EVALUATION OF CRITICAL AND EMERGING SECURITY TECHNOLOGIES FOR THE ELABORATION OF A STRATEGIC RESEARCH AGENDA

DELIVERABLE D2.1

Intermediate report on critical dependencies

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July 2013

Content

1. Introduction

The objective of WP 2 "Identification of critical dependencies" is to unveil the factors that lead to dependency of the European industries in the security sector, due to patents, trade restrictions, restrictions of contraction, new economic models and shifting production to third countries, long-term research insufficiency, industrial concentration, and other factors.

Building on the List of Critical Technologies (D1.2), offered as an output by WP 1 "Identification of critical technologies", a succession of filters had to be applied in order to end up with a shorter list of technologies in which Europe is dependent. However, this method proved to be inappropriate and encountered the following limitations:

1) The definition of the technologies was varying from specific (e.g. Speech processing technology) to very generic (e.g Software engineering), which made it impossible to apply the same filtering criteria to all technologies. The necessary analysis per technological family introduced a great level of subjectivity and arbitrariness, resulting in the exclusion of technologies deserving more attention;

2) The long list of technologies made it practically impossible to consult in detail every technology and fully explore its possible limitations within the framework of this project;

3) It became apparent that the succession of filters in this context did not ensure real control of the dependencies and would rather lead to loss of valuable information, misinterpretation and possibility of erroneous conclusions;

4) It became obvious that the application of each filtering criterion produces results that are not conclusive and indisputable. There was no explicit evidence that a certain dependence exist or doesn't exist considering furthermore that the term "Critical dependence" was not sufficiently defined for this assessment.

In order to improve the outcome of this WP within the given circumstances it was decided to adapt the initial methodology and follow an updated approach while at the same time respecting the main filtering criteria. Therefore the following adjustments were made:

1) Preparatory research was conducted in order to add security characteristics to the technologies and information about the origin of the leading manufacturers (Complementary Features);

2) The successive analysis of criteria was substituted by a parallel analysis offering in this way a more open and flexible framework for the evaluation;

3) The patent analysis was conducted with two complementing approaches: a narrow focus of ten selected technologies and a broad focus involving all technologies.

2. Preparatory research

The technologies were analysed and categorized as "relevant for security", "possibly relevant for security" and "not relevant for security" based on their importance for the security area. The technologies marked as relevant and possibly relevant were examined in order to reveal their possible application in the security sector, the main suppliers and the country of origin of the leading manufacturers. In more detail, the following steps were undertaken in order to examine the technologies:

1) Identification of possible security applications (short, mid- and long term if applicable)
2) Identification of corresponding sub technologies
3) Identification of scientific challenges, key publications, emerging technology areas and perspectives (if data was available)
4) Identification of the country of the manufacturers
5) Research on details on dual-use application

Example for the methodology applied:

177	119	**Physiology Science & Medical technologies**	
178	119-1	Medical products and materials	E.g access to vaccines in case of pandemi, or rare radioactive isotopes used for specialised medical treatment
179	119-3	Human survivability, protection and stress effects	In case of crisis
180	119-6	Genome Engineering	In case of "designer" infections and diseases
181	119-7	Biomedical technologies	A wide topic, but relevant for protection against disease
182	119-8	Rapid diagnosis of infectious disease	Crisis management
183	119-9	Telemedicine (diagnosis and surgery)	For distributed medical care if society is severly disrupted, but the technology is in its infancy and has only been demonstreated recently. An emerging technology
184	119-10	Novel antiviral, antibiotics, vaccines, and drug development	In case of new infection diseases

The area is too broad

Specific technology: Instruments for Radioactive Isotopes measurement and calculation

In case of crisis. Physical Protection Systems: http://www.gen-4.org/Technology/horizontal/TechAddndm.pdf, Evaluation of proliferation resistance, Safeguardability of Nuclear Facilities, Safeguards-by-Design, Sensitive nuclear materials, Radioactive wastes and other by-products of nuclear power generation, Maritime Shipment of Nuclear Material, Reaction Capabilities (Reaction Capabilities: Chemical: Na, NaBH4,vLiAlH4, vitride, hydrazine etc., Catalytic: Based on noble metals., Oxidation : KMnO4, H2O2, peracetic acid, Alkylation : N,O,C – alkylation under phase transfer conditions, Lithiation : using butyl lithium, Freidelcraft Reactions Fluorination, Grignard Reactions, Condensation Reactions (Base Catalysed), Suzuki Coupling, Diazotisation, Sandmeyer Reactions, Nitration, Chlorination, Bromination, Iodination, etc. Longterm: Survival technology, for example microorganism-mediated production of cellulosic ethanol, the "new biofuel process" (Paley, S. 2008)

Country of the manufacturers?

Low-background coaxial High Precision Germanium detector (Canberra, Aus), Genie-2000 spectroscopy software (Canberra, Aus), Efficiency calibration (Canberra, Aus), Portable spectrometer (Microspec, USA), FH 40GL/GX (Thermo Eberline, USA);

Details on dual-use application

Not found

Although that the information collected through the preparatory research wasn't sufficient to lead to any determinant conclusion for the purposes of the project, it was determinant for the development of the next steps in the WP.

3. Analysis of the regional distribution of patents

Patent data is one of the most detailed and complete data sources for the analysis of technology development with respect to time, country, or technologies. A big advantage of patent records is that this data directly represents technologies, not companies or proxies for technologies. Patent data provide an elaborated classification scheme for these technologies - International Patent Classification (IPC) - which is more detailed than the taxonomies for publications or economic activities. Moreover, patents are the outcome of an innovation process and are, therefore, expected to be economically valuable in one way or another; either by using them, or by preventing their use by competitors. Otherwise, a company would not apply for patent. The analysis includes International Patent Classification (IPC) codes which are used to classify a patent against standard technology definitions. IPC codes categorize patents by general subjects. IPC codes are divided into sections A through H, which are sub-divided into classes, subclasses, groups, and subgroups. The codes are hierarchical; therefore, the longer the code, the more specific the concept.

The aim of this task as part of WP 2 was to unveil the factors that lead to dependency of the European industries in the security sector due to patents. Building on the List of Critical Technologies (D1.2), patents were analysed in order to provide a more concise list of technologies in which Europe is dependent. It was planned to consider two levels: A macro level on the basis of the patent classification codes (IPC); and a micro-level for selected particular hot technology topics and related country specific intellectual property rights and claims.

