.
[40] Y. Fromion: National assembly report XIII° législature, # 1202 "Environnement Et Prospective De La Politique De Défense".
[41] www.ttu.fr/site/francais/frdocpdf/EtudeDefence.pdf.

To complement the landscape of France and American import/export controls over the defense industry, the European Union control regime, under recent strong development, must also be addressed.

European Union: Over the last 20 years, European military budgets have remained stable or decreased, while in other countries, particular the U.S., these budgets drastically increased, widening the discrepancy of defense investment between the U.S. and European countries. In addition, the imbalance between the U.S. and Europe at the corporate level and the enormous consolidation process that took place from 1993 to 1997 within the U.S. defense industry reinforced European anxieties about the threat of U.S. market hegemony.

Facing competition from giants such as Boeing, Lockheed-Martin and Raytheon, supported by a huge national defense market, Europe's national champions and their respective governments began to accept cross-border integration as the only way to avoid being squeezed out of the market and/or forced into unbalanced subordinate partnerships. The main result of the restructuring process that followed was the creation of three big groups, EADS, BAE Systems and THALES, each of them linked to each other and to the remaining groups by numerous international joint ventures. This, in turn, triggered the so-called Letter of Intent (LOI) process between the governments of the major European arms-producing countries (France, Germany, Great Britain, Italy, Spain, and Sweden). In July 2000, the six partners signed a Framework Agreement covering (1) Security of Supply, (2) Transfer and Export Procedures, (3) Security of Classified Information, (4) Research and Technology, (5) Treatment of Technical Information and (6) Harmonization of Military Requirements, committing them to create a more homogenous regulatory framework to improve market conditions for an increasingly transnational industry.[42]

The LOI countries agreement is the first example of simplification of exchanges between EU member states. The defense industry legal framework in the EU is addressed at two levels: the multilateral agreement at the LOI countries level and at the EU level. These issues concern both EU countries (including some of the former Eastern Bloc countries) and non European Union countries. The export chapter of the agreement supports the simplification of exchanges between members of the LOI

[42] Burkard Schmitt, "European and Transatlantic Defence-Industrial Strategies", IISS/CEPS European Security Forum, Brussels, 25 November 2002, http://www.eusec.org/schmitt.htm, March 23, 2009.

(aim: reduction or even suppression of procedures) and convergence of export policy to third parties. The harmonization chapter proposes to start with a project in early stages to initiate cooperative research, development and procurement. Although the agreement is not legally binding, the LOI is a first step in extending cooperation between EU member states. It could provide a catalyst to increase cooperation with other European countries, particularly the Eastern European countries. The fact that 45% of the EU market of war equipment lies outside the LOI member states supports regulations in war equipment development and business being extended to the whole EU.

Although Article 296 of the European Community Treaty allows member states to derogate from internal market rules on public procurement and the fact that defense remains a desired competency of the EU member states both encourage non-collaboration, a constant effort is of EU aims to support construction of a future European Defense Equipment Market (EDEM) and related industrial base. In May 1998, a European code of conduct was adopted that provided an initial EU reference for arms exports within the framework of the Common Foreign and Security Policy (CFSP), to increase transparency between member states related to the war equipment business, while acknowledging the desire of EU member states to maintain separate defense industrial bases. On January 14, 2009, according to the European Security and Defense Policy (ESDP), the European Union Parliament passed the Defense Package, a set of decisions aimed at improving European Defense Industry competitiveness, and opening the intra-community market to the European defense industry. Two of the directives have been adopted:

- A directive tailor-made to the procurement of arms, munitions and war materiel, as well as related works and services, that aims to limit the use of Article 296.

- A directive aiming at simplification of the transfer of defense equipment between member states (supporting the access to innovative high tech SME).

In addition, the measures planned to reinforce the competitiveness of the defense industry include the following: promotion of standards, the guaranty of equitable competition, a European information security framework, analysis of the control of foreign investment in strategic companies, set to foster collaboration between member states.

The former Eastern Bloc countries have a significant war equipment industrial base, but it is often structured from rules inherited from the Cold War, with the defense industry restricted mainly at subsystem levels. Creation of a European open market for defense products harmonization will provide the Eastern European countries that are member states of the EU with a simplified framework for building European collaboration efforts and benefit from EU measures for defense industry support, resulting in reinforcement of their war equipment industry.

Funding for Collaborative Research and Technology

Besides the necessity of a strong legal framework and functioning system needed to enable adequate investment in research and technology, funding is required. Moreover, in any discussion regarding the United States and the international community providing financial aid to encourage development and advancement in scientific research and technology, there is no lack of consensus on the need to do so. The direct relationship of research, basic or applied, to innovation and progression that benefits economies and living standards is clearly recognized.

United States: In the U.S., the White House's website reaffirms this position by stating, "21st-century technology and telecommunications have flattened communications and labor markets and have contributed to a period of unprecedented innovation, making us more productive, connected global citizens. By maximizing the power of technology, we can strengthen the quality and affordability of our health care, advance climate-friendly energy development and deployment, improves education throughout the country, and ensures that America remains the world's leader in technology."[43]

Discord remains over how to coordinate available funding and apply it to the highest priority requirements to best serve the wider interests of not only the scientific and research community, but also the U.S. taxpayer (for funds coming from the federal government) or international community (for funds coming from entities such as the United Nations). This often becomes an area of contention because clearly identified interests that are benefited by specific research provide a better

[43] The Agenda, The White House, http://www.whitehouse.gov/agenda/technology/.

leveraging mechanism to obtain funding, especially in a constrained budgetary environment, given the current global economic crisis, than do general discussions of potential benefits emanating from basic scientific research.

In a recent U.S. National Science Board publication, the difficulties involved in this prioritization were explained as follows. To ensure the most effective use of Federal discretionary funding, it is essential that agreement be reached on which fields and which investment strategies hold the greatest promise for new knowledge that will contribute most effectively to better health, greater equity and social justice, improved living standards, a sustainable environment, a secure national defense, and to extending our understanding of nature. It is intrinsic to research that particular outcomes cannot be foretold; but it is possible, indeed necessary, to make informed choices and to invest wisely. The need for better coordination and priority setting is not related to cycles of fiscal constraint alone. It is, rather, an integral aspect of a sound, future-oriented strategy for the investment of limited Federal dollars.[44]

European Union: European Union members following the Lisbon Strategy in March 2000 set a goal of 3% of GDP for R&D expenditures (public and private), as a means to foster economic growth and employment. Each country may provide national incentives to increase R&D investments, specifically in private companies (e.g., R&D tax credit in France). The main EU common tool is the Seventh Framework Programme for Research ("FP7", 2007–2013), which seeks to consolidate the European Research Area and stimulate the national investments needed to reach the R&D target of 3% of GDP.

The main funding tool in this effort is the Cooperation Program dedicated to collaborative R&D. Proposals must be set up by consortia from several EU countries' organizations. Its budget has reached the considerable amount of €32B ($42B) over a 7-year period. As most projects are only partially funded, this has led to a total R&D investment estimated to be €60B ($78B) in both the public and private sectors. An initial priorities allocation has also been defined that reflects the relative importance of technologies for economic development: Information

[44] Dr. Ian M. Ross, Chairman, "Government Funding of Scientific Research: A Working Paper of the National Science Board", Section IV, NSF-97-186 (Washington: 1997), http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsb97186, December 2, 2008.

and Communication (28% of the budget), Health (19%), Transport (including Aeronautics, 13%), Nanotechnologies (11%), Energy (7%), with the remaining being spread over Biotech/Food Processing, Environment, Space, Security, and Social Sciences.

The above notwithstanding, there are funding streams available that could provide opportunities for scientists and engineers in the Eastern European countries that are the focus of this project to further their desired areas of research, benefiting not only themselves, but also their countries and the West. One of the best centralized websites to locate funding opportunities is found through the University of Virginia at: http://www.cs.virginia.edu/research/sponsors.html. It includes both government and private links that offer a strong starting point on funding opportunities. For potential funding from the United Nations and the entire international community, the most comprehensive website seen is the Community of Science (http://www.cos.com), which provides centralized information on the means to obtain funding information as well as a location in which to showcase an individual's areas of expertise for others seeking such expertise. The European Union has also opened a portal to facilitate access to FP7 funding programs. It provides information on processes, existing projects, and links with partners[45].

Eastern Europe: Regarding legal and funding issues, we must consider considerably different situation between Eastern Europe countries, within the European Union, and outside the EU. Romania benefits from the EU subsidies for R&D which are for civil purposes. Private funding is also available in the form of publicly leveraged venture capital organizations, to help transfer R&D results to companies and to the economy. Researchers in Romania are also getting accustomed to the process of obtaining grants from competitive research proposals. Romania is highly integrated with the EU Lisbon strategy to foster economic growth from innovation and knowledge. However, even if considerable amounts are available for civil R&T targeting economic growth, the defense R&T budget is very small and its management still to be organized. It could noticeably benefit from civil ongoing R&T efforts if dual-usage technologies are properly handled.

