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## Exploitation Plan

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**Main Authors:**    Elena Turco and Narcis Avellana (S&C), Mark Richardson and Michalis Koutroumanidis (KCL), Christos Antonopoulos and Nikolaos Voros (TMES), Andreas Ioannidis (AAISCS), George Kostopoulos & Vasileios Megalooikonomou (UoP), Artur Krukowski (ICOM), Andre Bideaux (KIT)



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**Contributions from partners**

<b>Version</b>	<b>Date</b>	<b>Author (Benef.)</b>	<b>Description</b>
00	13/08/13	Elena Turco (S&C)	Preparation of the template and preliminary list of exploitable results
01	17/10/2013	Sergio Jurado (S&C)	Implementation of the contents extracted from the document Exploitation of ARMOR technology
02	03/01/2014	Elena Turco (S&C)	Implementation of the updated list of innovation, modification of the list of exploitable results and new questionnaire
03	11/03/2014	Elena Turco (S&C)	Exploitation opportunities: chapter including list of potential customers, draft business model and calls for ARMOR 2 proposals
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06	20-22/6/2014	Narcis Avellana and Andreas Ioannides & Vahe Poghosyan	Review
06a	18/7/2014	TMES	contribution
07	18-20/07/2014	Narcís Avellana	Global Exploitation Strategy

**EXECUTIVE SUMMARY**

The aim of this document is to prepare the Exploitation Plan including the preliminary Exploitation Claims and Strategies for each ARMOR partner and for the whole Consortium.

The document “ARMOR\_Initial market survey”, produced by Mark Richardson (KCL) on 12<sup>th</sup> June 2013 is summarized in **Chapter 2**; while the “ARMOR\_innovations\_FINAL”, describing the most relevant achievements of the project (contributions by the corresponding ARMOR partners), is reported in **Chapter 3**. Both documents underline the added value of the ARMOR results with respect to current State of the Art solutions and they are the basis to build the preliminary list of exploitable results.

In **Chapter 4** an overview of the scenario described in DoW regarding the possible exploitation strategies for each ARMOR partner is reported, as a starting point and reference for the definition of the ARMOR exploitation strategies. Moreover the draft version of individual exploitation plans for the industrial partners AAISCS, S&C and ICOM is also included in **Chapter 5**, summarizing the contents of the document “Exploitation of ARMOR technology”.

The preliminary list of possible Exploitable Results is reported in **Chapter 6**. The list of the Exploitable Results and the related information will be regularly updated and optimized till the end of the project, discussed during the WP7 and Exploitation meetings and reported in the final progress report.

An overview of the whole ARMOR Exploitation opportunities is finally reported in **Chapter 8**, including a list of potential investors, the ARMOR Business model and possible funding schemes for “ARMOR 2” proposal submission.

## DOCUMENT INFORMATION

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<b>Authors (Benef.)</b>	Elena Turco (S&C), Prof Mark Richardson(KCL)		
<b>Responsible Author</b>	<b>Mark Richardson</b>	<b>Email</b>	mark.richardson@kcl.ac.uk
	<b>Beneficiary</b>	KCL	<b>Phone</b>

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## 1. LIST OF BENEFICIARIES

Nº	Name	Short name	Country	Role in the project
1	SENSING & CONTROL SYSTEMS SL	S&C	Spain	Coordinator; Middleware
2	TECNOLOGICAL EDUCATIONAL INSTITUTE OF MESOLONGHI	TMES	Greece	Encryption module
3	UNIVERSITY OF PATRAS	UoP	Greece	Neurophysiology; Data analysis and management and their application in diagnosis and management of epilepsy
4	ST. THOMAS' HOSPITAL, KINGS COLLEGE, LONDON	KCL	UK	End user
5	AAI SCIENTIFIC CULTURAL SERVICES LTD, LAB. FOR HUMAN BRAIN DYNAMICS	AAISCS	Cyprus	Support medical diagnosis through translation of basic neuroscience results
6	INTRACOM S.A. TELECOM SOLUTIONS	ICOM	Greece	PHR platform
7	SYSTEMA TECHNOLOGIES S.A.	STMA	Greece	Drop out of the ARMOR Consortium
8	KARLSRUHER INSTITUT FUER TECHNOLOGIE	KIT	Germany	Sensing units