The macro-level analysis was intended to show in which Critical Technologies Europe has a low patent presence, without taking care of technological details. Critical Technologies from WP 1 were matched with IPC-Codes (International Patent Classification). This table of correspondence was used by both CEA and AIT to retrieve patents for a period of five years. However, the databases used for extracting the patent information differed. AIT used the PATSTAT data base, while CEA derived their data from the international data base Fampat, through the Questel/ORBIT platform. It was not possible to compare whether the sets of data were actually identical or not in the given time.

AIT on the other hand identified weak and (for security context) relevant IPC categories by the following criteria: International Patent Classification (IPC) categories were identified that are at the same time a) potentially security relevant (matching the Critical Technology List of WP 1); b) of absolute importance (i.e. a share of more than 0.1% in worldwide patenting) and c) show a low relative specialization of the EU-27. The dependencies of these specifications were analysed by AIT using its software for bibliometric and technometric technology monitoring (BibTechMon™).

The task of CEA was to conduct an analysis of patents from selected industrial companies in the period 1995-2008 to find technologies that are protected up to 2015, thus it was planned to be more specific than the overall analysis of dependency of IPC codes of AIT. Rather than focusing on specific industrial companies, the analysis performed by CEA exceeded this and included specifically selected topics. The validated patent families (priority patent and extensions) were transferred into a patent analysis software-as-service, Intellixir. Within these topics time and geographical distribution, European and world-wide companies and other facts could be identified and were summarized by CEA in their report.

In the discussions between CEA and AIT about the best approach to tackle the problem, some factors were becoming obvious, that led to the final decision to perform two separate analyses. The origin of data was different and due to technical and legal restrictions it was not possible to exchange the original data of each other. Also as the timeframe was rather tight due to delay in previous work packages it was decided to immediately start with the analyses and produce results instead of comparing sets of data. Furthermore, the software systems used for the analyses produced different outputs and both partners were not sure if these results were comparable or rather building on top of each other.

3.1 Technology Patent Analysis (AIT)

For its analysis, AIT used patent data provided by the European Patent Office (EPO) which gave a detailed picture of technology development in Europe and of developments that are relevant for the European market. The criteria for including patent documents in the analysis consisted in the selection of patent categories with sufficient relevance to the critical technologies that are also important for security issues as identified in WP 1. The initial Critical Technology List was based on the Staccato taxonomy that was created in a previous EU-project. Some terms in the Staccato taxonomy rather referred to services than technologies, the former being not patentable and thus not included in this study. Only those patent categories which were considered relevant for the selected critical technologies were included in further analysis and compiled in a list. As only International Patent Classification (IPC) categories with a relative low specialization are relevant for the identification of critical dependencies, AIT only included these patents in its analysis and named these IPC categories Weak Critical Technologies, while Strong and Average Critical Technologies were excluded. The specialization analysis was performed for both, the location of the inventor and the applicant. The results are very similar for both cases and the identified potential critical IPC categories are the same.

The examination process of a patent application causes considerable time lags between the invention and the availability of patent information and the time lag between priority date and final grant of the patent can add up to several years. As a consequence, patent data issued after 2008 seems to be less reliable than data from the mid-2000s. To avoid analysis of incomplete data, due to the time lag between filing and application and granting of the patent, only patent applications with a first priority date from 2004 to 2008 were included in the analysis of identification of Critical IPC codes. For the analysis of topics within these critical IPC Codes more recent patents were also taken into account. The study showed that the share of the EU-27 on worldwide patents is with 40% slightly lower in all critical technologies compared to 45% in worldwide patenting. USA has a share of 29% of all critical technologies compared to 26% in total patents. Asian countries including Japan, Korea and China also have a slightly higher share.

The picture changes completely when looking only at the weak critical technologies, i.e. the security relevant technologies with a low EU-27 specialization. The EU-27 share in these weak critical technologies is by definition much lower due to the low relative EU-27 specialisation as selection criteria. As a result, the EU-27 only accounts for about 27% of all patents. However, this lower EU-27 share does not go along with a higher share of all other world regions and countries in these technologies. Also the share of other European countries is with 1.4% very low in these technologies; the same is the case for the countries summarized under "Rest of the World" (Africa, South and Central America and Oceania).

Another interesting discovery is that nearly all patent categories including critical technologies that were weak in the EU but with high worldwide growth rates at the same time are within IPC sections G (physics) and in particular H (electricity). This fact confirms that these two sections are of major relevance concerning weak critical technologies in the security sector.

Figure 1 shows the distribution over world regions/countries for all weak critical IPC categories for the years 2004-2008.