[45] http://cordis.europa.eu/fp7/home_en.html

Other Eastern European countries like Ukraine and Moldova do not benefit from massive public investments to sustain economic growth based on innovation. However, the example of STCU proves that even limited funding (an average $140,000 per project) has a considerable effect in aiding scientists, provided access to information and proposal submission is made highly-efficient through the usage of web technologies. STCU intends to sustain projects with improved economic viability; company creation by researchers is one way to do this. Limited funding may prove sufficient, as in the case of the STCU average project costs, and opens the way to "micro-credit" style private funding.

Funding availability may be limited in some Eastern European countries due to fear of corruption and/or effective applicability of regulations concerning Intellectual Property Rights. One way to reassure public and/or private investors is to define specific business zones. As an EU member, Romanian public and private R&D organizations are eligible to participate in FP7. As a result, Romania is very proactive, setting up a permanent presence in Brussels to support its national organizations willing to participate in FP7 consortia, the Romania Office for Science and Technology (www.rosteu.net).

Leveraging Bank and Private Funding

Although not directly related to the science base, it is important to mention that the European Investment Bank (EIB) supports eastern infrastructure projects outside the European Union (EUR 3.7B, including Russia, Ukraine, and Moldova). The targets are projects of significant interest to the EU in transport, energy, telecommunications and environmental infrastructure.

The EIB supports a much larger funding program for EU member states. In particular for Romania, after 16 years of financing projects fostering the integration of Romania into the European Union, the European Investment Bank's lending operations now support small and medium-sized companies (through local financial institutions, notably local venture capital organizations), and the development of a knowledge-based economy. This provides leverage for venture capital private funds willing to invest in new technology companies.

The STCU (Science and Technology Center in Ukraine) is an intergovernmental organization, established in 1993, created to assist former Weapon of Mass

Destruction scientists or technologists in the transition to self-supporting, peaceful activities in the international science and business communities using the best professional practices. It is currently publicly funded by Canada, Ukraine, the European Union and the U.S. and supports research projects carried out not only by Ukrainian, but also Azeri, Georgian, Moldovan, and Uzbek former weapon scientists. Since 1993, private companies and government agencies from the European Union, United States, and Canada have used the STCU to manage over 1300 R&D projects, worth over $182 million. STCU is currently moving to increase the amount of private sector funding and improve the cooperative depth of private sector projects (i.e., projects that more substantively fulfill actual customer needs and do less concept exploration) to encourage long-term partnerships and sustainability for former weapon scientists and institutes.

Recommendations: Legal and Funding Framework

Based on the discussion above, five recommendations are offered in the realm of legal and funding initiatives to help further the development of collaboration between the West and Eastern European scientists and technologists.

Recommendation #3

Simplify the rules for import/export authorizations in Western nations to allow access to smaller, more innovative companies. In particular, during the earliest phases of procurements, allow more early, business development contacts in war equipment exports.

Recommendation #4

Simplify the legal framework for defense procurement to allow defense industry consolidation to include Eastern European industrial capabilities, especially for subsystem production.

Recommendation #5

Establish a dual-usage R&T funding program dedicated to Eastern European EU member states. Such a program could select civil R&T projects of interest for defense applications using defense-related funds provided by US, EU (possibly European Defense Agency) and/or NATO.

Recommendation #6

Extend STCU's new strategy for non-EU Eastern European countries to provide an internet-based business incubator, where scientists willing to create a company can meet early-stage private domestic or foreign investors.

Recommendation #7

Establish clearly-identified economic development zones in Eastern European countries, specifically where a high concentration of S&T competences exist, where domestic and/or foreign project funding can legally flow directly to end-users, and where compliance with state IPR rules is guaranteed and independently audited.

Technical Research Collaboration

Overview

Research and technology cooperation is a factor of peace, allowing communities to exchange and know themselves on non-or not too sensitive subjects. It appears therefore as a good opportunity to increase the productive use of former Eastern European countries scientists and to build partnerships. Former eastern European countries also benefit from existing university laboratories, highly experienced and skilled in different areas and sometime with more efficient and original approaches, coupled with small series manufacturing capabilities. They have lost their former unique customer (USSR) since the fall of Berlin's wall, and search for new partnership opportunities.

Targeting Technical Research Collaboration Using TRLs

As mentioned in Chapter 2 of this report, collaboration on technical and scientific research allows societies to exchange information on subjects not directly tied to politics, and is therefore often a contributor to peaceful exchanges between nations. It is simultaneously a good way to increase the productive use of Eastern European countries' scientists and technologists as part of the broader process of building international partnerships. However, some types of technical research are better suited as a target for collaborative West-East activities than other types.

One way to frame the discussion of those areas of technical research that are well suited for West-East collaboration is in terms of Technical Readiness Levels, or TRLs. The concept of TRLs was developed by the U.S. National Aeronautical and Space Administration (NASA), and is now commonly used by governments and industries around the world. As stated in the NASA white paper on the subject: "Technology Readiness Levels (TRLs) are a systematic metric/measurement system that supports assessments of the maturity of a particular technology and the consistent comparison of maturity between different types of technology."[46]

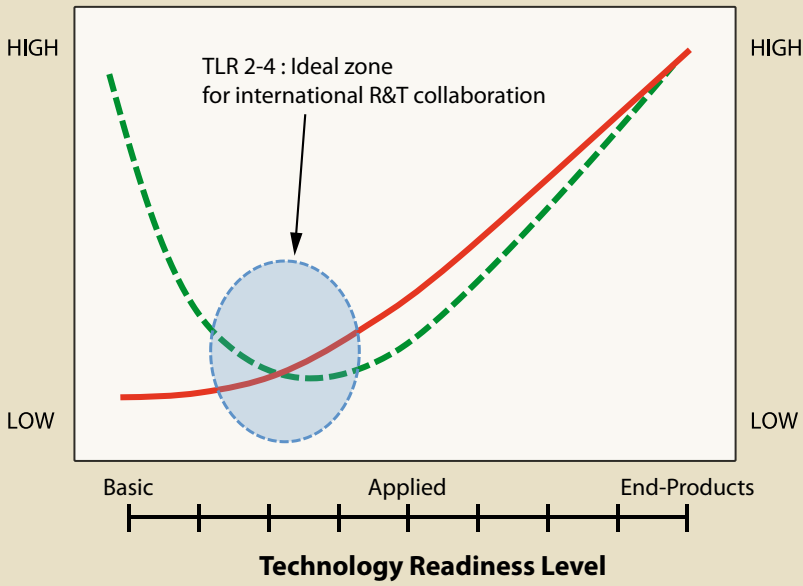
TRLs are measured on a scale of 1 to 9, with 1 being the least mature, and 9 the most mature. Roughly speaking, a technology at TRL level 1 is at the basic science research level (e.g. the study of new fundamental physics theories), while a technology at TRL level 9 is an end product being bought and sold on the market and used commonly in society.

The following Figure depicts TRL from 1 to 9 along the horizontal axis of the diagram. The vertical axes on the left and right axes each have a range of low to high, and each qualitatively depicts a practical consideration related to Technology Readiness Levels. The left vertical axis (matched to the green/dotted line) indicates the degree of capital investment, highly specialized training, and general funding required for a nation to pursue a given portion of the TRL spectrum. The right vertical axis (matched to the red/solid line) indicates the degree of collaboration barriers (legal, policy, security, intellectual property, proprietary, etc.) facing a nation attempting to pursue a given portion of the TRL spectrum.

All factors taken together, the sweet spot most conducive to multi-national collaboration, especially between the West and former Eastern Bloc nations, is on projects in the TRL range from 2 to 4. This is the ideal zone for international R T collaboration, especially in the defense sector, because:

At the lowest-level TRLs, exploring fundamental research, there are typically high requirements for world-leading technical experts, large national funding requirements, and leading-edge and capital intensive research facilities;

[46] Mankins, John C., "Technology Readiness Levels: A White Paper", (Washington: April 1995), www.hq.nasa.gov/office/codeq/trl/trl.pdf, accessed May 1, 2009.



Targeting Technical Research Collaboration Using TRLs.

At the highest-level TRLs pursuing advanced development and industrialization of products, there are typically high barriers in terms of legal issues, policy limitations, intellectual property rights, and proprietary concerns;

Thus, since TRL can be roughly matched to these practical factors, policies on collaboration should intentionally target those levels with the greatest promise to allow Eastern European nations to gain the benefit of the fruitful use of their existing research laboratories, the employment of their skilled technologists, and the opportunity for developing their small series manufacturing capabilities. Such activities are vital, since these nations have lost their former unique customer in the Soviet Union, and are searching for new research partnership opportunities.

R&T Collaboration Strategy for Eastern Europe

Previous sections of this report have referred to the numerous organizations that exist, who are devoted to improved S&T collaboration between the West and the Eastern Europe. This section will analyze these organizations in detail, and the opportunities they present for collaboration. The variations in reforms within former Eastern Bloc countries have created different frameworks which must be utilized to promote S T collaboration in each nation. Some nations have already entered the EU and/or NATO, and nations which have not yet made the transition. Those in the former category have access to developmental initiatives that those in the latter category do not. For that reason, this section divides the discussion of organizations pursing expanded West-East S&T collaboration into three groups, EU-based organizations, US-based organizations, and other organizations and initiatives, and discusses the opportunities available to each of the three nations included in this study.

