2 CASE-STUDY 1 – OPEN INNOVATION

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In this and the next two Chapters we explore new and promising areas for cooperation in the defense and security domain in more detail through three case studies. In these case studies we explain how a few non-defense and security actors are taking advantage of new forms of cooperation to pursue their objective(s); describe to what extent our NDOs are already investing in these areas; and explore the advantages and disadvantages for NDOs to invest more in these areas.

These case studies constitute examples that might be helpful in systematic thinking about various models of cooperation for the type of large organizations that NDOs constitute. The examples were selected based primarily on their relevance for NDOs and the availability of information. Another factor was the genuine novelty of these forms of collaboration that did not exist until widespread adoption of the internet. NDOs can borrow some successful innovation practices from private companies and learn important lessons with regard to challenges and barriers in implementing open innovation.

2.1 WHAT IS OPEN INNOVATION

Despite the fact that there is no common definition of "innovation", it can generically be described as the process of creating value through idea development. In one of the earlier definitions, innovation was defined as "the generation, acceptance and implementation of new ideas, processes, products or services."[13] Baragheh et al. (2009) have pointed out that the definition of innovation has until now remained a discipline-specific process.[14]

Whatever its precise definition, innovation is crucial in today's quickly changing world. In order to stay competitive in the global marketplace, companies have to constantly develop better products, services, business models, or processes. Previously, companies relied predominantly on their internal resources, such as research and

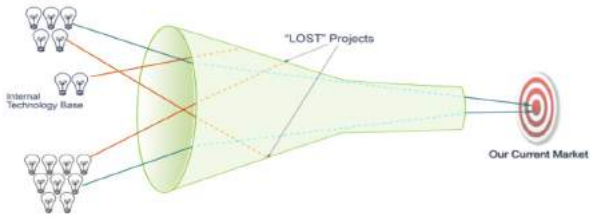

FIGURE 1: CLOSED INNOVATION. SOURCE: EIDON LAB, 2011.

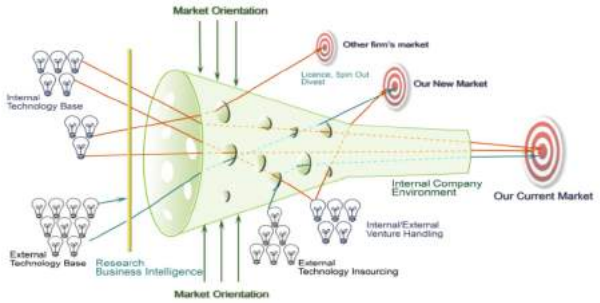

FIGURE 2: OPEN INNOVATION. SOURCE: EIDON LAB, 2011.

development (R&D) facilities and staff, to develop new ideas into viable products and services ("closed innovation", see Figure 1).[15] However, in the last two decades many companies have been actively pursuing increased involvement of external parties in their innovation processes. The concept that firms should look "outwards" for ideas and knowledge from a broad range of outside sources instead of just "inwards" is known as "open innovation". The term open innovation was introduced and popularized by Henry Chesbrough, professor at the University of California, in particular in his book *Open Innovation: The New Imperative for Creating and Profiting from Technology* (2003).

The idea behind open innovation is not particularly new. The academic science has always been an example of open (albeit traditionally fairly slow) innovation: collaboration between various researchers has been a norm and the results of research have been broadly shared via seminars, academic journals, the internet, etc. In the corporate world, customers, competitors, and suppliers have been an important but, most often, informal source of new ideas for a long time. R&D collaboration between the private sector and universities and applied science institutes (such as the

Netherlands Organisation for Applied Scientific Research, TNO) has been growing since the end of World War Two (WW2). However, most companies still see innovation to a great extent as a proprietary, closely guarded process, collaborating only with a small number of carefully selected organizations.

In contrast, open innovation relies on collaboration with a much larger pool of actors than was previously the case, including small companies, ad hoc informal groups, or individuals (see Figure 2 and Table 1).[16] It often involves ceding important decisions about the content of products to these networks of external participants. For this reason, some authors see open innovation as "democratized" innovation.[17]

"CLOSED" INNOVATION VIEWPOINT	"OPEN" INNOVATION VIEWPOINT
Nobody can know what we are innovating	Nobody can know the confidential ideas that we are working on
Spending more on internal R&D will improve our market position and help us to grow	"Smart" innovators engage with the global innovation community and reap the highest returns
First-to-patent = highest profit	First-to-market = highest profit
We need more R&D staff to close our knowledge gaps	We need our R&D staff focused on our core competencies, allowing outside solution providers to provide the rest

TABLE1: CLOSED VS. OPEN INNOVATION. SOURCE: EIDON LAB, 2011.[18]

Open innovation is a relatively new term and its exact characteristics are still debated. It may, at least, partially overlap with other similar terms such as user innovation, mass innovation, distributed innovation, crowdsourcing, etc. There are no clear boundaries between these terms.

2.2 WHY OPEN INNOVATION?

"No matter who you are, most of the smartest people work for someone else" – this phrase is attributed to Bill Joy, co-founder of Sun Microsystems, and it became known as Joy's law in the high-tech industry.[19] It describes the basic fact that for all organizations, relevant information and expertise residing outside an organization's boundaries significantly exceed those inside the organization.

Private companies have always been interested in accessing external sources of knowledge by using various forms of cooperation such as alliances, joint ventures, licensing agreements, and other means. Typically, these forms of cooperation focused on a careful selection of the limited number of organizations (or experts) that would

have the necessary resources or expertise, and included extensive negotiations between the parties involved and detailed legal contracts. The development of information and communication technology in recent decades and, in particular, the widespread availability of the internet have drastically reduced the costs of communication and created opportunities for radically disruptive forms of collaborative knowledge production. For instance, people with interesting ideas residing outside professional networks can now easily share them through blogs and other simple web tools. Wiki-style web sites, cloud-based platforms, social networks and similar tools enable large numbers of participants located in various parts of the world to work simultaneously on the same subject. The decline of long-term (for life) employment and the growing mobility of labor, in particular of highly-educated people, was another factor contributing to a wider distribution of knowledge.[20]

Technological and societal changes made open innovation possible and facilitated its adoption. But large organizations, especially business firms, have to see significant practical benefits in order to use this radically different approach to innovation. The potential benefits are numerous and might differ depending on a particular form of collaboration. In general, the major advantages of open innovation can be listed as follows:

- It provides an opportunity to access new sources of ideas and expertise. It stimulates the reuse of knowledge developed (and paid for) elsewhere, in what is called "knowledge circulation" within and across between different knowledge and application areas.[21]
- It might increase the speed with which an innovation track can be initiated and completed.
- It offers higher flexibility and responsiveness. Drawing on a much large source of potential collaborators, both quantitative (more experts) and qualitative (different experts) scaling can be achieved on a case-by-case basis.
- It might be less expensive. Outsiders might be cheaper than the full cost of insiders – similar to the cost benefits of outsourcing. Furthermore, payment might be contingent on meeting a set of requirements.
- It might increase the quality of a product. Involving a large number of people at much earlier stages in its development helps to remove errors and improve weak points, e.g. open source software, beta testing of software by companies such as Microsoft, crowdfunding, etc.).
- By involving users in its development, a product can be better tailored to users' need and requirements.