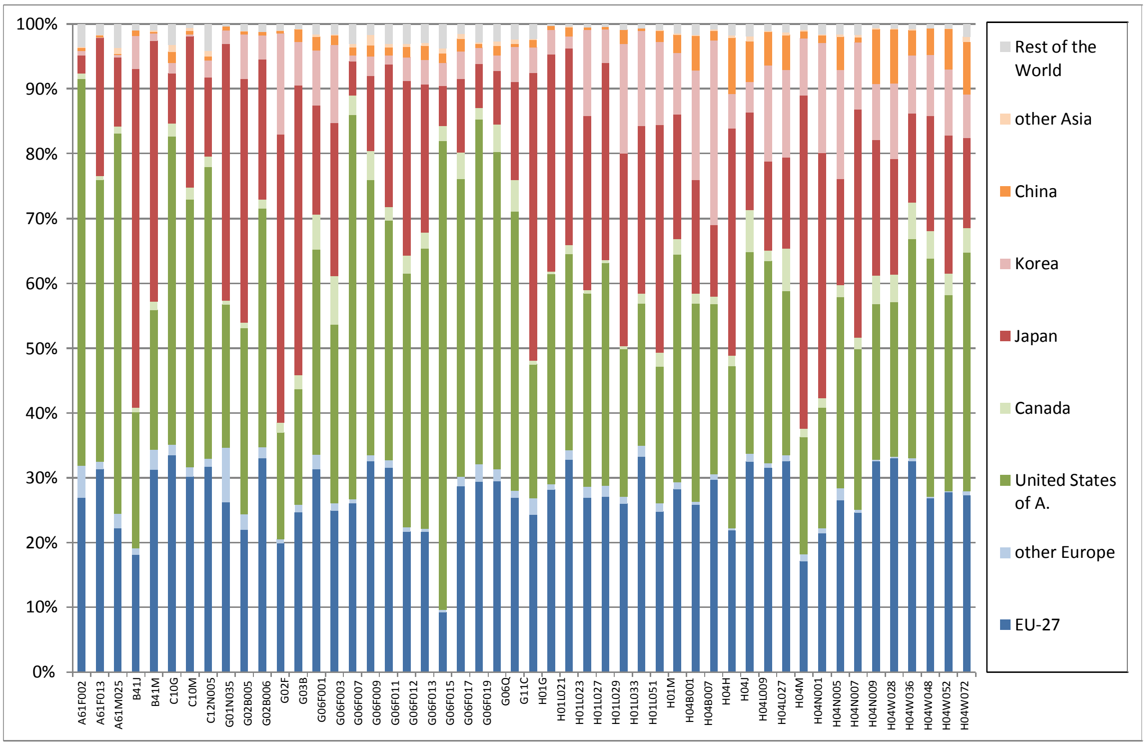

Figure 1: World region/country shares on total patenting in weak critical technologies, 2004-2008; Source: EPO Patstat April 2012 edition, own calculations

To measure specialization a Revealed Technological Advantage Index (RTA-Index) was applied. The lower the RTA-Index-Value is, the lower is the importance of a certain IPC category in the EU-27 compared to the worldwide importance of the IPC category category considered. The corresponding RTA Index values were analysed for the years 2004-2008 and revealed some important facts. In patent sections A (human necessities) and C (Chemistry, Metallurgy) the USA show highest specialization, in patent section B (Performing Operations, Transporting) Japan is the country with most patent applications. However, these categories show a low worldwide growth rate and comparable low number of patents. In section G (Physics) Japan, Korea, Canada and the USA have outstanding specialization for selected codes. For section H (Electricity) China and Korea are the most obvious countries with strongest specialization in the last years.

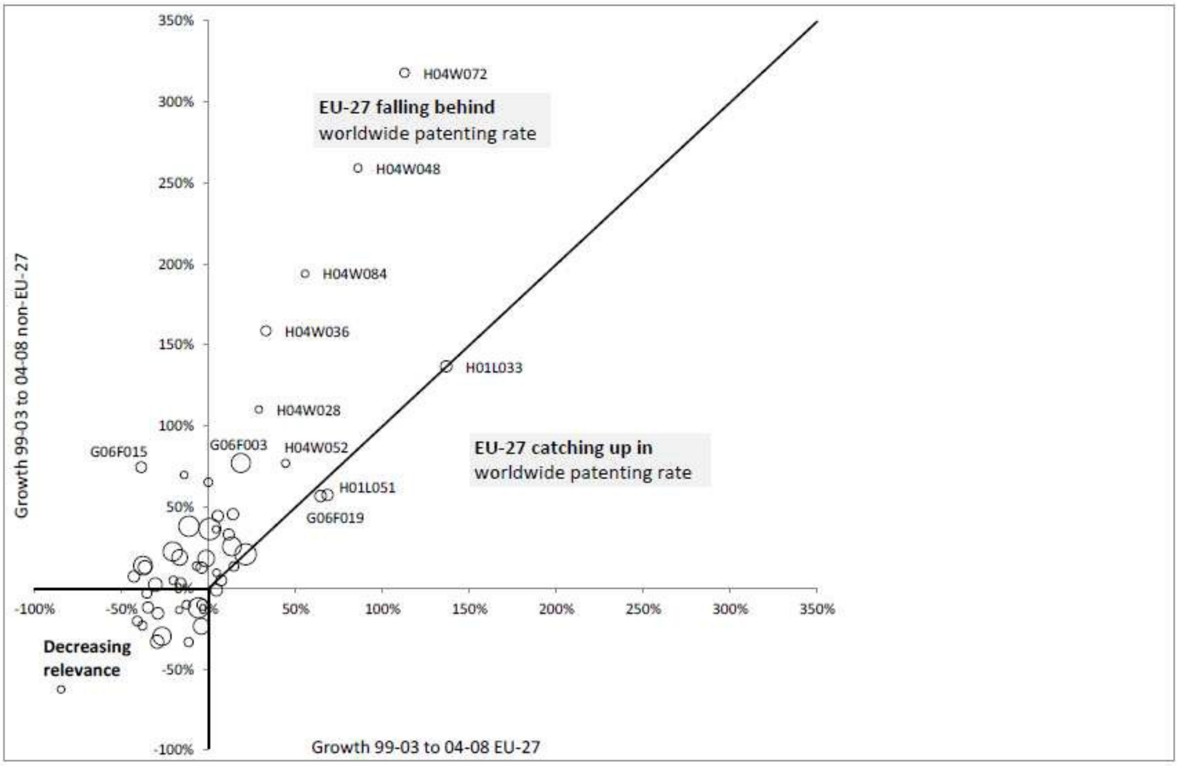

Figure 2: Growth rate (1999-2003 to 2004-2008) of weak critical technologies within EU-27, non-EU and number of patents (2004-2008) worldwide; Note: Based on inventor's location; Source: EPO Patstat April 2012 edition, own calculations

The main concern from an EU-27 point of view are clearly the categories that are falling behind, the weak critical technologies with (very) high growth rates outside the EU-27 but lower or negative growth rates in the EU-27. This was analysed by comparing the growth rates of weak critical technologies in the EU-27 and outside the EU-27 (Figure 2).

Almost all categories that are falling behind in Europe are main groups of just two IPC-4-digit subclasses, H04W (Wireless Communication Networks) and G06F (Electrical Digital Data Processing). While various H01L main groups (Semiconductor devices, electric solid state devices not otherwise provided for) also show similar high growth rates outside the EU, the growth rate of the EU-27 is at a similar level (circles on or below the 45 degree line in Figure 2).

3.2 IPC Code Dependencies (AIT)

Patent applications of weak critical IPC codes were analysed for the most recent years (2010, 2011 and part of 2012) in order to get insight into the latest topics data. AIT applied its bibliometric tool BibTechMon™, based on the methodology of co-object analysis. In this case an object (a node in the network) is a patent code in the patent analysis, or an IPC code in the analysis of dependencies. The "size" of a node in the first case is related to the number of IPC Codes this patent cites. The more IPC codes a given patent cites the "bigger" the node is. Two patents share an edge together if they cite the same IPC codes. The nodes find their positions in the network graph based on their relations to all other nodes, i.e. the more often two IPC codes are cited together the closer they lie in the graph. For a better overview only patents with more than five IPC codes were included in the graphical analysis. From this graph a density map was generated, so that the height of peaks indicates the number of patents in an identified cluster (Figure 3).