## 2. INITIAL MARKET SURVEY (SUMMARY)

### GENERAL MARKET OVERVUE FOR ARMOR

ARMOR exploitation will develop at a time of relatively booming market for both brain-monitoring devices (currently) and neuroinformatics tools (forecasted). This is due to both increasing demand (increase of diagnosed brain disorders) and advances in biomedical technology allowing more effective diagnostic ways; which however already pose constrains to the market (increasing health costs, insufficient training of hospital technologists etc.)

**"The global brain monitoring devices market was valued at \$1.08 billion in 2012, and is poised to grow at a Compound Annual Growth Rate (CAGR) of 8.6% to reach \$1.63 billion by 2017"** (1). Currently USA companies lead the market with EU second, but Asia countries have by far the highest CAGR. Devices like EEG, MEG, EEG-triggered functional MRI etc., help in monitoring a range of functions such as electrical and metabolic activity of the brain and several other body functions. By exploiting recent technological advances they acquire increasingly high functionality, lower cost/benefit, ease of operation, and miniaturization of devices, thus fuelling the growth of this market. Most relevant to ARMOR, the traditional use of EEG devices as a diagnostic and research tool, has now expanded to a wide range of applications. Beyond offering even better ways to monitor epilepsy, sleep quality, sleep apnea and coma, they are employed in various new applications ranging from monitoring of fatigue and stress to a means of communication for patients with 'locked-in syndrome' using a brain-computer interface. The increase in computing power allows prospects of a study of the brain with the speed, sophistication and data basing/mining/correlation capacity which the enormous complexity of the brain demands. Rising incidences of neurological disorders - due to increasing life expectancy, environmental and other stress, and increase in diagnostic capacity - along with the technological advancements in brain monitoring devices and the convenience offered by wireless and mobile devices, are currently the major drivers slated to propel this market. Even more growth is anticipated in the forecasted as great demand for brain monitoring devices beyond medicine into the video-games industry, neuropsychological evaluation, neuromarketing research, pharmaceutical development etc.

The market of brain monitoring devices is primarily driven by EEG devices, owing to ICT advancements such as wireless and mobile EEG devices, as well as advances in EEG technology as fast, dense arrays with 64, 128 or 252 channels, exact sensor position measurement, and EEG source localization methods which have significantly improved the spatial resolution of the EEG devices. This has made it a cost effective option against functional MRI and positron emission tomography. Sleep disorders lead the applications followed by epilepsy, with stimulation devices starting to increase too. According to Millennium Research Group (MRG), increasing reimbursement opportunities for obstructive sleep apnea (OSA) diagnosis and treatment will drive the OSA market to \$1.5 billion by 2014 (2)

Factors limiting the growth of this market include the **shortage of skilled technicians** to handle these complex devices and the finite budgets of health systems. The market is marked by high competitive intensity. There

are a few well-established firms and several small ones with similar product offerings. Players compete on factors such as affordability, innovation, and increased customer services and warranties; the dominant players, however, have advantages such as access to best sources of raw materials, proprietary technologies, distribution channels, offices at strategic locations, and better brand association (1).

Directions for market growth have been long recognized but the respective challenge remains poorly met. Among these directions are the integrated monitoring with multimodal brain and body sensors, the convenient long term use of such sensors and the personalized approach in both monitoring and automated analysis of recorded data with the eventual capability of online analysis, alarm and feedback.