2.3 FORMS OF COOPERATION

In order to understand open innovation better, it is helpful to use a framework to organize various forms of collaboration taking place in this area. One framework that is simple and practical is provided by Pisano and Verganti (2008).[22] It lists four collaboration modes based on two parameters: the type of governance – hierarchical or flat (who makes decisions), and participation openness – whether anyone can participate or if there is a selection mechanism (see Table 2).

	INNOVATION MALL	**INNOVATION COMMUNITY**	Participation
	A place where a company can post a problem, anyone can propose a solution, and the company chooses the solution it likes the best	A network where anybody can post problems, offer solutions, and decide which solutions to use	Open
	ELITE CIRCLE	**CONSORTIUM**	
	A select group of participants chosen by a company that also defines the problem and picks the solution	A private group of participants that jointly select problems, decides how to conduct work, and choose solutions	Closed
Governance	Hierarchical	Flat	

TABLE 2: FOUR COLLABORATION MODELS. SOURCE: PISANO AND VERGANTI, 2008.[23]

Traditional forms of cooperation in the private sector in the science and technology field have used the closed mode of cooperation. Companies would carefully select potential partners based on a variety of factors: possession of a particular technology or capability, strategic fit, preemption of competition, and other factors. Most often, cooperation was also characterized by the hierarchical type of governance. One partner (such as a system integrator, e.g. Boeing in aircraft development) would be in charge and take key decisions.

The opposite of this traditional mode of cooperation are communities with open participation and flat governance. The most well-known examples of such a mode of cooperation are loose communities of programmers working on the development and improvement of open source software (OSS) such as Linux, Apache, Mozilla, and others. Between these two extremes there are two mixed models combining flat governance with closed participation ("Consortium" mode) and hierarchical governance with open participation ("Innovation Mall" mode). Examples of the former are consortiums that are often created for the promotion of a particular standard or technology (such as The DVD Forum, the Wi-Fi Alliance, or the Grand Alliance for the HDTV standard). The "Innovation Mall" mode is probably the most popular among companies engaging in open innovation and we consider a few examples in detail below.

Before considering specific examples we should note the important role that web-based tools play in enabling and facilitating open innovation involving a large number of participants that are spread out geographically. They take many different forms and are often called "open innovation platforms". Stoetzel et al.[24] classify open innovation platforms into four main clusters using two dimensions: platform purpose and platform operator (see Table 3).

PLATFORM PURPOSE				
	Understand Customers	Dell Ideastorm	Getsatisfaction	Identify customers ideas and needs
		Starbucks Idea	Suggestionbox	Customers can discuss and vote for ideas
		Ideas.nagios.org	Pleasefixtheiphone	No monetary incentive
		Preideas.com	Foursquare on Getsatisfaction	
		Easyjet on Getsatisfaction		
	Find Solutions	Cisco I-Prize	InnoCentive	Specific problem or challenge to be solved
		YTL myprize	NineSigma	Typically expert knowledge required
		Doritos crash the superbowl	Bootb	Monetary incentive for best solutions
			Idea-Bounty	
			Crowdspirit	
		Company	3rd party	
		PLATFORM OPERATOR		

TABLE 3: OPEN INNOVATION PLATFORMS. SOURCE: STOETZEL ET AL., 2011.[25]

Their classification lists platform examples for each cluster (it should be remembered that the study did not aim at the whole spectrum of open innovation platforms excluding, for example, business-to-business platforms or platforms with closed participation).

2.4 INNOCENTIVE

We here analyze a particular open innovation platform, InnoCentive, in greater detail. InnoCentive is an online platform for crowdsourcing innovative ideas and solutions to various challenges facing businesses, nonprofit organizations, or government

agencies. Challenges posted on the InnoCentive website deal with a broad range of issues such as computer science, chemistry, physical sciences, agriculture, and entrepreneurship. The company was founded in 2001 and is headquartered in Waltham, Massachusetts in the United States (US). It is home to a community of over 365,000 from nearly 200 countries that stand ready to help organizations devise innovative solutions to the challenges they face.[26]

This section of the report analyzes the InnoCentive platform in greater detail, listing the advantages and disadvantages of pursuing open innovation through this platform, and assessing its potential applicability to NDOs.

2.4.1 HISTORY

InnoCentive is the brainchild of a senior executive of Eli Lilly, a major American pharmaceutical company with over 40,000 employees all over the world and almost $20 billion in yearly net sales. Eli Lilly is one of only 3 US companies that consistently outperformed its industry competitors for more than 50 years.[27] In 2000, Eli Lilly's vice-president for R&D, Alph Bingham, had an idea that would radically innovate and transform the R&D process. Bingham's idea evolved around the notion that internal R&D processes are not able to capture the full potential of innovation. External innovators, even when working in unrelated fields, have the ability to provide innovative solutions that are not immediately considered by a firm. He emphasized the importance of being close enough to the field to understand the technical requirements but not so close that you are biased by the way those immersed in the problem tend to think.[28] Bingham thus decided to launch what is now known as InnoCentive: an online platform that matches organizations that are "solution seekers" with a wide array of potential "problem solvers". Firms facing specific R&D challenges can publish these on the InnoCentive website along with a prize award for those who are successful in solving the particular issue.

2.4.2 HOW DOES INNOCENTIVE WORK?

By connecting "seekers" and "solvers", InnoCentive tries to foster an environment of innovation in order to improve problem solving productivity.[29] By partnering with InnoCentive, organizations get access to InnoCentive's diverse solver community. The InnoCentive platform as such serves as an innovation hub that connects organizations that face a particular challenge and are searching for an innovative solution with individuals or organizations that have registered on the InnoCentive website and are attempting to find a solution to these challenges.[30] Today, the InnoCentive solver community has grown to more than 365,000 registered solvers from over 200

countries. Challenges are posted by corporations, governmental, and non-governmental organizations as well as a variety of other actors. For example, InnoCentive has partnered up with pharmaceutical companies such as AstraZeneca, governmental organizations such as NASA, and even with the US Department of Defense. Through dedicated innovation pavilions, partners can post their challenges to the public or they can decide to post challenges anonymously.