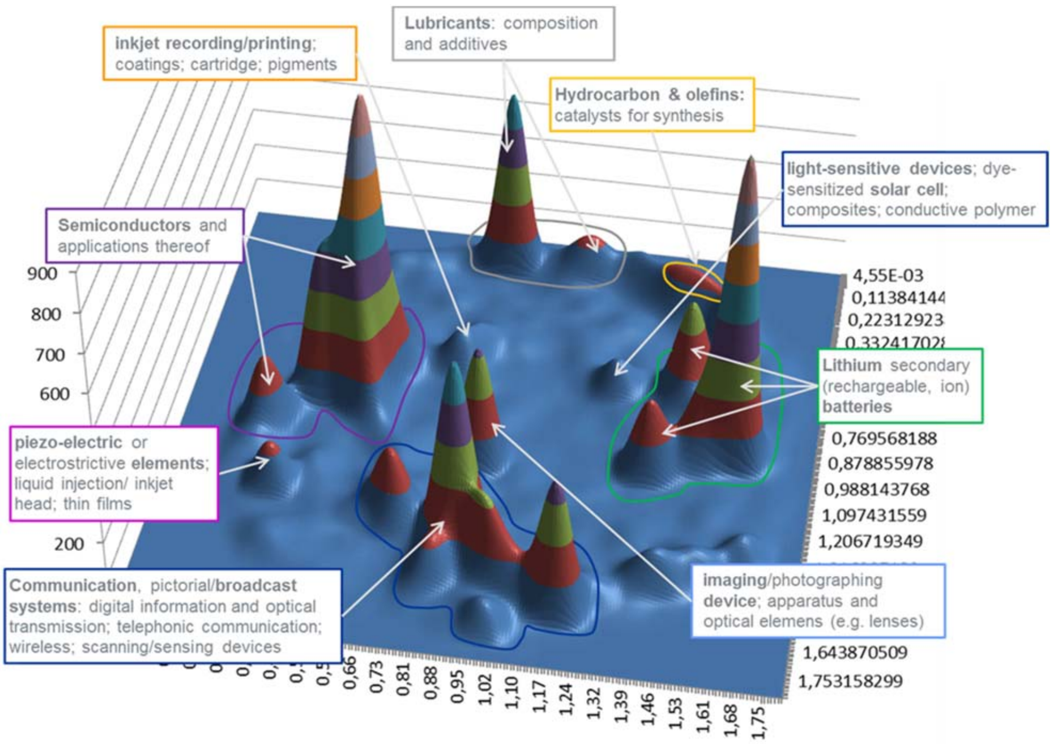

Figure 3: Main topics identified from 12,891 (out of 169,484) patents assigned to weak critical IPC codes which cite five or more IPC codes. The nodes depict patents that are connected through IPC codes. The more IPC codes two patents share, the closer they are positioned in the graph.

As a result, the following main issues were identified within the weak and critical patent classes, that further explain the IPC Categories mentioned above:

- Communication and broadcast systems, esp. wireless communication networks
- Hydrocarbon & olefins
- Lithium batteries
- Lubricants – composition and additives
- Semiconductors and applications thereof
- Light sensitive devices, solar cells
- Imaging/photographic devices, optical elements
- Inkjet recording/printing
- Piezo-electric or electrostrictive element

When considering possible dependencies of EU-27 to other countries one must take those categories into account that show the highest growth rates worldwide, namely H04W (Wireless communication networks), G06F (Electric digital data processing) and the corresponding 6-digit main groups. The growing share of the Asian economies in both subclasses, especially in Korea and China, followed by Canada are obvious, while a significant decrease in EU-27 can be observed. In all weak critical technologies that are mentioned above Korea, shows a very high relative specialisation while the rates of EU-27 decrease substantially (33% to 25%). Presumable dependencies of EU-27 in the above mentioned areas must be avoided, but are foreseeable if the downward trend in development continues.

To conclude, all technological areas detailed above indicate clearly what sort of technologies EU-27 is currently neglecting in its RTDI activities and research focus. If the downward trend is not stopped or even reversed in these areas in the near future, EU-27 will face severe dependency on other countries and continents concerning technological know-how and innovation in these areas in the long run. This is particularly true for the patent category "Wireless communication networks" (H04W). If Europe wants to keep track with world-wide technological advance in wireless communication technologies it is strongly recommended for Europe to promote activities in this area.

Concerning the Critical Technology List (CTL), the patent analysis revealed the following issues:

- As the CTL attempts to be as comprehensive as possible, it contains also many aspects related to critical technologies that are not technologies sensu strictu but part of security aspects of the whole system, e.g. related to human sciences.
- Items on the CTL often describe products that can be used in security-related activities, rather than clearly discernible aspects of technologies, e.g. light materials for human protection, Surfaces treatments for improvement of mechanical properties and Anti-blast glasses. It is recommended that the list should identify and focus on the technologies rather than on the products, their applications or their anticipated effects.
- Although the CTL manages to compile many, security-relevant technological aspects, it fails to weight the importance of the individual aspects and position them within the security system. In contrast, patent analysis manages to single out specific weak technologies with top priority for action. For example, although secure communication is a recurring topic throughout the CTL, it is only the patent analysis that helps to rank wireless communication on the top position.

3.3 Distribution of critical technologies patents (CEA)

After defining selection criteria that correspond to the requirements of the project, from the WD1.3 "Enriched Validated List of critical Technologies" the following technologies were selected:

110-2 X-ray technologies
110-3 Gamma-ray technologies
110-5 IR Spectroscopy
110-10 RF sensor technologies
110-19 Techniques for discrete surveillance (uncooled IR sensors)
119-8 Rapid diagnosis of infectious disease
121-9 Food testing and control techniques
200-11 Biological substances detectors
200-23 Terahertz detectors.

To carry out macroscopic patent landscapes in each of the nine technological areas, the study used patent datas provided by the International data base Fampat, available at the Questel/ORBIT platform. The validated patent families (priority patent and extensions) were transferred into a patent analysis software-as-service (Intellixir) in order to reveal technological trends, emerging techniques or players and market shifts. The patent analysis was made first at a global level and was then focused on identified European players.