European Union Organizations and Initiatives

Within the EU, the European Defense Agency (EDA) was created under a Joint Action of the Council of Ministers on 12 July, 2004 "to support the Member States and the Council in their effort to improve European defense capabilities in the field of crisis management and to sustain the European Security and Defense Policy as it stands now and develops in the future."[47] It serves as an EU initiative to jointly consolidate the efforts of participating Member States (pMS) to fill the military capability gaps identified in Europe. As such, the EDA includes both an armament branch and an R&T directorate.

Romania and other former Eastern Bloc countries, known as defense R&T "newcomers", have shown a real interest in developing a strong R&T capability. In fact, Romania has asked EDA for support in organizing a new defense R&T initiative. Other Eastern European countries such as Estonia and Lithuania experience the same difficulties in standing up defense R&T programs and have also contacted EDA for assistance. As a result, EDA has organized a workshop on defense R&T for these newcomers to the field, planned for the first part of 2009. The objective is to

[47] European Union Defence Agency website, http://www.eda.europa.eu/genericitem.aspx?area=Background&id=122, March 24, 2009.

first establish a defense or armament industry catalogue and identify the companies, laboratories, or subject matter experts (SME) of interest for defense. This catalogue could then assist participation of these companies in consortia for defense R&T studies proposed by EDA.

It must be underscored that many former Soviet bloc countries such as Romania were forced by the USSR to specialize their defense industrial bases – where present - and related R&T activities within a dedicated sector (e.g., armored vehicles, electronics, etc.), thus preventing too much independence from the USSR and development of a real defense industry. Since the demise of the Soviet Union, these countries are attempting to increase both the autonomy and the reliability of supply in organizing their defense industries and armament acquisition processes. This could lead to useless and costly duplication, as their R&T efforts are already very low.[48] It would therefore appear necessary to offer a mutually-interdependent approach between EU and NATO members to assure reliability of supply for the defense industrial base would avoid wasted effort in the R&T arena.

The planned EDA defense R&T workshop would also be a good opportunity to analyse the feasibility of creating a network of defense research centers in Europe. For example, technical military centers exist in Romania (although these are generally aging facilities), which might be utilized as centers of defense research. Biology (BSC) could also offer a good axis around which to develop collaborative research both within these countries and with the West.

In addition, it can be observed that these Eastern European R&T newcomers often have civilian scientific capabilities. Thus, a dual use (civilian/military or security) approach for future projects could aid them to enter the military R&T arena and support building their own defense R&T and industry capabilities without duplication of effort, perhaps in cooperation with western European countries. For everything related to dual scientific subjects, the European Commission (EC) and the 7th PCRD[49] with a cooperation program (including Space and Security) appear

[48] One third of European investment comes from the UK and 1/3 from France. The six LOI countries (UK, France, Denmark, Italy, Spain, Estonia) plus the Netherlands represent ~98% of European defense R&T, and the remaining ¾ of European countries represent ~2%. The last ½ percent represents the defense R&T "newcomers" including many Eastern European countries. Nevertheless, some of these newcomers are beginning R&T efforts; e.g., Austria has recently multiplied by tenfold its R&T effort.

[49] Programme commun de recherche et développement.

to be an adequate framework. Some Eastern European countries can already be involved in EC security programs. In the 8th frame program, joint efforts between EC and EDA[50] could be envisaged in order to increase and enhance the involvement of Eastern European countries. The planned EDA defense R&T workshop would also be a good opportunity to analyse the feasibility of creating a network of defense research centers in Europe. For example, technical military centers exist in Romania (although these are generally aging facilities), which might be utilized as centers of defense research. Biology (BSC) could also offer a good axis around which to develop collaborative research both within these countries and with the West.

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NATO Organizations and Initiatives

As both a NATO and EU member, Romania has access to all R&T defense initiatives launched by NATO and the EU. Some NATO-related initiatives are also available to Ukraine and Moldova. In this section we will discuss programs of each type.

NATO Research and Technology Organization (RTO)

The NATO Research and Technology Organization (RTO) was created in 1998, taking up management control of all former R&T activities. Directions are given by the Research and Technology Board (RTB), currently chaired by France. Actions are supported by the R&T agency. RTO delivers a knowledge and information base for NATO and the nations, allowing leverage of national R&T efforts.

[50] As was performed for instance for the Software Radio Programme.

The NATO RTO also actively pursues defense R&T cooperation with NATO's Partnership for Peace (PfP) Partners, including the Russian Federation and Ukraine. Twenty-three non-NATO nations are participating in the PfP program (including Moldova and Ukraine). The Euro-Atlantic Partnership Work Programme (EAPWP) lists all activities offered by NATO for participation to PfP nations, including all RTO activities open to PfP nations. EAPWP activities are, in principle, open to all PfP nations. The relation between NATO and Ukraine is based on the Charter on a Distinctive Partnership. Implementation of the provisions of the Charter is overseen by NATO-Ukraine Commission. Defense R&T cooperation between NATO and Ukraine also takes place in the framework of the EAPWP.

NATO Science for Peace and Security (SPS)

NATO has another program designed to support practical cooperation in civil sciences and innovation in the three countries of interest in this paper, known as the Science for Peace and Security (SPS) program. The aim of the SPS program is to "contribute to security, stability and solidarity among nations, by applying the best technical expertise to problem-solving. Collaboration, networking and capacity-building are means used to accomplish this end. A further aim is to facilitate continued democratic growth and support economic development in NATO's partner countries."(51)

Ultimately the SPS committee advises the Council and other NATO bodies as appropriate. The committee provides a "unique forum for the sharing of knowledge and experience on technical, scientific and policy aspects of social and environmental matters in both the civilian and military sectors among NATO and EAPC partner countries."(52) The SPS program includes activities funded directly by NATO, as well as nationally funded SPS activities. In the former case, the activities are based on either applications submitted by individual specialists, or on proposals developed by the SPS Secretariat or the Advisory Panels. In the latter case, they are based on proposals submitted by nations.(53) Although proposals for nationally-funded activities reflect the prerogatives of the sponsoring nations, the SPS committee determines whether such proposals should be conducted within the framework of the SPS.(54)

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(51) NATO, "Science for Peace and Security", http://www.nato.int/science/about_sps/introduction.htm, November 12, 2008.
(52) *Ibid*.
(53) *Ibid*.
(54) NATO, "Science for Peace and Security," http://www.nato.int/science/nationally_funded_activities/guidelines.htm, February 25, 2009.

The following examples show the scope of SPS involvement with countries that are a part of this study. Ukraine has been fully engaged in SPS since 1991, with 781 Ukrainian scientists (an increase since April of 2008 of 22) having had a leading role with responsibility for a team of experts in SPS-funded activities. Moldova has been involved in SPS since 1994 with 63 Moldovan scientists having had a leading role with responsibility for a team of experts in SPS-funded activities. NATO should continue the SPS program, increasing emphasis in Moldova to allow them to be more fully integrated as Ukraine.

United States Organizations and Initiatives

Another source for collaboration support to the Eastern European R&T community is the U.S. Civilian Research & Development Foundation (CRDF). CRDF is a nonprofit organization authorized by Congress and established in 1995 by the National Science Foundation. Their vision is to promote peace and prosperity through international science collaboration, using grants, technical resources, and training. Based in Arlington, Virginia, CRDF has offices in Moscow and St. Petersburg, Russia, Keiv, Ukraine and Astana, Kazakhstan. The CRDF mission has four main goals:

- Provide cooperative research and development (R&D) opportunities that enable scientists and engineers to address critical security, economic, education and other societal needs.
- Advance peace and prosperity by funding civilian research and development projects that contribute to global nonproliferation objectives.
- Promote the application of science and technology to economic growth through international partnerships and training that foster invention, innovation, entrepreneurship and the commercialization of technology.
- Strengthen university research and education in science and engineering.