Depending on the challenge, InnoCentive and the seeker sign a terms of use agreement that defines the legal obligations of both parties to each other as well as those of the seeker organization to the solvers. Through this agreement, the solver's rights are protected. In addition, solvers are obliged to sign a specific terms of use agreement depending on the challenge.[31] In addition, both InnoCentive and the seeker organization work together in developing the challenges and formulating the problem statements. This is done through the InnoCentive Client Services Team (CST), which works not only with the Seeker organization but also with the solvers who might have questions related to the challenge. The CST is also able to work with organizations in case they need to post anonymous challenges in a way that would disguise the type of industry as well as the real nature of the posted challenge.[32]

InnoCentive offers a variety of products and services to its seeker organizations. The main products are the InnoCentive Challenge Programs, the InnoCentive@work software, and the InnoCentive Idea Management (IC IM) software. Depending on the specific innovation needs of the organization, it chooses to cooperate with InnoCentive on using one or more of the InnoCentive platforms. Through the InnoCentive Challenge programs, seeker organizations post their challenges on the InnoCentive website. There are several types of Challenges, such as the Ideation Challenge, Brainstorm Challenge, Reduction to Practice (RTP) Challenge, or the Theoretical Challenge and Electronic Request for Proposal (eRFP) Challenge. Organizations choose a certain challenge type based on their specific needs and requirements.

Organizations that are in need of a novel and creative idea and are still in the first stages of product development can opt for an Ideation or a Brainstorm Challenge. Both seek to provide a breakthrough idea or a creative solution to a problem; whereas the former is closed in format, the latter represents an open version of the former where solvers can interact with each other. In RTP Challenges, solvers have to present a successful prototype and prove that it works within the parameters and needs set by the organization. Theoretical Challenges constitute the same as RTP challenges, only they fall short of actually coming up with a prototype. They bring the idea closer

to an actual product or solution by giving a detailed theoretical explanation on why their solution will serve the organization best. In case a seeker organization is looking for a partner who has already developed a certain technology or has enough expertise to help develop it, then eRFP Challenges would be best suited for the organization.

The relation between the Seeker, Solver, and InnoCentive is determined on the basis of the Challenge type through the Terms of Use, the Challenge Specific Agreement (CSA), and other related documents. Through the CSA, which InnoCentive devises in collaboration with the Seeker organization, each challenge has different mechanisms regarding payment, dispute resolution, Intellectual Property (IP) transfer rights, etc. In most challenges, for instance, only InnoCentive and the Seeker are allowed to view the proposed solutions. However, in Brainstorm Challenges, solutions can be viewed by all participants.[33]

The CSA also decides the process of solution acceptance. In most cases, however, CSAs mention that the acceptance of a particular solution is the absolute and sole discretion of the Seeker and that merely meeting the predetermined minimum challenge requirements does not guarantee acceptance by the seeker.[34] The Brainstorm Challenge Terms of Use also mention that in cases where the seeker fails to notify InnoCentive with the selection of a winner, the latter is automatically chosen by the most votes in the Project Room community.[35] Depending on the challenge type and the CSA, the number of possible winners is determined. While some challenge types such as Theoretical Challenges only involve an award when challenge criteria are met, Brainstorm Challenges are guaranteed at least one winner. Conversely, eRFP Challenges do not involve cash awards but rather let winners negotiate the terms of the contract directly with the Seeker.[36]

Some CSAs specify dispute resolution mechanisms to be followed in case conflicts arise between a solver and InnoCentive. The arbitration procedure is subsequently administered by the American Arbitration Association in accordance with the Commercial Arbitration Rules.[37] In addition, CSAs can include exclusivity periods whereby solvers agree that their solution submission grants the Seeker the exclusive right to acquire the solution.[38] Other CSAs entitle Seekers to use material that has not been chosen as award winning solutions in case the material provided is similar to what a seeker already possesses.[39] To date there has never been an instance in which Seekers were found to have been in breach of IP law. According to InnoCentive, this also has to do with the fact that Solvers have to specifically identify the Seeker that stole their IP. The ability for Seeker organizations to remain anonymous prevents such

a case from occurring.[40] This effectively means that solvers will have less of a chance to know whether their solution has ultimately been used by the organization despite its official rejection. Solvers have little choice but to rely on the goodwill of the seeker organization and on InnoCentive and its technical capabilities to differentiate between successful and unsuccessful solutions.

Besides Challenges, InnoCentive also developed other products through which it could develop its partnerships with seeker organizations. A notable example thereof is the InnoCentive@work platform. The Innocentive@work platform offers partners the ability to incorporate the InnoCentive platform in a secure and cloud-based platform where challenges would only be available to a chosen private set of participants such as the company's employees, partners, or even customers. Organizations such as NASA and Eli Lilly have developed such a platform for their employees in collaboration with InnoCentive.

The InnoCentive Idea Management (IC IM) software is a social platform for idea management that InnoCentive developed in cooperation with NOSCO. It allows organizations to run idea campaigns, collect and share knowledge from employees and selected audiences in a structured way. Employees and invited audiences are then allowed to share their ideas, post comments, photos, and videos in a way that would allow the company to engage its employees and make full use of its idea generation potential.[41] By offering a customized innovation experience to seeker organizations through the InnoCentive@work or IC IM platforms, organizations can maximize the full potential of their employees without risking any of the adverse risks such as knowledge diffusion traditionally related to pursuing an open innovation policy.

In addition to the abovementioned products, InnoCentive also provides consulting and training services to organizations that are looking to invest in open innovation. InnoCentive's ONRAMP (Open iNnovation Rapid Adoption Methods and Practices) program provides training sessions for managers and employees in order to show how to effectively use the full potential offered by open innovation and ensure the success of its implementation.

2.4.3 WHO USES INNOCENTIVE AND WHY?

InnoCentive's platform 'InnoCentive@work' could be a valuable tool to organizations that prefer to operate through a platform that is not entirely open to outsiders. As a case in point, NASA has developed its own internal open innovation platform in collaboration with InnoCentive called NASA@work. NASA@work allowed NASA's

challenge seekers to post challenges that would only be available to NASA employees across its 10 field centers without the risk of knowledge leakage. It also helped in fostering a collaborative environment across NASA's field centers (for more information on how NASA engages in open innovation see 2.5.3).