To synthesise the results, the table below indicates for each selected technology area the total number of patents over the period 1999-2011, the repartition of patents by continent (US, EU, Asia), the repartition between industries and academics, and the repartition of all players by continent.

The position of Europe is indicated as WEAK, MEDIUM, GOOD by using the number of the European patents and the number of European players compared to the worldwide inventive activity. The European countries that are the most active are also indicated.

Technologies	**110-2**	**110-3**	**110-5**	**110-10**	**110-19**	**119-8**	**121-9**	**200-11**	**200-23**
Number of patents	918	265	397	915	1346	466	905	371	1215
Repartition of patents by continent	US 58% **EU 21%** Asia 20%	US 68% **EU 15%** Asia15%	US 80% Asia 11% **EU 9%**	**EU 70%** US 17% Asia 13%	US 45% Asia 35% **EU 17%**	US 52% Asia 38% **EU 8%**	US 68% Asia 19% **EU 11%**	US 79% Asia 10% **EU 9%**	Asia 52% US 29% **EU 19%**
Repartition between industries and academics	IND 74% ACAD 20%	IND 66% ACA 34%	IND 57% ACAD 43%	IND 89% ACAD 11%	IND 75% ACAD 25%	ACAD 51% IND 49%	IND 56% ACAD 44%	IND 58% ACAD 42%	IND 53% ACAD 47%
Repartition of all players by continent	US 74% **EU 15%** Asia 9%	US 64% **EU 17%** Asia 16%	US 67% **EU 17%** Asia 16%	**EU 41%** US 34% Asia 22%	US 48% Asia 29% **EU 19%**	US 49% Asia 39% **EU 11%**	US 62% Asia 21% **EU 15%**	US 75% Asia 13% **EU 10%**	US 35% Asia 34% **EU 30%**
Europe positionning and main active countries	**Weak** NL, GE, FR	**Weak** UK, GE,FR	**Dual use** FR, GB	**Good** FR, GE, IT, NL	**Weak** FR, UK	**Weak** FR, NL	**Weak** IE university	**Weak** FR, GE	**MEDIUM** UK, GE, FR

Figure 4: Own elaboration by CEA

For each technology area, main results and trend are presented in the Annex "Report on the Analysis of the distribution of critical technologies patents"

4. Bibliometric Analysis of Weaknesses in European research

Scientific activity and the associated research output are reflected in the number of scientific publications issued worldwide in any field of research. The total number of scientific publications on a particular technology in a country or region therefore provides a metric for scientific activity as well as for development of that technology. Consequently, low numbers of scientific papers on a particular technology in a certain area indicate a lack of scientific activities and specialization in this area, which may result in technological dependencies on other regions concerning this particular technology. For example, if core research on a security relevant technology takes place outside Europe, skills derived from these scientific activities might not be available in a sufficient manner in Europe.

A particular European focus on specific research areas indicated by especially high numbers of publications (e.g. more than 100,000 publications during 2007-2011) results only in a relative specialization in this area. The Revealed Technology Advantage Index (RTA-Index) shows that this relative specialization is eliminated when number of publications are compared to the rest of the world, as EU-27 produces only high numbers of scientific papers in scientific areas and technologies that constitute major research area around the world and therefore yield high numbers of publications in other, major areas of the world as well. In short, no European dominance could be revealed for any research area when compared to the worldwide publication activities.

An insufficiency and therefore a weakness in European research activities (RTA-Index-Value ≤ 0.75) could be spotted for six research areas (i.e. Web of Science Categories): Automation & Control Systems, Manufacturing and Petroleum Engineering, the area dealing with Film, Radio and Television, Material Sciences dealing with textiles, as well as Primary Health Care. In these research areas other, non-European countries or regions, dominate the worldwide research and technology landscape and EU-27 is facing dependency on the key players such as USA, Canada, China and Korea concerning new technologies and know-how.

Table 1 EU-27 dependencies in core research fields with low specialization (Web of Science categories with security relevance corresponding to Critical Technologies as identified in WP1) on countries and regions outside of Europe (RTA-index 2007-2011). The background colour indicates the categories for specialization: orange: RTA ≤ 0.75, low specialization; dark blue: RTA ≥ 1.25, high specialization.

Web of Science Category	EU-27	Other Europe	USA	Canada	Japan	Korea	China	Other Asia	Rest of the World
Automation & Control Systems	0.74						2.50		
Engineering, Manufacturing	0.66					1.25	2.60		
Engineering, Petroleum	0.57	1.66	1.62	3.48			1.51		
Film, Radio, Television	0.66		2.03						4.11
Materials Science, Textiles	0.67	1.36					2.43	1.64	
Primary Health Care	0.53		2.22	4.90					2.49

5. Knowledge Protection and Trade Barriers

As part of the general objective to unveil factors that lead to dependencies of the European industries in the security sector, in this part the main legal forms of technology protection that the European Technological and Industrial Base (ETIB) have to face in order to achieve access to the required critical technologies, are described.

The following table summarizes the generic protection means of technology and products:

Subject of the protection	Scope	Means of Protection
Intellectual assets (Information protection)	Governmental	Information Classification
	Industry	Corporate Classification
	IPR Law	National laws compliant with WIPO
Trade	Governmental	• Customs duties • Customs procedures • Technical regulations
Weapons & dual use elements	Governmental	Conventions for Weapons of Massive Destruction • Treaty on the Non-Proliferation of Nuclear Weapons (NPT) • Biological Weapons Convention (BWC) • Chemical Weapons Convention (CWC)
		Regime for Weapons of Massive Destruction • Nuclear Suppliers Group (NSG) • Australia Group
		• The Missile Technology Control Regime (MTCR)

Source: ISDEFE (2013)

Depending on the scope and the field of application, the knowledge as intellectual asset or as information (technological or not), generated personally or collectively, can be protected against third parties in different ways.

5.1 The Information Sharing Traffic Light Protocol (ISTLP)

Normally a government must be ready to release classified information to other entities, due to its membership to an organization (NATO, EU, FRONTEX, etc.) or its participation in operations (International Security Assistance Force-ISAF, EUCAP NESTOR, Atalanta Operation, etc.) or due to international industrial activities (projects, contracts, etc.). The Information Sharing Traffic Light Protocol was created to encourage the sharing of sensitive information between individuals, organisations or communities in a controlled and trusted way. The originator signals how widely they want their information to be circulated beyond the immediate recipient. The ISTLP is based on the concept that the originator marking the information with one of four colours (red, amber, green and white) to indicate what further dissemination, if any, can be undertaken by the recipient.