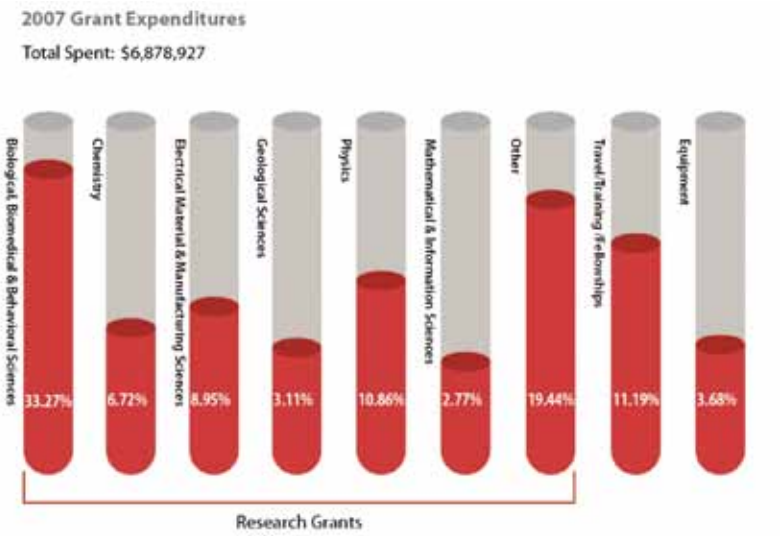
In its first ten years of operation, CRDF made more than 3,000 awards and implemented 1,000 grant projects, totaling almost $240 million and involving over 25,000 scientists. Although Romania has not yet participated in the programs, Ukraine and Moldova have been active participants. Since 1996, CRDF has awarded 560 grants to Ukraine involving over 1,600 researchers, and has committed over $11 million. In cooperation with the CRDF, the Ukrainian government has also

Civilian Research & Development Foundation Participation Locations

committed more than $1.8 million to further support the projects. Regarding Moldova, the CRDF has awarded 165 grants to over 600 Moldovan scientists, for a total of over $7 million, which the Moldovan government has provided an additional $1 million. The CRDF field office located in Kiev, Ukraine, provides an administrative and logistics support to assist the projects. The projects with these two countries cover a variety of areas, to include travel support, travel support, collaborative R&D, and major equipment purchases.

Inter-Governmental Organizations and Initiatives

Inter-governmental organizations such as ICST (International Center for Science and Technology) and STCU (Science and Technology Center in Ukraine) were created in 1993 and dedicated to the prevention of the proliferation of expertise related to weapons of mass destruction (WMD). These organizations aim at assisting former WMD scientists or technologists of former Soviet Republics in the transition to self-supporting, peaceful activities in the international science and business communities. Private companies and government agencies from the EU, U.S., and Canada have used ICST and STCU to manage and to fund several hundreds of R&D projects.



Civilian Research & Development Foundation 2007 Research Grants

The main tool used by ICST and STCU to promote the funding of proposed new R&T projects and to identify new partnership opportunities appears to be their websites, where former Soviet Republics labs and universities propose new ideas and projects (web portals). Nevertheless, the scope of these projects is limited to purely civilian applications (non-military and non dual-use). This situation leads ICST and STCU to refuse many potential new projects whose applications would be in defense or security fields. A possible solution could be to permit NATO RTO to create a similar web portal open to both NATO and PfP members.

Upstream and Downstream Developments

Other initiatives and recommendations can be envisaged in order to develop both downstream (TRL > 4) and upstream (TRL < 2) R&T collaboration opportunities with Eastern European countries. With respect to downstream opportunities, it is necessary to involve large western transnational defense companies. These companies are currently searching for new markets, and Eastern European countries are for them a unique opportunity. These nations are currently equipped with aging former USSR weapon systems, and look for replacement programs based on Western standards (security and interoperability needs). However, they also

desire to have significant levels of involvement of their own local industry, defense labs, and universities. As such, they cannot be considered as purely export market opportunities, but more in the future as emerging cooperative program partners.

The governmental and intergovernmental initiatives recommended previously should lead to downstream efforts between Western transnational defense groups and a network of companies, labs, and universities located in Eastern European countries and involved in defense or dual use activities. Eventually, long-term partnerships are possible, with common product developments and integrated program teams. These efforts could be supported both by governmental (EDA, EU, NATO…) networking initiatives and by dedicated exchanges structures on web portals.

With respect to upstream opportunities, it appears useful to promote exchanges between high-level scientific communities in order to identify partnership opportunities at very early stages in areas of fundamental research. A relevant framework would be to promote contacts between National Academies of Sciences of Western countries and Eastern European countries.

Recommendations: Technical Research Collaboration

Based on the discussion in this section, five recommendations are offered in the realm of technical research initiatives to help further the development of collaboration between the West and Eastern European scientists and technologists.

Recommendation #8

Focus for now R&T collaboration initiatives on TRL 2 to 4 to identify new opportunities for engaging former Eastern Europe countries scientific communities.

Recommendation #9

Take advantage of the planned EDA defense R&T workshop to:

1) provide Romania and former Eastern Bloc countries with a shared approach to reliable supply of their defense industrial base, based upon mutual interdependency, and focusing on establishing new defense R&T efforts to avoid duplications
2) analyze the possibility of creating a network of defense research centers in Europe involving Eastern European labs

Recommendation #10

Emphasize a dual-use (civilian/military) approach for future projects to support Romania and Eastern European countries in building their own defense R&T and industry capabilities in relation to western European countries, looking for complementary R&T domains. Support this dual approach with joint EDA/EC efforts in the framework of the 7th and 8th PCRD.

Recommendation #11

Propose that the NATO RTO create a defense and security web portal open to all NATO and PfP member countries (including former Soviet Republics like Ukraine and Moldova), to allow the respective countries' organisations (labs, universities, companies) to propose new defense and security R&T projects, and search for new partnership and funding opportunities (similar to the one used by ICST and STCU websites, which are limited to purely civilian applications).

Recommendation #12

As far as TRL > 4 are concerned, promote downstream R§T cooperation opportunities between Western defense transnational companies and Eastern European countries companies, labs and universities

- through support provided by networking initiatives launched by governmental initiatives
- through dedicated exchanges structures (for instance secured extranet) in the frame of defense projects web portals

Social Networking and Collaboration

Thus far in the chapter "Strategy For S&T Collaboration", the strategy for S&T collaboration with Eastern European scientists and technologists has focused on traditional educational initiatives and technical research initiatives. This final section presents material related to the cutting-edge arena of social networking methodologies, and the potential of this domain as an enabling mechanism to transform international S&T collaboration.

New Opportunities in a "Flat World"

Anne-Marie Slaughter, Dean of the Woodrow Wilson School of Public and International Affairs at Princeton University, stated in a recent article, "We live in a networked world" and in this world, "the measure of power is connectedness."[55] As was seen during the success of the Obama campaign and his use of social networking tools such as Facebook and MySpace during the 2008 campaign, the use of on-line technology has made the world much smaller, more interconnected, and poised to bring diverse cultures and ideas together in a way never before experienced. Although the speed of thought is faster, digital technologies have simplified the basic need of humans to interact, socialize and communicate; social networking and social networking analysis is really nothing new.

Caroline Wagner, lead research scientist at George Washington University's Center for International Science and Technology Policy in Washington, D.C., and senior policy analyst at SRI International, says "the present-day system by which scientists work together may be thought of as a 'new invisible college,' an updated version of a 17th century model. At that time, European scientists, who mostly worked alone, exchanged ideas and discoveries among themselves by post, constituting what they called the 'Invisible College.'"[56] This statement is refreshing to those comfortable in the new world of on-line living and social networking and heresy to the established higher educational institutions with walls, windows, and legions of educational staffs who have kept knowledge walled in for thousands of years and only shared that knowledge among those privileged enough to be born to a certain socio-economic class.

With the development of the internet and the Web 2.0 tools, information has spilled out of the cloistered worlds of scientific research, mathematics and medicine. With the power of the internet and new technology, information that once was only available to a small group of scientists and researchers now is easily available to anyone with connectivity to the net. This phenomenon places global knowledge at the fingertips of academics, but also lay people throughout the world without the confines of the traditional research methods and networks.

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[55] Anne-Marie Slaughter, "America's Edge: power in the Networked Century", Foreign Affairs, vol 88 Issue 1, Jan/Feb 09, p94-113.

[56] http://www.aaas.org/news/releases/2008/0116stls_wagner.shtml, Author Caroline Wagner Urges More Inclusive Global Science Cooperation.

Fundamentals of Social Networking

The Lexicon of Social Networking

Wikipedia, perhaps the ultimate social networking site for information, best describes the terms "social network" and "social network analysis."

. A social network is a social structure made of nodes (which are generally individuals or organizations) that are tied by one or more specific types of interdependency, such as values, visions, ideas, financial exchange, friendship, sexual relationships, kinship, dislike, conflict or trade.
. Social network analysis views social relationships in terms of nodes and ties. Nodes are the individual actors within the networks, and ties are the relationships between the actors.[57]

In its simplest form, a social network is a map of all of the relevant ties between the nodes being studied. The network can also be used to determine the social capital of individual actors. These concepts are often displayed in a social network diagram, where nodes are the points and ties are the lines.[58] In the past, the academic study of networks mainly concentrated on mathematics or relational linkages in science to discern commonalities in symptoms or disease. With the world now connected via the web, sharing information is easier than ever, and occurs at an alarming rate of data exchange; the social aspects of networking have become a new phenomenon and a place where science and technology can benefit.

On-Line Social Networking Demographics

There are hundreds of social networking sites worldwide; the most commonly used for social interaction are MySpace, Habbo and FACEBOOK. The number of users is estimated between 150 million and 250 million people worldwide on each site with numbers continually increasing. The estimated number of social networks is over 250 with a combined user base of over 1.5 billion people.[59]

[57] Social Network, http://en.wikipedia.org/wiki/Social_network, accessed May 2009.
[58] http://en.wikipedia.org/wiki/Social_network#Social_network_analysis 15 March 2009.
[59] Social Network Service, http://en.wikipedia.org/wiki/Social_network_service.