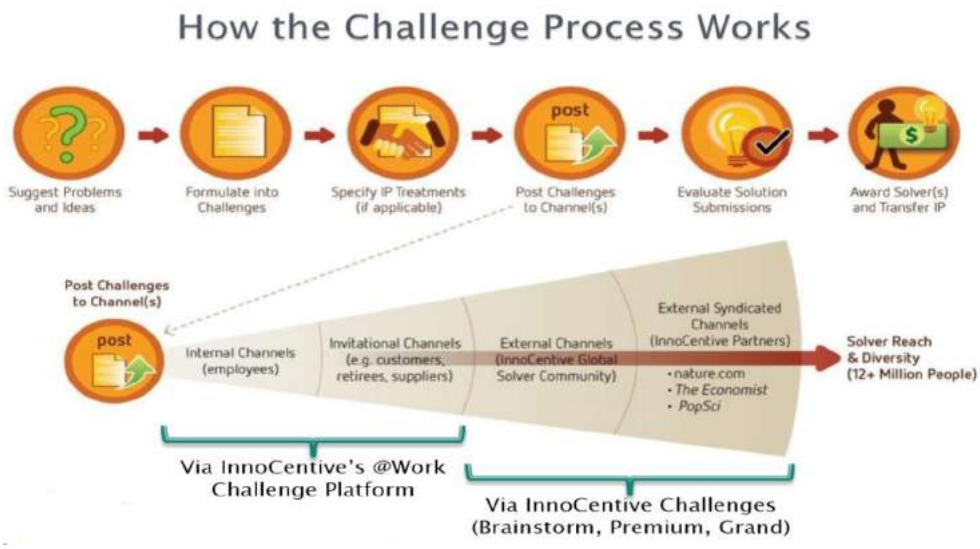

FIGURE 3: THE INNOCENTIVE@WORK TOOL. SOURCE: FRANKLIN, 2013.[42]

Figure 3 shows a schematic overview of how the InnoCentive@work functions and how NASA uses it within the organization. It demonstrates a best-practice approach where NASA challenge seekers initially opt for an internal challenge through NASA@ work in order to either find a solution, or at least fine-tune a challenge topic, and then follow it with an open challenge through one of the external open innovation platforms.

2.4.4 BENEFITS OF USING INNOCENTIVE

The InnoCentive platform can offer substantial returns to corporations looking to invest in open innovation. The costs associated with partnering up with InnoCentive, posting a challenge, and receiving a solution are much lower than the costs associated with traditional modes of R&D. InnoCentive's awards normally range between $5,000 and $1 million, which is a fraction of what is generally spent on a traditional R&D process.[43]

Another reason why organizations would choose to work through InnoCentive is that it broadens the solutions space, including those solutions that would be considered to

be too unorthodox within the organization itself. The speed by which new innovative solutions can be found also serves as a pull factor. By being able to tap into a much larger pool of potential problem solvers, challenges that a company normally spends years on solving through its traditional R&D process can be solved in a matter of months.

Furthermore, making use of InnoCentive fosters an innovative culture, opening up the organization to accepting new ideas and working with external partners. It benefits the employees of the seeker organization by advancing their ability to frame research challenges. Employees are then able to use these new skills in other areas of their work. The organization benefits from a smoother IP transfer process by having InnoCentive deal with any legal issues. This means the organization has more time to work on research and spend less on IP lawyers.[44]

2.4.5 RISKS OF USING INNOCENTIVE

An organization might face a backlash from experimenting with open innovation owing to cultural resistance. Most in-house R&D professionals are used to spending time on challenges and have pride in coming up with their own solutions. This drive is an invaluable asset to an organization. Open innovation as the main innovation mode in an organization would fundamentally change the role of R&D professionals: from problem solvers to problem formulators in search of solution seekers.[45]

Another important issue that has to be dealt with when introducing open innovation practices is knowledge diffusion. Although open innovation allows you to tap into a vast pool of resources, it also exposes the organization in the sense that competitors may know what you are planning and tailor-made solutions can become available to opponents.

2.4.6 RISK MITIGATION

As mentioned in the previous section, InnoCentive limits the risks of knowledge outflow by offering the option of anonymity to the Seeker organization and letting the company decide whether it wishes to reveal its name. InnoCentive also cooperates with the Seeker during the problem formulation process in order to hide the true nature of the problem, as well as the organization's industry. This assures InnoCentive's partners that their competitors, or otherwise unwanted actors, do not get their hands on information that the organization prefers to have under its control.

The development of the InnoCentive@work platform further mitigates the risk of knowledge outflow. Organizations that are hesitant in acquainting the public, and their competitors, with their current problems and knowledge gaps would be able to open up the process as they deem appropriate. By using an invite-only platform, companies can choose who to share their challenges with (employees, customers, or partners), thus minimizing the risk of knowledge outflow.

InnoCentive's partnership with the Seeker organization could also help with the mitigation of internal organizational risks such as cultural resistance. The ONRAMP service and the open innovation workshops provided by InnoCentive to the Seeker organization are available to anyone in the organization, from executives to challenge owners. These workshops aim to ingrain a culture of open innovation into the organization and align the views of stakeholders regarding the importance and benefits of open innovation. This ultimately facilitates a smoother adoption of open innovation practices.

Seeker organizations can also pursue risk mitigation practices. To mitigate the problem of open innovation resistance, NASA's Human Health and Performance Center established the Solution Mechanism Guide (SMG), an online tool developed through another open innovation challenge. The SMG helps employees in selecting a project management approach which would work best given the resources and needs of this specific project.[46] It gives employees the opportunity to use both traditional as well as open innovation tools so that the most efficient mechanism would be recommended. Employees can use the SMG in two main ways. First, the SMG acts as a filtering mechanism. By entering the parameters of a certain problem, the SMG filters the solution mechanisms to meet the criteria. Thus, the employee is better informed about which external or internal platform to use for his challenge. Second, the SMG also acts as an educational and training tool for employees. Through the SMG, employees can view past case studies and user experiences and learn new tips and tricks on using a particular solution mechanism.[47]

The use of a platform such as SMG has several benefits: it improves communication within an organization by speeding up the process of information dissemination; it increases employee awareness regarding the utilization of different solution mechanism tools; it reduces the time needed to solve problems; and it empowers employees. SMG thus contributes to the creation of an organizational culture that is collaborative and amenable to open innovation platforms.[48]

2.5 NEW FORMS OF OPEN(ISH) COOPERATION IN DEFENSE

The processes whereby NDOs define their capability needs and then ensure access to those capabilities remain one of the most difficult – and controversial – aspects of what some call the "defense enterprise". In the past decade – and especially since the advent of austerity – value for money has become one of the foremost battlefronts of defense transformation. "Big A" (the main weapon platforms for sea, land, and air) acquisition has been at the heart of this battle. Many of the problems in this area are fairly well understood.[49] But even the most advanced NDOs (e.g. the United Kingdom and the US) keep struggling to come up with effective solutions.

One of the fundamental problems with the Big A acquisition process in many NDOs lies in the earliest stages when defense requirements are defined. For most of the Cold War, the main drivers of the requirements-setting process were the services NDOs provided: they were responsible for training and equipping the troops. Because of the many fragile political compromises this entailed – both within as well as across the services – nobody really had any incentive to rock the boat. This also meant that the interaction with the outside world (including the private sector) was preferably as closed as possible, with a small number of preferred, strategic partners that could be trusted to stay in the box. The actual permeability of this process to outside influences varied with the particular "political economy" of defense in various countries,[57] but most countries found it extremely difficult to avoid collusion effects.