5.2 World Intellectual Property Organization (WIPO)

The World Intellectual Property Organization (WIPO)[1] is the United Nations agency dedicated to the use of intellectual property (patents, copyright, trademarks, designs, etc.) as a means of stimulating innovation and creativity, by promoting the development and use of the international IP system. As part of the United Nations system of specialized agencies, WIPO serves as a forum for its Member States to establish and harmonize rules and practices for the protection of intellectual property rights.

5.3 World Trade Organization (WTO)[1]

Rules governing the international trade are primarily those established under the World Trade Organization (WTO) or, since February 2008, those contained in bilateral Free Trade Agreements. The World Trade Organization (WTO) is the only global international organization dealing with the rules of trade between nations. The WTO agreements cover goods, services and intellectual property. These agreements are not static; they are renegotiated from time to time and new agreements can be added to the package. WTO has created some specific agreements covering the main barriers than a country can establish as trade protection measure.

5.4 The Trade Barriers Regulation (TBR)[2]

The Trade Barriers Regulation (TBR), issued by the Directorate General for Trade of the European Commission, is the legal framework in support of EU enterprises and industries when there is evidence of a violation of international trade rules (import or export activities) which has resulted in either adverse trade effects or injury, affecting the trade between the EU and a third country. It applies not only to goods but also to services and intellectual property rights. A barrier to trade is defined in the TBR as "any trade practice adopted or maintained by a third country in respect of which international trade rules establish a right of action". In this context, international trade rules are primarily those established under the World Trade Organisation (WTO) or those contained in bilateral Free Trade Agreements. The TBR is designed to ensure that the rights of EU under international trade agreements can be enforced in cases where non-EU countries adopt or maintain "illegal" barriers to trade. The EU, through the Directorate General for Trade, carries out an annual monitoring of trade barriers applied by third countries that can affect either European import or export activities.

The latest results are issued in two main Reports:

- Trade and Investment barriers Report 2012. Report from the commission to theEuropean council (SWD (2012) 19 final).
- Ninth report on potentially trade restrictive measures identified in the context of the financial and economic crisis (September 2011 - May 2012).

[1] http://www.wipo.int/portal/ The information contained herein comes from the home page of the WTO: http://www.wto.org/
[2] http://ec.europa.eu/trade/tackling-unfair-trade/trade-barriers/

5.5 EU Market DataBase (MADB)[3]

Developed in the framework of the Commission's Market Access Strategy, the Market Access Database (MADB) provides an overview of the barriers that the EU is in the process of investigating with its trade partners. Thus, the main objectives of the MADB are:

- To provide basic information of interest to EU exporters (e.g. import duties, related taxes and documentary import requirements applicable in export markets, trade statistics, studies on market access related topics);
- To list all trade barriers affecting EU exports by country and by sector and to ensure systematic follow-up of the barrier identified and
- To provide an interactive means of communication between business and theEuropean authorities, allowing an exchange of information on-line.

5.6 Other International Agreements

Trade on weapons knowledge, technologies or components are strictly controlled through international agreements. The following Conventions or Regimes for Weapons of Massive Destruction (WMD) and Regimes for dual-use products were identified:

- Treaty on the Non-Proliferation of Nuclear Weapons (NPT) Biological Weapons Convention (BWC)
- Chemical Weapons Convention (CWC) Nuclear Suppliers Group
- Australia Group
- The Missile Technology Control Regime (MTCR) Wassenaar Arrangement
- Export and End User Control List
- Commerce Control List (CCL) - (EAR)

The study also involved the main barriers to trade regarding possible defence and security technology, systems or components in the five countries: China, India, Russia and Japan. For more information please refer to the Annex "Technological Dependence: Knowledge Protection and Trade Barriers".

[3] MADB is available online at the following address: http://madb.europa.eu

6. Economic barriers

Despite the overall size of the EU market, **fragmentation** at national and even regional level increases costs and reduce the competitiveness of the EU security industry. The negative consequences are observed in a variety of areas, such as low level of EU industry organisation and cooperation, limited depth of EU security industrial base, potential vulnerability of SME due both to high market entry barriers and potential international competition. From a more global perspective, organisational uncertainties on the demand side of markets (e.g. over allocation of security responsibilities and budgets) combined with apparently **low levels of awareness and knowledge of procurers and users** of security technologies and capabilities are seen to restrict the efficient and effective functioning of the market.

Inefficient research funding is a further cause for the suboptimal condition of the security market. The attitudes within EU markets tend to be relatively conservative concerning the adoption and implementation of new technologies and innovative solutions, which clearly dampen the incentive to EU firms to invest in research and technology development. It is not clear whether public support for research, including European research programmes, is **adequately focused** on addressing actual security needs and reflecting industry and market realities. Additionally, in times of financial constraints, an emphasis should be given to a better exploitation of synergies between civilian and defence orientated research and to avoidance of overlapping and duplication between existing programmes.

This lack of a "EU brand" is critical and has proven to be a disadvantage compared to US companies in terms of international competition. Asian countries are closing the technological gap that separates them from EU companies due to their great production cost advantage. As a result, EU companies, especially SMEs need more support in their efforts to **access international markets** in third countries. Furthermore, growing social concerns and the commercialization of services are not sufficiently reflected in business models and strategies and need to be further examined and exploited.

Finally, the absence of an EU-wide scheme for **standardisation** and the certification of security equipment hampers investments, efficiency, and slows down the EU's ability to respond and adapt quickly to new and emerging threats. It furthermore hinders interoperability as a major driver for the **harmonization** of the European Security market.

Experts point out that the communication between the end-users in Security and the SMEs, together with the uncertainty associated to the procurement process and the monopolization of the **technology push** by the big companies, extending the use of a given accepted technology to its pre-obsolescence stage, has driven many technology-oriented SMEs out of business. Even though there are variations from country to country in Europe, it is a generalized perception that the integrators didn't share a culture of joint activities with the technological SMEs with respect to their former usually monopsonical customers.

Low exploitation of the results of research accomplished by research institutions, notably universities, is associated with **weak technology transfer agreements** and also by a less than perfect symbiosis between business and research. Something surprising taking into account that the revolving door from research to business, at least in the technical responsibilities and referred both to big companies and SMEs has been always patent.