United States Social Network Age Demographics Adoption

As seen in the figure above, in the United States the age demographics of social network users shows a preponderance of "millenials", or those between the age of 18 and 29, with a growing market in the 30-39 as well as in the 12-17 categories. With the increase in wealth and the growth of the middle class, the numbers that now use technology and subscribe to on-line memberships will most likely continue to rise. The U.S. age demographics shown are likely consistent with other parts of the world, considering that the youth generally embrace technology faster than other groups.

Social Network Sites and the Six Degrees of Separation Theory

The "small world problem", also known as the six degrees of separation theory, deals with the assertion that anyone can reach anybody in the world within six relationships. This theory was made popular with the Kevin Bacon game that was started in Hollywood.[60] The basic theory states that even though there are over six billion people on the planet, any of us can reach any one in six steps. American sociologist, Stanley Milgram experimentally studied this theory in 1967[61] and it was verified by Duncan Watts through experiments and mathematical models and concluded six degrees was accurate in this phenomenon.

[60] Duncan J. Watts, "Six Degrees: The Science of a Connected Age", (New York, Norton & Company: 2003), p93.
[61] Stanley Milgram, "The Small World Problem", Psychology Today 2, (1967), 56-63.

Milgram's theory was built on the paradox that most people's friends are also friends of each other (clustering), and there are always interconnections between different "clusters" of friends that makes it possible to know anyone in the world in six easy steps. In 1973, Sociologist, Mark Granovetter found that interconnections are made possible through the existence of "weak ties" or casual acquaintances. He argued that clusters of friends with few weak ties had a small probability of getting in touch with other groups and thus, a small chance of having any effect outside of their circle (for social or political purposes for example).[62] His work was analyzed and confronted with other experimental studies and in 1983, he complemented his theory and singled out the role of specific weak ties that act as "bridges between network segments."[63]

Using Social Networking for S&T Collaboration in Eastern Europe

Applying Social Networking Theory to S&T Collaboration

Milgram's theory is an important foundation for proving the utility of "on-line" international S&T collaboration. It points to the possibility that social networking has the means to capture the necessary information exchange required to collaborate in the areas of science and technology, and that such collaboration is thus within reach of anyone with access to the internet. Social networking in the scientific community is not a new phenomenon, scientists have been aware of the "company they keep" and the groups in which they belong and what the internet has done is take the same dynamics that occurred in small cities and campuses and has now facilitated collaboration on a global scale.

Ronald Reagan said during his speech in Berlin in 1987, "Mr. Gorbachev, open this gate! Mr. Gorbachev, tear down this wall!"[64] Never would he have envisioned a world where walls are no longer a barrier to thought. The internet has provided global access to more knowledge than any one educational institution could possibly hold within their stacks of books and libraries; what the worldwide web has provided is an environment where a person can be self-taught and be on par

[62] Mark Granovetter, "The Strength of Weak Ties" ,The American Journal of Sociology, Vol. 78, No. 6. (May, 1973), pp. 1360-1380.

[63] Granovetter Mark, "The Strength of Weak Ties:a Network Theory Revisited", Sociological Theory, Volume 1 (1983), pp. 201-233.

[64] President Ronald Reagan, Remarks on East-West Relations at the Brandenburg Gate in West Belin, June 12, 1987, http://www.reagan.utexas.edu/archives/speeches/1987/061287d.htm, accessed May 2009.

with the most coveted degrees from the most prestigious educational institutions. The worldwide web has enabled the disadvantaged and disenfranchised the same access to knowledge and thought as the most advanced thinkers of our day.

Through the internet, Eastern European nations, such as Moldova, Ukraine, and Romania have the same opportunities to integrate with the global research community in the near future. Caroline Wagner states, 'the organization of scientific research is changing in fundamental ways. Self-organizing networks that span the globe are the most notable feature of science today. These networks constitute an invisible college of researchers: scientists who collaborate not because they are told to but because they want to, not because they work in the same laboratory or even in the same field but because they have complementary insight, data, or skills. Networks can take on the role of institutions in some parts of the world that do not have a long history of building scientific infrastructure."[65]

New software tools are available to determine the structure and analyze the density of information exchange in networks. This information is important to the researcher to identify the organization of scientific networks and links between universities and among researchers. This information is a continuation of the human instinct to be among those most popular in a network. With this information, the researcher can determine the domains of excellence between and among laboratories and their targeted areas of research. As in the analogy of the school cafeteria, this initial level of information can be used to determine to what group or clique the researcher wants to belong. With this information, the key players, or hubs can easily be recognized so that the researcher can target a link and using the six degrees of separation theory, can make contact.

Researchers can also take advantage of online resources such as wikis and e-learning forums[66] and weblogs to share information, to discuss findings and engage discussion. Wikis (web-based sites to share text or graphical information) can be used to build a clearinghouse of common areas of research in addition to social bookmarking (rating of websites according to their relevance and interest).

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[65] Caroline Wagner presentation on dynamic self-organizing networks in higher education, http://www.huliq.com/50808/caroline-wagner-presents-dynamic-selforganizing-networks-higher-education.

[66] Robin Mason and Frank Rennie, E-Learning and social Networking Handbook, (New York, Routledge: 2008), chapter 4, "the tools in practice".

Challenges to Social Networking S&T Collaboration in Eastern Europe

Generally, with a few exceptions, the information technology infrastructure of Eastern Europe is far behind that of the West. Where such infrastructure does exist in Eastern Europe, it tends to be in wealthy areas that cater to Western business or tourists. However, even in those areas the standards may be well below a typical Western environment. While this poses a challenge to immediate progress in network-based S&T collaboration, it also provides opportunity for investment, development and training.

There is a good chance for the East to learn from the West and to skip several steps in the developmental process. One example of this would be the rapid adaptation of cell phone use in developing areas. Many individuals' "first" phone is a cell or mobile phone. Given the existing technology, it is faster, easier and cheaper to install a cellular network than to run a complete copper landline system. As regions of Eastern Europe progress, they may choose to go straight to wireless service over a traditional land phone line based system.

Access to the internet is vital to the future educational development of any nation. As a tool for gathering information, leaning about news, access to government services or perhaps most importantly educational resources, internet access is vital. In the early stages of information technology development in a country access is limited to elites, often high-level governmental individuals, research centers, foreign industry, and technological elite. Development from there spreads more widely to public institutions (libraries and schools/universities) and public access points (internet cafes). Finally, internet access expands to small businesses and individual homes.

As important as the existence of access is the actual type of access. While in initial stages, dial-up access may be the norm, dial-up as a primary means of access is quickly surpassed in today's high bandwidth society. For effective access to modern content and educational material, broadband access is essential. The transfer rate of dial-up cannot support more than simple point-to-point basic email. Broadband is needed to support point-to-point video, download of course content and materials, and with the new website designs, even simple browsing may require a high-speed connection. The speed of the connection is more important that the means of delivery. Delivery can be DSL based, fiber optic or wireless (such as Wi-Fi or 3G).

Of the three nations under study, Romania is the only nation that is a current member of the European Union. Given that status, Romania has access to funding and resources not available to the other countries. However, Romania has yet to fully benefit from this process. Of the nations of the European Union, Romania ranks last in Internet-Broadband connectivity with only 13% of households having this access. This is compared to Western Europe with France at 57% and Netherlands at 74% (citation: Eurostat). It ranked 61st of 127 Nations in the The Networked Readiness Index 2007–2008 rankings at http://www.weforum.org/pdf/gitr/2008/Rankings.pdf.

The situation is even more challenging in Ukraine, which ranked 70th of the 127 nations in network readiness. It has one of the lowest bandwidth per 10,000 inhabitants and less than five computers per 100 population. This can be compared to 76/100 and 57/100 in US and France. Clearly, there is a lack of even the most basic equipment in much of Eastern Europe.

As dismal as the situation in Romania and Ukraine may appear, it is better than the Moldovan situation. Moldova ranked among the lowest level in Europe. Only about 10% of the population has any access to the internet and of that 10%, 50% have access only at work. Home access is around 3.5% of the population.[67] Moldova ranked 96th of 127 countries in network readiness.

The statistics cited clearly show an important first step to improving education must be improving communication linkages. In many transitioning countries, communication is limited the poor quality of national information technology infrastructure. Operating costs and a lack of end-user equipment (computers, peripheral devices, etc.) further exclude many from fully joining the information age. The good news is that these problems are technically simple, and the benefits are immediate and profound. As with the proverb about teaching a man to fish, working to improve communication capacity provides the fishing pole (or better "the net") to Eastern Europe. Once they have the "net", opportunities can more rapidly develop. Examples of programs which would immediately benefit from development programs in this area would be distance-learning in US/EU schools, video teleconference participation in international conferences and forums, access to standardized testing, and access to language training. Such access also allows for reduced travel and transportation expenditures.