The past few decades brought three main changes to this situation. The first one was that most NATO countries moved towards a more joint process of defining requirements. This already led to more internal openness. These countries, secondly, also strengthened the walls between the requirement setting stage and the subsequent procurement stages in which tenders are issued, competing offers are assessed and adjudicated, and the actual procurement process is set in motion. The hope was that by sheltering the requirements setting process from untoward influences, the "defense enterprise" would better be able to decide for itself what it really needs, unencumbered by external pressures and/or conflicts of interest. The third major change was that, under pressure of ever more demanding publics and parliaments, the NDOs gradually also became somewhat more transparent in what they divulged about all of these choices.[50] Here, too, the hope was that this increased openness would lead to sounder balance-of-investment choices.[51]

Reality, alas, proved more recalcitrant. The dynamics between the services did not really disappear and the early stages of the requirement setting process became in

some ways even more bureaucratic and (because of its isolation) inward-looking. Rather than going for 'better together (with others)', the process arguably became 'worse alone (amongst ourselves)'. This more insulated approach had two negative consequences. First, outside inputs (and – often – reality checks[52]) were weak or absent. And second, the main players (the services) engaged in even more "logrolling" (trading favors: "I'll give you your pet toy, if you let me have mine"). So whereas the taxpayer was supposed to benefit from these changes, it is far from clear that she did.

A few countries have been trying quite diligently to remedy this unsatisfactory situation. And one of these interesting innovations in this area lies in the very early stages of the Big A acquisition process that we already alluded to as being critically important. The main idea here is to combine some of the strong points of the old system with some of the strong points of a less insular and more open system. Rather than drawing rigid lines between defense and non-defense, these new forms of somewhat more open cooperation between the private and the public sector try to come to a new equilibrium that may stand a better chance of providing the taxpayer with a better value for money proposition. In the very early stages of the process, the – in InnoCentive terms – seekers (in this case Defense) and the solvers (in this case the defense solution providers) jointly try to specify how a certain need could theoretically (pre-competitively) be met. This changes the decision-making dynamics by opening the process up to the outside. It gives Defense the advantage of being able to benefit from the often superior knowledge in the private sector about how problems can be solved in the process of defining the requirement. Based on this pre-competitive, pre-political, pre-bureaucratic stage, Defense can then decide on its own what it wants to do in the next (still sheltered) stage. But it will now, such is the logic, be able to do so on a more informed basis. All of this is not based on backroom deals or old boys networks but rather on a (relatively) level playing field and at least some dispassionate analysis.

To the best of our knowledge, there are three countries that have experimented with this model. The UK, really a trailblazer in acquisition reform,[53] was an early adapter through its "NITEworks" facility, which dates back to 2003 and is still going strong. The distinguishing feature of this new form of cooperation between the private sector and the public defense sector is that it is spearheaded by a national champion (BAe SYSTEMS). In 2005, the Australian NDO stood up RPDE, an Australian facility in Canberra that was inspired by NITEworks. The basic philosophy is the same but the kind of work undertaken is somewhat different as is the way it is set up. With NITEworks, the MOD uses BAe SYSTEMS as a prime to provide the physical

infrastructure and to engage the other organizations through subcontracts. In the case of RPDE, the Australian government provides the infrastructure, seconds an industry executive as the head, and has a contract directly with every member company. RPDE has many more members than NITEworks, including some one-man bands who only work for/at RPDE. In 2007-2010, Canada experimented with a similar model; however, it ultimately failed.

2.5.1 NITEworks (UK)

In 2003, the UK Ministry of Defense launched NITEworks, a partnership initiative that spans the UK defense sector to help improve decision making on requirements setting. As outlined in the 2005 Defense Industrial Strategy, NITEworks "was established to provide an integration and experimental environment to assess the benefits of Network Enabled Capability (NEC) and the options for its effective and timely delivery".[54] However, NITEworks' remit was not strictly limited to NEC since work focused on both the network and information flows. NITEworks received an initial 5-year £47 million Assessment Phase contract, which was renewed in 2008 for another 5 years. In this second contract, the area of interest was widened. MOD specified the following priorities: support to frontline operations, capability improvements, and enhancements and acquisitions decisions. The MOD also had the organization adopt a more competitive business model, attracting funds from across the MOD rather than reliance on a single MOD funding line. Considerable weight was given to achieving value for money.

In addition to the MOD itself, NITEworks consists of twelve UK defense industry companies, as well as more than 130 Associate Organizations. Companies that have capabilities that could be of use to the defense sector can apply for membership. Once accepted, they have access to all partnership communication, workshops, and activities.[55] NITEworks has a core staff of 37, drawn from the military, MOD civil service, the Defense Science and Technology Laboratory (Dstl) and industry.

Working together with defense industry and academia to analyze problems and look for solutions, the MOD claims to be better informed about what the solution space may actually look like and to select solutions that offer excellent value for money. The partnership also allows the MOD to "de-risk and accelerate the provision of military capability."[56]

How does NITEworks actually work? MOD staff can post particular challenges on the NITEworks platform after internal communication with NITEworks' Stakeholder Management Team (SMT). Only challenges where "benefit is gained from the use of a

pan-industry/MOD partnership"[57] can be posted on NITEworks. The SMT then works together with the MOD sponsor[58] to formulate the problem question. This is followed by the development of a business case to finally determine whether the NITEworks platform will be chosen. Subsequently, a role request is issued to NITEworks partners and associates who subsequently apply to join this specific challenge. At the end of the selection process, a small and focused team consisting of defense and industry experts is selected. The team then starts refining and defining the scope of the problem question. The overall process takes on average six to eight months to finalize and deliver the final product.[59] When it comes to IP provisions, the British Crown retains all IP rights and only issues licenses for partners to use the knowledge for the Crown, not for commercial use. Associates can only access an executive summary of the output, not the output itself. However, they can still access work in which they directly participated.[60]

To date, NITEworks projects have dealt with a wide array of fields including logistics and sustainability, increasing open source intelligence capabilities, improving aviation simulation, as well as cybersecurity. In 2010, as part of the Strategic Defense and Security Review, the MOD sought to plan for the future of equipment priority in order to ensure "resources are directed to the most urgent areas."[61] A small NITEworks team was assembled and joined the MOD team tasked with developing the plan. The team suggested novel ways of campaign planning based on a color-coded bullseye chart (see Figure 4) that basically enables employees to "indicate the level of capability available at different points in time."[62]

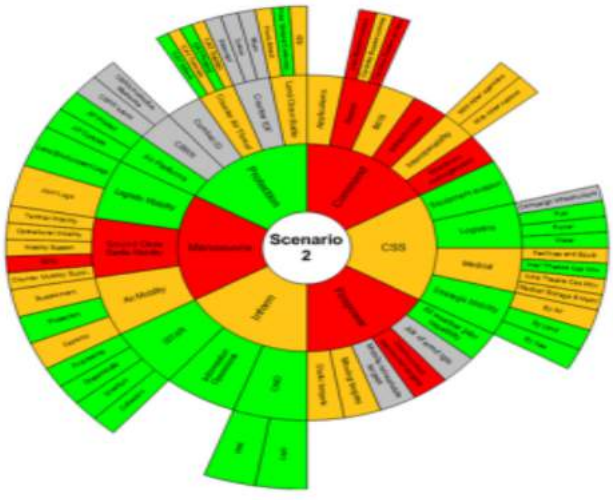

FIGURE 4: COLOR-CODED BULLSEYE CHART. SOURCE: NITEWORKS, 'ARMY EQUIPMENT DEVELOPMENT PLAN (AEDP), 2011.