The late increase of public funding specifically addressed to the Security field has caused a **limited effect**, as the value chains in the sector weren't appropriately established. That is why the results have been rather modest and adverse to technological adventures, which would have permitted the exploration of diverse solution for a given problem, open the door to possibilities to avoiding dependencies. Deficient metrics and evaluation criteria, for example, not including the concept of dependency or not having enough acceptances from the end-users to cooperate in field tests may have hassled further progress in alternative technologies.

Some experts working at big companies emphasizes the tension between the **apparent variety of user's requirements**, even if they operate under the same framework, and the need of reaching economies of scale by the companies. In the case of big companies, this behavior leads to a very restrictive view of the technological risks, even in cases when there is public funding for it. In the case of small companies, they are driven to an endless development process that seldom results in configuring a marketable product, and often ends in bankruptcy.

There are cases in which some speakers doubt that a **Security market** exists as it could be generically defined in European terms. Market fragmentation is underlined but moreover the lack of homogenized speaking parties on the end-user side is blamed as one of the worst causes of reinforcing the fragmentation. This is linked with the need of overcoming the first barrier of a technology: the one of having a deployment in the real life that can be used as a reference. Traditionally, technology companies knocked at the door of their national end-users seeking the **primal implementation** for an innovative technology or application. In an increasingly globalized market companies tend to differentiate in business models rather than risking in new technologies. Ironically, this leaves out of the game many SMEs whose core is technology innovation, which definitely blocks solutions other than the expectable ones, normally associated to technology dependencies.

7. Usage of the WBAM

One goal of task 2.4 "Adaption of the Weighted-Bit Assessment Method" was the adaptation of the WBAM to the assessment of critical dependencies and alternative technological solutions. This constitutes a novel approach to the assessment of technologies.

Some first steps in this adaptation process were taken derived from the structure of WP 2 "Identification of Critical Dependencies", identifying these categories, as a first working proposition: Intellectual property rights, Trade and academic, and Commercial. Additionally, it was decided to keep the three items concerning "Ethical Considerations" developed in WP 4 "Scanning for Emerging Technologies".

Based on the document "Technology Dependence: Knowledge Protection and Trade Barriers" several new items were included. Equally, some first ideas concerning market inadequacies were collected. Finally, after receiving first draft reports on the analysis of the regional distribution of patents, an additional item was added to the IPR subsection.

At a later stage, the number of items was reduced by collapsing two or more issues into one. During the further course of the work, the table was split into two sections: "Nature of the dependency" (associated with WP 2) and "Obstacles to closing the gap" (associated with WP 3).

Initially, the functioning of a Weighted-Bit Assessment Table depends on a completely filled binary matrix (yes = 1, no = 0). In the case of the WBATCD created within the ETCETERA project, a major problem was the lack of information concerning the many "Critical Technologies". In order to incorporate all information available, which was in some cases of the nature "a specific problem exists for a given technology" and in other cased of the type "we know that a specific problem does not exists of a given technology", a **ternary system** of yes = 1, no = -1, and unknown = 0 was introduced.

A section of the WBAT-CD after all those adaptations is reflected in Figure 5.

In terms of verdict, the adaptation of the WBAM to the analysis of critical dependencies and the support for substitute technologies **enabled aggregating expert opinion** on a very broad scope of reasons for technological dependencies and on possible measures to overcome these dependencies.

STACCATO-Taxonomy		Essential IPR is held outside Europe.	There have been relatively few patent applications by European actors in the last years.	A relevant portion of the IPR is classified by government.	The technology is included in export control lists and/or has high potential for dual use (civil/military).	IPR & Trade Restriction SUBSCORE	There are no production facilities for this technology in Europe.	There are only three or less production facilities for this technology in Europe and/or there is a tendency to "offshore" the production of the technology.	The technology requires raw materials or intermediates that are not readily available in Europe.	Production Gap SUBSCORE	There is only very limited research capacity (institutions and/or human resources) for the technology in Europe.	There is a lack of systems integration capability.	Capacities SUBSCORE	The market for the technology is highly fragmented and/or a lack of standardisation troubles the marketing of the technology.	End-users are content with the solutions currently available. There is no requirement pull for new technologies.	Public funding is currently insufficient to foster the development of the technology.	Market Inadequacies SUBSCORE	Could this technology raise privacy issues?	Is it likely that this technology will be used to provoke any physical or mental harm to humans?	Could the technology be exploited by criminal organisations in the next few years?
		NATURE OF THE DEPENDENCY: IPR & Trade Restrictions					NATURE OF THE DEPENDENCY: Production Gaps				OBSTACLES TO CLOSING THE GAP: Capacities			OBSTACLES TO CLOSING THE GAP: Market Inadequacies				OBSTACLES TO CLOSING THE GAP: Ethical Issues		
In general: yes = 1 / no = -1 (WBAM Factors:)		1	1	1	1	X	2	1	1	X	2	1	X	1	1	1	X			
XXX-XX	Pure and Applied Madness	-1	1	-1	-1	-2	-1	-1	-1	-4	-1	1	-1	1	1	-1	1	1	1	1
100	**Structural materials and technologies and**																			
100-2	Ceramic composites					0	-1	-1	-1	-4	-1	-1	-3				0			
100-3	Composites materials technology					0	-1	-1	-1	-4	-1	-1	-3				0			
100-4	Powder metallurgy					0	-1	-1	-1	-4	-1	-1	-3				0			
100-5	Dense alloys					0	-1	-1	1	-2	-1	-1	-3				0			
100-6	Organic composites					0	-1	1	0	-1	-1	-1	-3				0			
100-7	Metal-matrix composites					0	-1	1	-1	-2	-1	-1	-3				0			
100-8	Carbon-carbon composites					0	-1	0	-1	-3	-1	-1	-3				0			
100-10	Synthetics fluids and lubricants	1	1			2	-1	-1	0	-3	-1	-1	-3				0			
100-11	EM radiation absorbers				1	1	-1	-1	-1	-4	-1	-1	-3				0			
100-12	Magnetic metals					0	-1	0	1	-1	-1	-1	-3				0			
100-13	Superconductors				1	1	-1	0	1	-1	-1	-1	-3				0			
100-14	New metallic alloys				1	1	-1	0	1	-1	-1	-1	-3				0			
100-15	Metallic composites				1	1	-1	1	-1	-2	-1	-1	-3				0			
100-17	Concretes resistant					0	-1	-1	-1	-4	-1	-1	-3				0			
100-18	Anti-blast glasses					0	-1	1	-1	-2	-1	-1	-3				0			
100-19	Materials for thermal control					0	-1	-1	-1	-4	-1	-1	-3				0			
100-20	Nano components and structures (tubes, ceramics, …)					0	-1	0	-1	-3	-1	-1	-3				0			
101	**Light and strong materials, surface treatments.**																			
101-1	Light materials for human protection				1	1	-1	-1	-1	-4	-1	-1	-3				0			
101-2	Light materials for site protection				1	1	-1	-1	-1	-4	-1	-1	-3				0			
101-3	Armor and anti-armor materials				1	1	-1	-1	-1	-4	-1	-1	-3				0			
101-4	Self-protective and explosive resistant material technology				1	1	-1	-1	-1	-4	-1	-1	-3				0			
101-6	Structural & Smart Materials				1	1	-1	-1	-1	-4	-1	-1	-3				0			
101-7	Surfaces treatments for improvement of mechanical properties	1	1		1	3	-1	-1	-1	-4	-1	-1	-3				0			
101-8	Surfaces treatments for improvement of life duration, corrosion reduction	1	1		1	3	-1	-1	-1	-4	-1	-1	-3				0			
101-9	Paints (without CoVs…)					0	-1	-1	-1	-4	-1	-1	-3				0			
101-10	Replacement of Cd, Hg, Cr	1	0			1	-1	-1	-1	-4	-1	-1	-3				0			
101-11	Simulation for surfaces treatment				1	1	-1	-1	-1	-4	-1	-1	-3				0			
101-12	Nano surfaces					0	-1	-1	-1	-4	-1	-1	-3				0			
101-13	Smart textiles				1	1	1	1	-1	2	-1	-1	-3				0			