The prominent players operating in this market include Covidien, PLC (Ireland), Compumedics, Ltd.(Australia), Natus Medical, Inc. (U.S.), Nihon Kohden Corporation (Japan), Integra Life Sciences Corporation (U.S.), CAS Medical Systems (U.S.), and Advanced Brain Monitoring Inc. (U.S.), among others

The **market for Neuroinformatics tools** is relatively smaller today compared to the market of brain monitoring devices, but holds a much greater potential for the near future. This was actually the resolution of the Organization for Economic Co-operation and Development (OECD) meeting at Ministerial level on 29-30 January 2004 (3): Neuroinformatics will be instrumental for sustainable economic growth. OECD had predicted the spurt of the bioinformatics/biotechnology market which is at its zenith now and predicts even wider horizons for tools which will help brain data acquisition, storing, analysis and modeling. Neuroinformatics is poised to become as important for the Neurosciences, as bioinformatics has become for genomics. While bioinformatics isn't likely to create any new software stars, neuroinformatics will; and the reason is simple: complexity. Among prime instigators in Neuroinformatics development are expected to be the Human Brain Project, the \$1.19 billion euros recent initiative by the European Commission, the USA Brain Initiative and the Canadian CBRAIN Project

The major competition of the data analysis algorithms developed in ARMOR will not be restricted to tools currently in the market. Most decisive will be the competition with expected developments in open source comprehensive data analysis environments. Examples include "Brainstorm" (4) which is a collaborative, open-source application dedicated to MEG/EEG/sEEG/ECOG data analysis (visualization, processing and advanced source modeling) and "EEGLab" (5), which is an open source environment for electrophysiological signal processing. International collaboration facilitated by open sourcing is actually promoted by both OECD (3) and the International Neuroinformatics Coordinating Facility (INCF, 6) as the currently appropriate means of facing the enormous complexity of the brain and so spearhead major breakthroughs . Like it happened with Bioinformatics, OECD and INCF foresee that revenue making products will benefit from such initial open source helped development and boom in the next decade or sooner. Possibly related to the above, there is a trend in industry to sell **brain data analysis tools together with the monitoring devices** producing these data, i.e. SYNAmPs EEG amplifiers are sold by Compumedics along with their analysis software Curry (see other



examples in (7). ARMOR therefore which will combine HW and SW (along with telecommunication and other options) will be suited to this aspect of the market

## MARKET SURVEY

This brief survey focuses on existing systems and systems known to be in development, which consist of any combination of hardware / software / middleware / services, and which address aspects of ARMOR scenarios. This survey is not intended to be comprehensive, but to offer an overview of current commercial and public sector activity in this area, from the perspective of an experienced clinician active in the epilepsy field.

ARMOR consists of several components, which may be summarized as follows:

- A set of **hardware devices** (sensors, amplifiers etc.);
- A set of **software/middleware** to allow data to be collected, integrated, encrypted, transmitted, stored in online PHR etc.;
- A suite of **tools to allow data to be analyzed** to identify relevant metrics, produce alarms etc.;
- A (potential) **set of services**, to provide remote monitoring services for patients, according to the needs of the ARMOR scenarios.

It is not in the remit of ARMOR to develop new hardware, although ARMOR may identify the need and/or opportunity to do so – for example, the need for EEG electrodes capable of operating unattended for very long periods of time (days – weeks – months) has been identified.

The expected progresses beyond the State of the Art of ARMOR project are summarized below:

- ARMOR project could offer an **EEG diagnostic and LTM (Long term Monitoring) service** achieving in-hospital quality standards, and addressing conventional “routine” clinic-based EEG service purposes, **at reduced cost and increased geographical availability**, likely to be of interest to commercial and public-sector healthcare providers.
- ARMOR could offer an **ambulatory EEG service** achieving in-hospital quality standards, and addressing conventional “routine” clinic-based EEG service purposes, with **increased geographical availability**, and **with enhanced capability** through other parameters of data collection, **especially video**. Although it is uncertain whether there would be cost savings relative to conventional ambulatory EEG, it is likely to be of interest to commercial and public-sector healthcare providers. Detailed costs and cost-savings of the currently available state-of-the-art home video ambulatory recordings are listed in page 35.