One of the largest projects ever undertaken by NITEworks is *Talon Strike*, a project aimed at enhancing battlefield interoperability between UK and US forces. After operations in Afghanistan, both countries realized the necessity of seeking more efficient information sharing and shared situational awareness capabilities. Thus, in 2008 a NITEworks team led by the MOD was assembled. In addition to the MOD and Dstl, the team also included NITEworks members such as BMT Hi-Q Sigma, Finmeccanica UK, Fujitsu Services, General Dynamics UK, Northrop Grumman UK, QinetiQ, SyntheSys Systems Engineers, Systematic Software Engineering, Systems Consultants Services, and Thales UK.[63]

NITEworks organized a conference in Farnborough, which was attended by UK and US war fighters. In addition to deciding on the command and control systems to be used during the exercise, the conference narrowed down the focus of the project and specified it to a "shared situational awareness, a common operational picture and a dynamic collaborative planning environment."[64]

NITEworks' task was then to work with the Command and Control Development Centre to develop a set of systems that enable information sharing including positional information, orders, and other information vital for battlefield operations. Based on these results, a two week joint exercise took place between US and UK forces where the latter were accompanied by the NITEworks team in order to aid in operational analysis and other complex technological tasks.[65]

The *Talon Strike* project ultimately led to a reduction in the risk of friendly fire incidents, helped in de-risking future requirements, and proved to the MOD the importance of understanding challenges emanating from interoperability and integration of Command and Control.[66]

The UK MOD's commitment to NITEworks was reconfirmed on July 30th, 2013 with the award of a £17 million, three-year MOD contract,[67] and on September 17, 2015, when the contract was extended until March 31, 2018[68] with the following statement: "the NITEworks approach enables the MOD to rapidly assemble expertise in an impartial environment, with access to prior knowledge and industry Intellectual Property from across the defense community. It brings together knowledge of the problem and solution space which both enables a better understanding of the feasibility of recommendations and allows them to be rigorously tested and challenged from a range of perspectives – blending incumbent knowledge with the fresh thinking of new suppliers – be they generated by SMEs or a global company."

2.5.2 RAPID PROTOTYPING, DEVELOPMENT AND EVALUATION PROGRAM (AUSTRALIA)

Similar to NITEworks, the Rapid Prototyping, Development and Evaluation Program (RPDE) is a partnership program between defense, industry, and academia, developed by the Australian MOD. It specifically deals with complex, high-risk capability problems that have a significant integration component. The solutions sought by RPDE are focused on accelerating the delivery of the Australian Defense Force's (ADF) war fighting capability through collaborating with defense industry and academia to support innovative solutions.

RPDE basically performs two types of activities; Quicklooks and Tasks. As a first step, a Quicklook is done by rapidly assembling a team through RPDE partners who submit a report on a certain defense capability issue usually within a three month timeframe with the aim of providing advice and guidance. Secondly, Tasks aims to deliver a prototyped solution in 12 to 18 months. These solutions could range from reports to proofs of concept or even physical prototypes.[69] Figure 5 shows the lifecycle of RPDE tasks.

FIGURE 5: LIFECYCLE OF RPDE TASKS. SOURCE: RPDE, 2013.[70]

Usually, RPDE Tasks finish at the Solution Development phase. However, in some cases RPDE can provide assistance in the implementation of the solution. As one example, an RPDE team was assembled to develop options for the provision of a digital hydrographic system. During the Solution development phase, the sponsor faced an urgent operational need to develop a Maritime Classified Geospatial Data Management System (MCGDMS). To deal with such an urgent need, the team developed a de-risking proof of concept and subsequently moved to the solution development phase in March 2013. Finally, in December 2014 the required outcome was delivered to the challenge sponsor.[71]

Another successful example was the development of a personnel-borne Improvised Explosive Device (IED) detection device. The Counter Improvised Explosive Device

Task Force (CIEDTF), who the sponsored this Task, was looking for a device that would be able to enhance ADF personal protection in combat zones by detecting whether an individual might be wearing an IED device. In 19 months' time, a successful solution was prototyped and developed. Starting with the Question development phase, the CIEDTF proposed the following problem question: "Can standoff IED detection technology be miniaturized and a concept demonstrator be developed to enhance personal force protection for soldiers from IEDs?" During the Discovery Phase, the task team analyzed worldwide technology related to IED detection capabilities and identified options that could be pursued based on several technological, size, and financial criteria. Subsequently, RPDE issued an Invitation to Register (ITR) to all RPDE participants. Shortlisted candidates were then asked to present their proposals. The proposal provided by Tactical Research Pty Ltd. was accepted, and upon authorization from the One-Star steering group, RPDE entered into a contract with the chosen organization. Through collaboration between RPDE and Tactical Research, a handheld IED detection system was developed and successfully tested in July 2014.[72]

2.5.3 NASA (US)

Open innovation within NASA falls under the Open Government Initiative, which aims to create "a new level of openness and accountability in [NASA's] policies, technology, and overall culture."[73] The latest open government plan emphasizes the encouragement of collaboration and innovation both within the agency itself as well as externally by enabling citizen participation and encouraging partnerships that have economic opportunity potential.[74]

In 2005, NASA launched the Centennial challenge program seeking to offer prizes to individuals and small businesses that successfully solved NASA challenges. A year later, however, NASA faced far-reaching budget reductions. This effectively meant that several ongoing projects were either delayed or scrapped altogether.[75] R&D units inside NASA had to find new innovative and cost-effective practices to mitigate the negative effects of budget cuts. Several reports and strategies were published to that effect including the May 2007 strategy,[76] the Augustine Committee report,[77] and a 2009 benchmark study,[78] all of which emphasized the importance of finding new ways to advance NASA's mission with the limited resources at hand. Historically, NASA relied on internal research and development. The new 2007 strategy, however, emphasized collaboration by developing strategic partnerships both internally with other US government agencies, as well as externally with international partners, academia, and commercial entities. The strategy also aimed to address traditional perceptions inside the organization that did not align with proposed strategic change,

such as risk aversion, civil servant superiority, or the perception that everything can be done by NASA itself.[79]