[67] Moldovan Internet User Habits, Ministry of Justice of the Republic of Moldova [internet] [cited 20 March 2009] Available from: www.cmb.md/igf/files/Moldova%20Users%20Habits.pdf

Recommendations: Social Networking and Collaboration

Based on the discussion in this section, two recommendations are offered in the realm of social networking initiatives to help further the development of collaboration between the West and Eastern European scientists and technologists.

Recommendation #13

Support the rapid and widespread development of information technology infrastructure in Eastern Europe. Target existing technologies for installation, especially those technologies that are able to provide rapid broadband access to remote areas with limited infrastructure, such as satellite-based internet. Fund significant numbers of wireless capable laptop computers in universities and schools.

Recommendation #14

Use social networking analysis tools to identify key players in selected scientific or business domains targeted for collaboration. Search Alumni data bases from Eastern European institutions of higher learning, or government laboratory personnel data bases. Investigate which technology leaders in Eastern European nations have already had contact with Western institutions or individuals. Cultivate those nascent social networking ties, then use local presence to physically contact those scientists to attempt to establish further collaboration according to the exchange strategy.

Since the end of the Cold War, many organizations and institutions have worked to develop mutually beneficial science and technology collaboration between the historic western Euro-Atlantic alliance and the nations of Eastern Europe. Yet today, the scientists and technologists of Eastern Europe, despite their tremendous talents and capacity to contribute to their home countries and to global development at large, often see limited opportunity for contribution to S&T activities.

In this report, the students from the French Centre for Higher Armament Studies (CHEAr) and the United States Industrial College of the Armed Forces (ICAF) analyzed the following essential question through a joint research project:

Concerning the future of scientists and technologists in Eastern Europe, what is the best approach to improving "in place" support to the scientific and technological communities to enhance regional security?

Our analysis of Romania, Ukraine and Moldova as representative examples of the broader reality of Eastern Europe indicates each nation has a significantly different capacity for overall forward progress. Nonetheless, all the nations demonstrate strong potential for collaboration in science and technology with the West. The findings of this report indicate that the broad keys to success in this endeavor are in the following overarching recommendations:

RESOURCE

Make rapid and widespread information technology (IT) infrastructure development in Eastern Europe the number one priority of Western investment activities. This is the principle catalyst for progress in all other areas of S&T collaboration and technical advances.

Finance the "final mile" to allow broadband access to the general public and all educational institutes, K-12+

Finance initial distribution of wireless capable computers to jump-start utilization and access.

COORDINATE

Establish a "Team of Leaders" to aggressively pursue coordination between and expand upon existing initiatives for S&T collaboration between the US/EU/NATO and the Eastern European technical community:

. Team of Leaders coordinates numerous existing initiatives and links available opportunities via web-based cooperative workspace (web 2.0)

. Coordinate expanded funding for armament related or dual use projects to leverage existing civilian R&D investments.

The idea to establish a "team of leaders" is not an attempt to establish yet another organization or international employment agency. It is simply a method to quickly establish a short-term working group to initialize the required structure of organization. The expansion and funding will favor defense armament projects that are at TRL 2-4.

ACTION

. Support the establishment of special development zones
. Similar to "duty free" economic zones, establish business development zones with special legal and regulatory statues to encourage development.
. Include direct funding provisions, protection of intellectual rights and anticorruption measures in these zones.
. Set up incentives for early stage micro funding to support emerging companies and new technologies related to defense needs.
. Coordinate fiscal advantages for western defense enterprises who invest in Eastern Europe.

Some of the areas identified as examples of technologies or recourses for development would be laser, plasma, radiation physics, fiber optics and aerospace. Our research and interviews have made it evident that these are areas where peer level work can be accomplished. They are also areas that are either military or dual use. It is this type of development and skills sets that benefit western powers in the development of Eastern Europe. It creates a mutual dependency that leads to stability. These highlight the reasons why this cooperation can be so mutually beneficial. The West can improve its research capacities at a lower cost, while the East continues to build their infrastructure for important technology improving its Economy and stability. Both of these contribute to western defense, regional stability and provide for enhanced security. Mutual dependence leads to stability and security.

ACTION

"In Place" development, Reverse the flow of students to the West
. Exchange professors vice students. Bring the mountain to Mohamed.
. Establish links with US/EU business schools to utilize Eastern European regions as projects, exchanges, and case studies.

A constant worry of the east has been the evident brain drain to the west. This started as early as post-WWII when the allies and the Russians scrambled to obtain Germany rocket scientist and other engineers. It was somewhat repeated post-Cold War with the break up of the former Soviet Union. Nations attempted to lure away the "best and the brightest" for either business reasons or in some cases

security reasons. Much of the antinuclear proliferation was aimed at reemployment of former weapons makers. Like wise many regions of the world, not just Eastern Europe, have seen a flow of students to the highly developed countries and less of a return of educated citizens. Once exposed to the increased resources, opportunity and higher living standard the idea of returning to a second or third tier country was unappealing.

We hope to stem this flow, partially with the previous initiatives, but also with efforts to concentrate on exchanges of educators and the building of partnerships that encourage development in place. The classic line of teaching someone to fish rather than giving them a fish to eat comes to mind. By focusing on the professors, we can multiply the effect much faster than the education of individual students. Short exchanges, one to three semesters would be sufficient to acquire knowledge but not so long as to establish long terms roots difficult to break. In particular, developing economies offer prime areas for students to apply basic techniques, develop models and expand on their learning. The fixed, existing structures of the west can also stifle new ideas and new methods. This may again provide a win/win situation where the east gets fresh ideas and trained students and the west gets improved economic and regional security.

It is evident from our joint work that this is a complex issue to develop, much less solve. It has also been made clear, in the numerous interviews and readings, of just how key this sector of the world is to stability and peace. As highlighted recent in events in Georgia, this is a region that continues to rapidly involve and exactly what their future is remains unclear. This is exactly why we have studied this region. There is a window of opportunity. How long will this window remain? Other global studies, of other areas, point to the rise in power of China in Africa. Africa was never before a traditional sphere of influence for China. But times have changed, as have world interest and needs. What other nations, what other power have intents on Eastern Europe? It is not clear. Will Russia allow this region to continue to shift to the west? Will Russia oppose NATO membership for Ukraine? EU membership? Will Eastern nations unite or spilt apart?

What we do know is that we have the resources, the opportunity and the ability to influence how this occurs. We have them now. We can shape the future of the scientist and technologist of Eastern Europe. What it required then is the political

will to act and do so rapidly. We believe we have set forth here a short list of simple yet powerful policy options that can be immediately implemented to take immediate effect. They will be successful at improving the security of Eastern Europe, the security of Western Europe and contribute to better lives for all. We encourage you to not just read them, but to act. It is in our mutual interest to create the mutual dependencies that act to assure our mutual security. We can help achieve the goals of increased security in Eastern Europe and lessen the burden on western defense institutions. It requires a few simple programs and a modest outlay of capital. We can set the future for the scientist and technologist of Eastern Europe. All we must do is act.

APPENDICES

Country Information: Romania

Population:	22,215,421 (2009e)
Ethnic groups:	Romanian 89.5%, Hungarian 6.6%, Roma 2.5%, Ukrainian 0.3%, German 0.3%, Russian 0.2%, Turkish 0.2%, other 0.4% (2002 census)
Religions:	Eastern Orthodox 86.8%, Protestant 7.5%, Roman Catholic 4.7%
Languages:	Romanian 91% (official), Hungarian 6.7%
Currency:	Romanian lei (RON)
Literacy: (age 15 and over can read and write)	Total population : 97.3% (2002) male: 98.4% female: 96.3%

The principalities of Walachia and Moldavia - for centuries under the suzerainty of the Turkish Ottoman Empire - secured their autonomy in 1856; they united in 1859 and a few years later adopted the new name of Romania. The country gained recognition of its independence in 1878. It joined the Allied Powers in World War I. Following the conflict, the autonomous province of Transylvania joined Romania in 1918 after a controversial vote of an auto designated assembly.

In 1940, Romania allied with the Axis powers participated in the 1941 German invasion of the USSR. Three years later, overrun by the Soviets, Romania signed an armistice. The post-war Soviet occupation led to the formation of a Communist "people's republic" in 1947 and the abdication of the king.

The decades-long rule of Dictator Nicolae Ceausescu, who took power in 1965, and his Securitate police state became increasingly oppressive and draconian through the 1980s. Ceausescu was overthrown and executed in late 1989. Romania

joined NATO in March of 2004 and completed accession talks with the European Union (EU) in December 2004, becoming a full member of the EU on January 1st, 2007.

Chief of State: President Traian BASESCU (since 20 December 2004); note - President Traian BASESCU was suspended by vote of parliament on 19 April 2007, but resumed his duties on 23 May 2007 after a popular referendum confirmed that his impeachment should not stand.

Head of Government: Prime Minister Emil BOC (since 22 December 2008) Cabinet: Council of Ministers appointed by the prime minister.