ARMOR would be able to build on the success of Kings@home, to provide a much **more extensive range of services**, as described in the ARMOR scenarios, and to integrate with **miniaturised multiparametric monitoring devices**, and online tools and services. This may be of interest to healthcare providers, and is likely to be of interest for direct marketing to consumers (eg.

for monitoring emergency situations). Information about Kings@home and its limitations is provided in page 36. DigiTrace provides a model of successful direct marketing of a diagnostic service to consumers as well as clinicians. It provides on-line spike and seizure detection and video system (DVS) in a patient's home or the hospital. It focuses on seizure detection in epileptic patients and on home polysomnography for assessment of sleep disorders. The success of motion detection devices, despite very poor evidence for their effectiveness, provides some encouragement that there is a consumer market ready for an effective seizure-detection service. There is toll free patient help line 24 hours a day, seven days a week for answers to questions or concerns. The help line is always staffed by registered EEG technologists. The fully developed ARMOR platform will be able to provide all these services, with additional capabilities to differentiate between epilepsy and non-epilepsy events and to diagnose their precise nature (vasovagal or cardiogenic syncope, psychogenic non-epileptic and other), based on the developed algorithms. Therefore ARMOR can provide wider diagnostic services covering all disorders that are associated with acute impairment or loss of consciousness. In addition, the ARMOR multifunctional alarm system, triggered either automatically by the detection of a malignant signal by algorithm, or by the patients or their carers in case of a clinical event, offers the important benefit of direct contact with physicians who will offer medical advice.

- ARMOR could seek to integrate, in the future and if there is apparent competitive advantage, successful outcomes of the **video seizure detection** project at SEIN, successful outcomes of the EPILEPSIAE seizure-prediction project, and successful outcomes of the PERFORM Parkinson's Disease remote monitoring project.

In summary, there is market for services that support specific diagnosing and monitoring needs, including epilepsy and home polysomnography diagnostics, development of specific sensors, alarm systems, databases of EEG / polysomnography recordings, but there is currently no commercially available single operational system that can combine all as ARMOR will be able to. That opens the possibility of exploitation not only of ARMOR as a complete monitoring and diagnostic device, but also its individual attributes and systems, including its EEG and seizure database.

### 3. LIST OF INNOVATIONS

The document "ARMOR\_innovations\_FINAL" summarizes the most relevant achievements of ARMOR and collects the contributions from almost all the project partners.

- **Enhancing Bluetooth communication security provision:** In the context of ARMOR Hardware implementation of AES encryption algorithm is provided offering highly competitive performance metrics. These metrics include speed, power consumption, and silicon area demands in terms of number of gates. As presented in both deliverable D3.3 (8) and in the published paper (9) compared to other published implementations our

proposal reduces the number of gates required by 65-70% while frequency increase is measured achieved is equal to 71-238%. At same time power consumption 128bit encryption key is below 1mW (0.945mW). Specifically the design has been evaluated compared to respective implementation and it is shown that it offers considerably higher data throughout, while consuming less energy and requiring less silicon as far as its implementation is concerned. Furthermore, the encryption module is able to use encryption keys of different sizes thus offering important configuration capabilities pertaining to the critical trade-off between security level and processing delay. Additionally, a respective decryption hardware module has been designed and implemented. . Furthermore, SW based solutions has also been considered and proven to be totally inadequate based on relative literature and simulation based evaluated (taking into consideration real performance measurements)as analytically presented in both deliverable D3.3 (8) and published paper (10).