The outcome of these strategies was the awareness that a new open innovation model had to be introduced within NASA. The Space Life Science Directorate (SLSD) took the lead role and decided to tryout three open innovation platforms, namely InnoCentive, Yet2.com, and TopCoder. Workshops were then designed and given to SLSD members by the three organizations. From 2009 to 2010, 11 R&D units put forward 14 problems on the open innovation platforms. Seven challenges were run on InnoCentive six on yet2.com, and one on TopCoder. The results were beyond expectations as all seven InnoCentive challenges proved either solved or partially solved. Out of the six challenges run through Yet2.com, one provided a novel solution, while the others had either generated ideas that could be incorporated for further development or had helped identify partners with whom NASA could work on solutions. The result of the TopCoder challenge was incorporated into an existing NASA medical database.[80]

In one particular challenge posted on InnoCentive, NASA sought an algorithm that would solve a 30 year old problem concerning data-driven forecasting of solar events. The solution required was supposed to forecast solar events four to 24 hours in advance with a 50% accuracy and a two-sigma confidence interval. Bruce Cragin, a retired radio frequency engineer, was able to find an algorithm that exceeded NASA's expectations. His algorithm was able to predict solar events eight hours in advance with 85% accuracy and a three-sigma confidence interval.[81]

Following the success of the pilot program with the external innovation platforms, NASA decided to build a new internal open innovation platform in collaboration with InnoCentive. This platform, called NASA@work, was similar to InnoCentive but open only to NASA employees. The idea behind it was to capture the full innovation potential of NASA. For NASA, as a large organization with thousands of employees, this meant that a challenge faced by an individual employee in one field center could now be accessed and solved by anyone in the agency without resorting to InnoCentive public Challenges. At the same time this would foster collaboration within the organization, help in team-seeking, and make use of employee diversity.[82]

Through Yet2.com, another online open innovation platform that acts as a technology scout, NASA has been able to find future collaborators that are not immediately on its radar. After NASA posts its technological needs, Yet2.com looks into its worldwide

network of specialists, runs competitions, and finds the most suitable partners from which NASA can subsequently choose who to collaborate with.

This means that NASA has adopted a flexible open innovation strategy. It moves between a closed participation platform such as NASA@work and an open one through InnoCentive and from an open platform – albeit more limited in scope – such as Yet2.com back to a closed one with its chosen collaborators, depending on the stage of the innovation process it finds itself in.

Still, NASA's adoption of open innovation was not without problems. In some cases, NASA's efforts at involving the public through different open innovation platforms found little success. Some Centennial challenges had to be closed without finding a clear winner. This was the case for the Strong Tether Challenge, which sought the development of components related to building a Space Elevator, yet ended up without declaring a winner.[83] The fact that the tether is made out of expensive carbon-nanotube material complicated the task of even finding competitors to enter the challenge; something that was hard to change no matter how high the prize money was.[84] The MoonROx Challenge suffered a similar fate in 2009 after no competitors even registered for the challenge due to its difficulty as well as the absence of any commercial potential. After seeking a way to produce breathable Oxygen from materials commonly found on the moon, the Challenge had to close and the prize of $1 million went unclaimed.[85]

Furthermore, the space agency found that not everyone within the organization viewed the adoption of open innovation positively. Some R&D professionals feared that their identity was threatened by open innovation. They believed that looking for solutions externally meant that they are no longer valued within the organization. There were also those who showed acceptance of open innovation practices, yet were in fact against it. To satisfy their managers, they simply opted for open innovation in strategically unimportant challenges and kept the more important ones for internal consideration. Sometimes, they withheld valuable information gained through open innovation platforms. The traditional identity of a smart problem-solver was thus threatened with the advent of open innovation and the accompanying new identity of a solution seeker. This meant that the perception of NASA as a place that allows its engineers to access, plan, and solve a problem was shattered. In fact, some even saw the idea of looking for external challenge solvers as cheating. This kind of cultural resistance can indeed pose a risk to organizations that view open innovation as a strategic objective.[86] Looking back, Lifschitz-Assaf (2015) found that the external

experts and managers who introduced the concept of open innovation to NASA focused primarily on the time and cost efficiency of the model and overlooked the organizational aspects and the adverse effects on R&D professionals. This in turn exacerbated the perception of identity threat to the employees.

2.6 APPLICABILITY FOR NDOs

Many of the advantages that have brought private companies to embrace the open innovation paradigm also hold for NDOs. Tapping into a (vastly) wider pool of experts than those within immediate reach is essential to maintain a technological edge in a world where ideas and solutions easily spread and western military superiority is no longer a given. Cost efficiency and better value for money are as important for military organizations as for private companies in light of budget constraints and scrutiny over the spending of taxpayers' money. Time efficiency, i.e. faster delivery of innovative solutions to particular problems, is also an issue in the military realm. This holds true in particular for actual missions confronted with an emergent challenge (such as the challenge of detecting improvised explosive devices posed in the Iraq and Afghanistan campaigns). Finally, the fact that embracing open innovation practices contributes to creating and stimulating a culture of innovation – as part of a more general culture of agility – probably also holds true for NDOs.

NDOs traditionally put a high premium on secrecy and have therefore tended to prefer closed modes of innovation. To some, the very notion of open innovation even contradicts the fundamental principles by which NDOs function. It is important to bear in mind, however, that secrecy is not a goal in and of itself. The real goal is to forge an attractive (security) value for money proposition that reliably safeguards the stakeholders' (countries' taxpayers) security at an affordable price. In this sense, NDOs do not differ all that dramatically from their public or private sector counterparts. Protecting one's crown jewels is vitally important to many private companies that may have billions of investments at stake. This is, for instance, the case in the pharmaceutical industry, which nevertheless is increasingly broadening its cooperation portfolio with elements of open innovation.

In this case study, we have particularly looked at InnoCentive as an example of an open innovation platform. The available evidence on InnoCentive illustrates both the first-order potential of such innovation malls and the risk mitigation strategies that both solution seekers and InnoCentive as an organization have resorted to in their interaction. The InnoCentive platform is developed in a way that allows the seeker company not only to post challenges anonymously but also to work with InnoCentive

in order to hide the true nature of the challenge and the industry involved, thus benefiting from open innovation while minimizing the risk of unwanted knowledge outflow.