Figure 5: Section of the WBAT-CD as of 30 April 2013

8. Conclusions

Conclusions are referred both to the outcomes of the research and the recommendations for further use of the methodology employed in WP 2 "Identification of critical dependencies".

8.1 Conclusion on technology dependence

- The share of the EU-27 on worldwide patents is slightly **lower in all Critical Technologies**. Even though differences might be small, it is worrying that if affects virtually all technologies unveiling a characteristic trait. The USA and Asian countries reflect a converse feature.

- In the Security sector Europe is especially weak in technologies encompassed in the **physics and electricity** categories.

- Other figures resulting from the analysis reveal that Europe is falling behind in the subclasses **Wireless Communication Networks and Electrical Digital Data Processing**, at least with respect to patents in the period in the study, a tendency that doesn't seem further corrected.

- Even taking a short sample of technologies on a given domain (although with ramifications to other ones) of critical technologies for Security, the position of Europe relative to the **number of patents** is more easily described as **weak** than as any other qualification.

- EU-27 produces only high numbers of scientific papers in areas that constitute major research around the world, so **no European dominance** can be identified for any research area, which could be interpreted as mere bandwagoning.

- **Insufficiency in research** activities can be clearly identified at least in these areas: automation and control systems; manufacturing and petroleum engineering; material sciences and textiles; and primary health care.

- Incentives on research are not really breaking the conservative position of end-users towards the adoption of new technology. Current **metrics and evaluation criteria** with respect to research don't consider the concept of dependency as crucial. Also, apparent difference between end-users' requirements are deemed artificially bloated.

- Growing **social concerns on the use of technology** are imperfectly taken into account in Security technologies business models blocking innovation and prospective European leadership.

- The absence of an **EU-wide scheme for standardization and certification** of Security equipment hampers efficiency in technological response to Security threats.

- There is a market failure stemming from the current culture of joint operations between integrators and technology-niche SMEs regarding innovation absorption. **Value chains** in the sector must be improved.

- **Models of technology and knowledge transfer** from research institutions and technology innovators need serious refining as they are regarded one of the main factors of the low impact of research in the market. Creativeness in agreements and exploitation conditions are highly demanded.

- In order to consolidate European technology, **fast-track to first references** with the support of local end-users through innovative mechanisms including IPR sharing seems promising.

8.2 Conclusion on the methodology

8.2.1 Highlights

- **Preparatory research** enriching laconic description of technologies proved useful for readily discarding the most obvious non-dependencies.

- Variety in patent analysis may improve results but additional work is required in **homogenizing data** in order to be comparable. This may entail special agreements for data sharing in case of a joint effort.

- The **macro and micro level approaches** in patent analysis offered a contrasting perspective meaningful to face individual analysis and prioritize specifically marked technologies.

- **Progressive criteria in patent analysis** taking the three steps on categories, i.e., potentially security relevant, of absolute importance, and showing low relative specialization, showed up a great potential in identifying weak areas of patent development.

- Patent analysis is not only useful for a comprehensive ex-post analysis once the CTL is determined, but it can also be beneficial for the **construction of the list** in the first place as it helps ranking the relevance of the technology according to patenting waves.

- The WBAM method adaption in ETCETERA proved to be an excellent instrument to flexibly **collect a variety of opinions from diverse experts** on several topics, helping to simplify the considerations for key features and easing the assessment in complex work-teams, enabling seamless aggregation of additional concepts.

8.2.1 Areas for improvement

- A **permanently updated list of critical technologies** for Security is needed. Current list lacks homogeneity and become outdated swiftly.

- **Consistent criteria** are required as to what a critical technology is. Clear separation between technology, systems, and services would help concentrate technology efforts while handling the rest of the dependencies in a different way.

- Aspects related to **human sciences** need improvement in description to be more focused on actual techniques.

- For the analysis to be conclusive, it must be undertaken on **one technology or technology family** basis only. If cross-analysis is needed between two or more technologies it would have to be based on the individual analyses in the first place. Big scale analysis of all the technologies seems out of reach even for an experienced team in a reasonable timeline.

- Parallelized strands of analysis didn't result in conclusive outcomes although they give some interesting insights. All in all, it is recommended to follow the initial planned **successive steps for each technology**.

9. Acknowledgments

The following experts contributed with relevant insight to the analysis of the economic factors of dependency.

- Mr **José Antonio Bartrina**, director of the Spanish Association of Enterprises of Aeronautics, Defense, Space and Security.

- Mr **Eduardo Díaz**, directcor of the Office for Technological Entrepeneurship at the Madrid Regional Government.

- Mr **Antonio González Gorostiza**, director of the delegation of Indra in Germany.

- Mr **Javier Warleta**, partner of Ethicas Consulting and former security cooperation projects manager at Telvent and Indra.