Election Results: Percent of vote - Traian BASESCU 51.23%, Adrian NASTASE 48.77%.

Economy-overview

Romania began the transition from a centralized socialist economy to a free market oriented economy in 1989 with a largely obsolete industrial base and a pattern of output unsuited to the country's needs.

The country emerged in 2000 from a punishing three-year recession, thanks to strong demand in EU export markets. Despite the global slowdown in 2001-02, strong domestic activity in construction, agriculture, and consumption have kept GDP growth above 4%. An IMF standby agreement, signed in 2001, has been accompanied by slow but palpable gains in privatization, deficit reduction, and the curbing of inflation. The IMF Board approved Romania's completion of the standby agreement in October 2003, the first time Romania has successfully concluded an IMF agreement since the 1989 revolution.

In July 2004, the executive board of the IMF approved a 24-month standby agreement for $367 million. IMF concerns about Romania's tax policy and budget deficit led to a breakdown of this agreement in 2005. In the past, the IMF has criticized the government's fiscal, wage, and monetary policies. Meanwhile, macroeconomic gains have only recently started to spur creation of a middle class and address Romania's widespread poverty, while corruption and red tape continue to handicap the business environment.

Romanian government confidence in continuing disinflation was underscored by its currency revaluation in 2005, making 10,000 "old" lei equal 1 "new" leu.

GDP	$271.2 billion (2008 est.)	GDP composition per sector:	Agriculture Industry Services	8.1% 36% 55.9%
GDP per capita	$12,200 (2008 est.)	Labor force – by occupation:	Agriculture Industry Services	29.7% 23.2% 47.1%
GDP real growth rate:	7.6% (2008 est.)		Unemployment rate	3.6% (2008)
Industrial production growth rate	8% (2008 est.)		Population below poverty line	20.8% (2006)
Inflation	7.8% (2008 est.)			

Agriculture – products	Wheat, corn, barley, sugar beets, sunflower seed, potatoes, grapes; eggs, sheep.
Industries:	Electric machinery and equipment, textiles and footwear, light machinery and auto assembly, mining, timber, construction materials, metallurgy, chemicals, food processing, petroleum refining.
Exports – partners:	Italy 17.2%, Germany 16.9%, France 7.7%, Turkey 7%, Hungary 5.6%, UK 4.1% (2007)
Imports – partners:	Germany 17.2%, Italy 12.8%, Hungary 6.9%, Russia 6.3%, France 6.2%, Turkey 5.4%, Austria 4.8% (2007)
Military branches:	Land Forces, Naval Forces, Romanian Air Force (Fortele Aeriene Romane, FAR), Special Operations
Military service age and obligations:	18 years of age, voluntary, 5 years months duration until age 36
Military expenditures:	$4.6B

Country Information: Ukraine

Population:	45,700,395 (2009 est)
Ethnic groups:	Ukrainian 77.8%, Russian 17.3%, Belarusian 0.6%, Moldovan 0.5%, Crimean Tatar 0.5%, Bulgarian 0.4%, Hungarian 0.3%, Romanian 0.3%, Polish 0.3%, Jewish 0.2%, other 1.8% (2001 census)
Religions:	Orthodox - Kyiv Patriarchate 50.4%, Orthodox - Moscow Patriarchate 26.1%, Greek Catholic 8%, other 15.5% (2006 est.)
Languages:	Ukrainian (official) 67%, Russian 24%
Currency:	Ukrainian Hryvnia (UAH)
Literacy: (age 15 and over can read and write)	Total population : 99.4% (2001) male: 99.7% female: 98.2%

Ukraine is situated in the Eastern Europe, bordering the Black Sea, between Poland, Romania, and Moldova in the west and Russia in the east. Ukraine is at the boundary of the European Union (Poland, Romania) and a founding country of the Commonwealth of Independent States (CIS). Its position is balancing between Eastern and Western communities: Ukraine did not ratify the charter of CIS, is considering cutting its funding to CIS and is a candidate to join NATO.

At 603,700 square kilometers and 2,782 kilometers of coasts, Ukraine is the world's 44th-largest country. It is the second largest European country (after European Russia and before metropolitan France).

Chief of State: President Viktor A. Yushchenko (since 23 January 2005)

Head of Government: Prime Minister Yuliya Tymoshenko (since 18 December 2007); First Deputy Prime Minister Oleksandr Turchynov (since 18 December 2007); Deputy Prime Ministers Hryhoriy Nemyrya and Ivan Vasyunyk (since 18 December 2007)

Cabinet: Cabinet of Ministers selected by the prime minister; the only exceptions are the foreign and defense ministers, who are chosen by the president

Election Results: Viktor Yushchenko elected president; percent of vote - Viktor Yushchenko 52%, Viktor Yanukovych 44.2%

Economy-overview

The Ukraine economy was the second largest in the Soviet Union, with important industrial and agricultural components. With the collapse of the Soviet system, the country moved to a market economy. After several years of hyperinflation, the prices stabilized after the introduction of new currency, the hryvnia, in 1996. The transition process was difficult for the majority of the population. Today, Ukraine is ranked 29th in the world and estimated at $337 billion GDP. The World Bank classifies Ukraine as a middle-income state. Significant issues are underdeveloped infrastructure and transportation, corruption and bureaucracy. Ukraine is suffering from international and Russia crisis.

GDP	$337 billion (2008 est.)	GDP composition per sector:	Agriculture Industry Services	9.3% 31.7% 58.9%
GDP per capita	$6,900 (2008 est.)	Labor force by occupation:	Agriculture Industry Services	19.4% 24.2% 56.4%
GDP real growth rate:	2.1% (2008 est.)		Unemployment rate	3% (2008)
Industrial produc-tion growth rate	5% (2008 est.)		Household income or consumption by percentage share:	low 10% 3.4%, high 10% 25.7% (2006)
Inflation	25% (2008 est.)			

Agriculture – products	Grain, sugar beets, sunflower seeds, vegetables; beef, milk
Industries:	Coal, electric power, ferrous and nonferrous metals, machinery and transport equipment, chemicals, food processing (especially sugar)
Exports – partners:	Russia 23.3%, Turkey 7.9%, Italy 5.8% (2007)
Imports – partners:	Russia 23.9%, Germany 11.8%, China 8.5%, Poland 8.1%, Turkmenistan 5.4% (2007)
Military branches:	Ukrainian Armed forces more than 190 000 people
Military service age and obligations:	18-25 years of age, compulsory, 18 months duration
Military expenditures:	$4.7B. Ukraine has to renew its armament and the related industry.

Country Information: Moldova

Population:	4.424.450 (2008)
Ethnic groups:	Moldavians 76%, Romanians 2.2%, Ukrainians 8.4%, Russians 5.9%, Gagaouzians 4.4% (Turkish dialect-speaking group), Bulgarians 1.9%, other 1.3% (2004)
Religions:	Eastern Orthodox Christians represent 90% of the population
Languages:	Moldavian (Romanian) and Russian
Currency:	Moldavian Leu
Literacy: (age 15 and over can read and write)	Total population : 99.1% (2005) male : 99.7% female : 98.6%

The Moldavian (or Moldovan in Romanian) Republic roots date back to the 14th century when it was the eastern part of the Romanian principality (current Romania). Most of the country was annexed by Russia in 1812; the territory was named Bessarabia. In 1918, Bessarabia joined Romania and in 1924, the Autonomous Moldavian Soviet Socialist Republic was created within USSR. In 1940, Romania let the Moldavian and Ukrainian Soviet Republics have Bessarabia, then during WWII, it got back under the Romanian authority to get back again in the Soviet Union the following year. In 1990, it declared its sovereignty and its independence in 1991. In early 1994, the first free legislative elections took place, it joined the Commonwealth of Independent Status (C.I.S.) to remain free of Romania, and it also joined the European Council the same year and adopted its new Constitution. During 1998's elections, the communist party is back, it reached the parliament majority in 2001, Vladimir Voronin was elected president in 2001. But in 1992, the eastern and Russian part of the newborn country (at the east of the Dniester River and along the Russian border), called Transnistria, had declared its "independence" (which is also the industrial heart of Moldavia implying a potential conflict). Transnistria has been let apart but the Russian President Dimitri Medvedev will not recognize its independence (2008). It still exist a deep ditch between Russian and Romanian speaking communities, the first one refusing to speak Romanian which is the unique

official language in Moldavia. The problematic –geopolitically wise- is clearly not the same as in Georgia. Furthermore, Transnistria is known as a platform for drugs, arms and human (prostitution) traffic. Notably, the Moldavian Republic is actually the poorest country in Europe.

Chief of State: President Vladimir Voronin (since April 4, 2001 ; second term ; next election June 2009) , elected by Parliament requiring the support of three fifths of the deputies.

Head of Government: Prime Minister Zinaida Greceanîi (since March 31, 2008).

Parliament: 101 seats, members elected by popular vote on party lists every four years. The main political parties are : the Party of Communists of the Republic of Moldova (PCRM) (50% voters), the Alliance Our Moldova, the Democratic Party and the Christian-Democratic People's Party.