In addition, there are ways to capture the value of open innovation without risking knowledge outflow, for example by investing in the InnoCentive@work or the IC IM platforms. In big organizations such as NDOs, the number of employees involved is often huge and they are most probably geographically spread out in different branches. The experience of NASA suggests that in such cases, an internal open innovation platform such as NASA@work captures the full potential of innovativeness inside an organization before an external challenge is required. In the case of NDOs, investing in such a platform could prove useful even if it is decided that internal challenges shall not be succeeded by external ones.

Although it is fruitful to mirror NDOs with the corporate world and their respective processes and value chains up to a point, a defense organization is not a business. *In ultimo*, the failure of NDOs to perform in the face of "competitors" may put vital national interests and even the very existence of the state in jeopardy. This is quite different from the workings in the commercial market place, in which the rise and fall of individual companies is part and parcel of a continuous process of creative destruction. Maintaining a competitive edge vis-à-vis (potential) adversaries, particularly for western NDOs that have technological superiority engrained in their modus operandi, is a far cry beyond achieving a temporarily "first market entry" advantage. MODs therefore strive to keep the exact specifications and even performance range of their core capabilities hidden (*"mil specs"*), both to deny possible opponents the same possibilities and to make it more difficult for them to design adequate counter-measures.

In addition, in particular for IT-heavy systems, information security is a crucial issue.[87] Defense organizations need to be fully aware of liabilities and vulnerabilities in their systems. At the same time, this information must be kept secret from potential adversaries as much as possible.

Furthermore, the (existing) military capability portfolio of NDOs is to a large extent built around a limited number of main weapon platforms, such as frigates, tanks, or fighter jets. Such large platforms remain in service for decades without major changes to the platform itself (hull / frame / chassis). This is in contrast to many of the components, which are not only carried as components of the platform but also

increasingly derive their functionality from software. It becomes meaningful to look upon some, possibly many, of these modules as applications that adhere to the much faster pace of IT-innovation. One of the big challenges for NDOs is to combine these dynamics into system integration processes that harness fast innovation at the component level in continuous performance improvement while retaining the structural integrity at the systems or systems-level.[88] Typically, effective system integration requires close corporation between a NDO and a handful of corporate system integrators.

A critical factor for NDOs to be able to unleash open innovation's full potential is to simultaneously organize and promote a process of functional decomposition and functional integration. On the one hand, the functionality of defense systems and processes must be split into clearly distinct modules that have maximal internal consistency and minimal external coupling. The interfaces between these modules, describing their functional interaction, should be standardized and open. Such a decomposition renders it possible to distinguish between core mil spec modules and modules that may be developed and acquired on the open market; furthermore, this allows for describing the latter in terms of their external behavior rather than their internal workings. This is the basis for being able to use the kind of open innovation platforms that InnoCentive exemplifies.

On the other hand, individual modules must also be easily clustered into an integral capability. This system integration is a dynamic process: according to momentary needs, it should be possible to add or withdraw modules in a plug-and-play fashion to generate a custom-made capability best fit to perform the mission at hand. The way in which mobile device owners create their own unique functional environment through the Apple iStore and Google Play platforms gives a vivid image of how functional decomposition (myriads of apps) and integration (clustering apps on a single mobile device, with some apps working closely together with some other apps) can meet.[89]

Finally, there is the issue of cultural resistance to open innovation in general. Defense organizations are known for having a comparatively high degree of resistance to change. Small, relatively inexpensive pilot projects using platforms such as InnoCentive may serve as eye-openers and track record cases to promote open innovation. Again, NASA can serve as an example. To mitigate the problem of open innovation resistance, NASA established the Solution Mechanism Guide (SMG), an online tool developed through another open innovation challenge. SMG helps employees in selecting a project management approach that would work best given the resources and needs of

this specific project.[90] It gives employees the opportunity to use both traditional as well as open innovation tools so that the most efficient mechanism will be recommended.

2.7 PRACTICAL EXAMPLES

US security and defense organizations have been especially interested in pursuing partnerships with InnoCentive. Since InnoCentive started, US governmental agencies have signed a total of nine contracts with InnoCentive worth $6.34 million,[91] with the Department of Defense being the most invested partner. Other NDO partners in the US include the Department of Interior and the Department of Homeland Security.[92] Even the Department of State has launched several Challenges using the InnoCentive website, most notably one relating to innovation in arms control.[93]

In 2013, the Defense Threat Reduction Agency and the US STRATCOM Center for Combating Weapons of Mass Destruction posted a challenge seeking an algorithm to analyze a sample of DNA in a rapid manner to help protect US personnel from bio threats. The winning team of three scientists from Germany and Singapore were able to find an algorithm that reduced this time from weeks to tens of minutes, thus enabling the treatment of personnel in the field.[94]

In addition, the Combating Terrorism Technical Support Office (CTTSO) has its own innovation pavilion on InnoCentive and has given awards to several challenge solvers. In one challenge, the CTTSO sought to address the ineffectiveness of screening out individuals predisposed to violence through a non-invasive method to predict violent behavior within society.[95]

Currently, the use of open innovation malls such as InnoCentive for NDOs seems to be limited to the sub-system level and non-mission critical components. (Better) use of open innovation platforms at this level could well be organized as an integral part of the supply chain of defense system integrators. As NDOs and system integrators gain experience in specifying functionality in a modular fashion, the use of open innovation platforms may multifold and possibly move up from the component level to the system and even system-of-systems level.

For more sensitive components, NASA's experience suggests that semi-open innovation mall mechanisms within a more controlled environment of trusted innovation partners is possible and potentially useful. An important lesson is that open innovation does not necessarily take place in a static form but could be dynamic,

moving between open and closed forms of cooperation. Companies that adopt dynamic open innovation have the ability to maneuver from open to closed forms and vice versa. Some developments in the InnoCentive case also point toward minimizing the risk of unwanted knowledge outflow while retaining the benefits from open innovation. The platform has developed mechanisms to allow the seeker company not only to post challenges anonymously but also to work with InnoCentive in order to hide the true nature of the challenge and the industry involved. An important lesson is that companies that adopt dynamic open innovation have the ability to maneuver from open to closed forms and vice versa. In particular, the closed-open-closed approach that NASA has tested – starting from a closed form of cooperation, followed by an open one, and then back to a closed form – might prove a valid template also for NDOs.

NDOs could also benefit from cooperation with InnoCentive in crisis situations and natural disasters. "Fast track innovation and procurement" processes may serve to fill an immediate operational gap or requirement in the context of ongoing missions. In many instances, an early response is paramount over secrecy, rendering innovation malls a possible instrument of choice. As an example, after the 2010 oil spill in the Gulf of Mexico, InnoCentive ran an emergency response challenge to assist British Petroleum (BP) in the remote sensing of oil and skimming technology. Although BP ultimately decided not to look into InnoCentive's proposals,[96] the ability of the InnoCentive community to address complex technical challenges in the event of natural disasters could potentially be of use to government agencies tasked to deal with their aftermath.