Election Results (last vote 5th of April 2009): winning 49.9% of the vote, the Party of Communists of the Republic of Moldova gained 71 of the 101 Parliament seats.

Economy-overview:

After the break up of the Soviet Union in 1991, energy shortages contributed to sharp production declines. As part of an ambitious economic liberalization effort, Moldova introduced a convertible currency, liberalized all prices, stopped issuing preferential credits to state enterprises, backed steady land privatization, removed export controls, and liberalized interest rates. Recent trends indicate that the Communist government intends to reverse some of these policies, recollectivising lands and placing more restrictions on private business. The economy returned to positive growth, of 2.1% in 2000 and 6.1% in 2001. Growth remained strong in 2007 (6%).

Moldavian's economy is essentially made of farming, and is economically dependent of Russia and Ukraine. During the Soviet Union era, electricity and electronics industries were strong but have nearly disappeared nowadays since Moldavia's independence.

The Moldavian Republic is the poorest country in Europe. W.T.O. (World Trade Organization) member since 2001. Also an I.M.F. (International Monetary Fund) member despite its political side. Foreign economic aid received in 2005: $ 191.8 M. The annual inflation is of 12.6% (2007 est.)

GDP	$9.756 G (2007)	GDP composition per sector:	Agriculture Industry Services	17.8% 21.7% 60.5%
GDP per capita	$2.897 (2007 est.	Labor force by occupation:	Agriculture Industry Services	40.7% 12.1% 47.2%
GDP real growth rate:	3 % (2007 est.)		Unemployment rate	7.3% (2007) 2.1% (2008).
Industrial produc-tion growth rate	1% (2007 est.)		Population below poverty line	29.5% (2005 est.)
Inflation	12,6% (2007 est.)			

Agriculture products	Vegetables, fruits, wine, cereals, turnsole seeds, tobacco, meat, milk. Limited illegal drugs production (opium and cannabis)
Industries:	Sugar, alimentary products, farming machines, melting steel pieces, refrigerators, freezers, washing machines, shoes, textiles &
Exports partners:	Russia 20.8%, Romania 13.9%, Italia 10.7%, Ukraine 9.3%, Germany 9%, Poland 6.7%, Byelorussia 4.5% (2006 est.)
Imports partners:	Russia 20%, Ukraine 15.8%, Romania 15%, Italia 5.7%, Germany 8.89%, Poland 4.1%,
Military branches:	Ground army (4500 + 15000 in war time)
Militia (2000) belonging to the MoD	
Air Force (1100)	
Military service age and obligations:	18 years of age, compulsory, 12 months duration
Military expenditures:	$150M, has very small armed forces.

Eastern European Educational Statistics

Variable	Ukraine	Moldova
Quality of math and science education	4.59	4.25
Quality of the educational system	3.97	3.40
Internet access in schools	3.16	2.94
Mobile telephone subscribers*	106.72	32.38
Personal computers*	4.61	8.28
Broadband Internet subscribers*	1.37	0.52
Internet users*	12.06	17.35
Internet bandwidth*	0.18	1.35

Variable	France	Romania
Quality of math and science education	5.71	5.37
Quality of the educational system	4.78	3.74
Internet access in schools	5.05	3.82
Mobile telephone subscribers*	85.08	80.45
Personal computers*	57.86	12.96
Broadband Internet subscribers*	20.91	8.18
Internet users*	49.57	32.36
Internet bandwidth*	33.06	15.03

Variable	United States	Canada
Quality of math and science education	4.54	5.21
Quality of the educational system	5.09	5.28
Internet access in schools	5.84	5.83
Mobile telephone subscribers*	77.40	52.51
Personal computers*	76.22	87.31
Broadband Internet subscribers*	19.31	23.57
Internet users*	69.10	67.89
Internet bandwidth*	33.06	67.34

Potential S&T Collaboration between US Army and Romanian Scientists

As part of the Acquisition Policy elective objectives, the students (with faculty guidance), focused on how to foster strategic innovation, collaboration, cooperation and possibly implement research and technology policy with Eastern European Scientists. As part of this effort, in October 2008 we visited the Polytechnic University of Bucharest and the Military Technical academy in order to gather information regarding their R&D efforts and the potential for future cooperation and collaboration with the US Department of Defense (DoD).

As part of this effort, and after months of coordination, the students of the Acquisition Policy elective of the Industrial College of the Armed Forces (ICAF) were able to establish a visit by the United States Army Research and Development Command (RDECOM), International Technology Center (ITC) located in London, England.

Prior to this visit, the ITC office informed the Romanian Delegation that the scope of the visit will be in accordance with the Office of the Secretary of Defense (OSD) Director of Defense Research & Engineering (DDR&E) Strategic Plan.

The ITC office visited the Romanian capital of Bucharest and received a thorough brief of the current Romanian Science & Technology initiatives by Mr. Iulian Fota, Ministry State Secretary for Science and Technology at the Cotroceni Presidential Palace. The briefings included sessions on Optoelectronics, Physics, Nanotechnology, and a brief from the National Institute of Lasers in research efforts being conducted in various areas. In addition, the group received a brief from industry and academia.

At the conclusion of the meetings, the ITC and the Romanian workgroup explored the potential for additional cooperative R&D efforts in areas of mutual benefit to Romania and the US. Further actions of this initiative will be properly coordinated between the ITC and Romanian counterparts.

Additional Details on Social Networking

In the past, the study of networks mainly concentrated on mathematics or relational linkages in science. With the world now connected via the web, sharing information is easier than ever before and at an ever increasing rate, the social aspects of networking has become a new phenomenon and where research in science and technology can benefit. The new technology has made information so pervasive that knowledge can no longer be contained within campus walls or within laboratory gates.

The dynamics of social networks

Another key feature of social networks that was closely analyzed was their dynamics and how they worked in relationships. Indeed, social networks cannot be studied only through a static description of relationships between people or groups of people, networks have to be described by their structure and by the nature of the relationship between their members. It is of key importance to identify the influential players such as the information brokers and the people acting as bridges. The evolution of the network also has to be considered, or in other words, the making and breaking of ties.

The most difficult parameter to analyze in a network involve the dynamics within the network, such as what kind of information is exchanged, who the most influential members are, and how information flows. With the recent rise in the usage of social networks and most notably their usage by terrorists groups, such as prior to the September 11, 2001 attacks, the United States Department of Defense has increased interest in the use of commercial social networks by studying human interactions and network interactions via the web.(68) One of the studies conducted by the DOD, compared the importance of organizational network analysis and social network analysis and concluded that social interactions are crucial in networking and that this has important consequences in decision-making and management of those networks.

(68) Tom Edison, "Social Networking Analysis: One of The First Steps in Net-Centric Operations", Defense Acquisition Review Journal, (Alexandria VA, Defense Acquisition University Press: 2005), http://www.au.af.mil/au/awc/awcgate/dau/edison_au-gnov05.pdf

Research Communities

Researchers have analyzed on-line social networking in an attempt to determine whether the conditions of communities of researchers could be improved with on-line social networking. Because a large part of research includes collaboration of ideas and information sharing, the web can now offer researchers a place to confirm their research or find avenues of extensions for their research in a global market.[69] According to these findings, academic networks possess three properties, whether in a campus setting or on-line. These three properties include a community structure with a strong role of social interaction, clustering and small world effects.

The research found that in order for networks to be successfully understood, one needed to understand the community structure or the simple relationship structure of the group. The structure provides the information such as who communicates with whom or who co-authors papers with whom in the given field of study. This is basic data and can be compared to walking into the cafeteria on the first day of school; when the new kid immediately has access to the information of who is friends with whom and who share their cookies with whom. This information is the initial data set when studying any groups as they interact with each other.

The clustering property is the level of connectedness between nodes or people within the network. The higher the network is clustered, the higher the density of relations is within the group. As a result, "the probability that scientists will collaborate increases with the numbers of collaborators they have in common." The last property, the small-world effect, which has already been discussed is that all people are within six degrees of each other in the largest network the world.

Another key component in the understanding of networks is the importance of hubs within the network. Carolan and Natriello describe the importance of "hubs" as the key nodes that facilitate the spread of information on the network to gain the maximum reachability of information sharing. These hubs are like the town gossip, who makes it their business to ensure everyone in the town knows what they know, whether they are on the inside of the network or on the far reaching ends of the network.

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[69] Brian V. Carolan and Gary Natriello, Data-Mining Journals and Books: Using the Science of Networks to Uncover the Structure of the Educational Research Community, Research News and Comment, April 2005.

New threats with social networks

With their ease of use, social networks are also attractive for bad-intentioned people. The lack of privacy is often the primary concern of users of these. In most cases, the user only has to provide an e-mail address to be a member of a network and thus is becomes privileged to personal information, such as spouse s names, children s names, places and dates of birth. Therefore, the use of social networks for personal and professional usage must rely on strong security measures and information awareness training. The choice to use closed networks, accessible only by invitation might be an option, however in this ever expanding on-line universe, most collaborations will likely move toward openness instead of back toward a closed model.

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