- **Enhancing WSN (Wireless Sensor Network) communication performance through compression algorithms:** A fundamental characteristic of ARMOR scenarios being a source for many challenges is the excessive amount of data acquired during typical operation. These data are either stored or wirelessly transmitted. In the former cases the excessive volume of them does not allow to store data for extended period of data. In the latter case leads to communication congestion (due to the typically limited WSN bandwidth) and rapid energy exhaustion since radio (being the most power consuming component) must be always active to perform communication task. In both cases compression techniques can mitigate problems. Innovation in the area included the proposal of adequate algorithms and the efficient hardware implementation of them so as to require minimum resources. Secondary innovation can be seen in testing such algorithms upon realistic medical datasets. Towards that end a variety of prominent respective algorithms have been implemented at MATLAB and evaluated with respect to compression rate and processing delay upon a variety of real EEG and ECG dataset of various sampling rates and sample resolutions -D3.4 (11). Additionally, two new novel extensions have also been presented, implemented in MATLAB and evaluated against the previous ones indicating critical advantages especially concerning offering optimum trade-off between compression rate and required processing delay-D3.4 (11). Furthermore as analytical presented in deliverables D4.5 (12) and D4.7 (13) proposed algorithm has been developed as hardware component. As evaluated drastic both delay and energy consumption benefits can be gained by integrating such a component into a WSN sensor reaching up to 60-70% for both metrics depending on the specific signal and/or radio chip considered.
- **Selection of optimal number and positions of sensors to extract critical results.** This innovation is related to the trade-off between the use of fewer EEG electrodes and the robust extraction of critical signals. Both these aspects are essential for ARMOR and other such systems. Minimizing the

number of required EEG electrodes in each specific case provides two key advantages: it makes ARMOR more comfortable for the patient, and importantly it reduces the amount of data that needs to be saved and/or transmitted online - as mentioned above, during typical operation ARMOR collects large amount of data and data reduction is one of its main challenges. However, the reduction of the number of sensors must be accompanied with their placement at case-specific well-determined positions over the scalp. Otherwise important brain signals may be missed. Moreover, even in cases where no electrode reduction is necessary, the optimal placement of sensors over the scalp may significantly enhance the amount of collected relevant signals. This innovation includes development of algorithms for selection of optimal number and positions of EEG electrodes based on anatomical information (e.g. brain region of interest, patient's structural MRI etc.) and/or previously recorded EEG signals with marked events of interest. The initial evaluation of the implemented tools at AAISCS using off-line analysis of EEG data has been successfully completed with excellent results. The final, more detailed evaluation based on simultaneously recorded sleep MEG data with just two EEG electrodes (data already available) produced limited but highly encouraging confirmation of the utility of the method. The methods of sensor selection can lead to new additional capabilities when they are combined with the recent improved methods for EEG localization (developed by AAISCS in another applied research project). It is envisaged that the combination of one-off high density EEG (and MEG if available) with targeted and personalized few channel EEG will be a key enabling technology for the next phase of ARMOR. Since there is no new MEG recording envisaged within ARMOR, a small set of combined EEG/MEG epileptic recordings have been obtained through an independent collaboration and the data analysis is ongoing with the aim of including the results in the ARMOR final report.

- **Design, implement and apply new data processing algorithms on multi-parametric and multi-modal data**, based on powerful machine learning algorithms and associated S/W tools, able to detect critical events, identify seizures, classify them, identify the information underlying in the multi-modal data, and fuse this information in order to minimize false identifications and classifications, detect patterns and associations and extract dependencies between data channel streams etc. comprise a significant innovation of ARMOR. Up to now, a significant amount of novel algorithms has been developed (novel methodologies for spike, K-complex, spindle and seizure detection have been reported and published). Since the specific expected innovation is related to offline and online analysis, the project has resulted in innovative methodologies for seizure detection, association analysis tools, motif discovery. Sophisticated architectures for seizure classification using fused EEG and ECG data have been produced (Barcelona 2013 meeting Demos). The design and implementation of several online algorithms in the Data Stream Management System (DSMS) is also an ARMOR innovation. Also the integration of multi-parametric data with data-mining methodologies leads to the development of innovative methodologies both for the characterization of sleep microstructure and for the detection of signal abnormalities and events of interest (spikes, seizure onsets, etc.). Moreover, the creation of models for different types of epilepsy and their combination

with the Patient Health Profile can lead to innovative decision support systems that are personalized considering the specific needs of each patient.

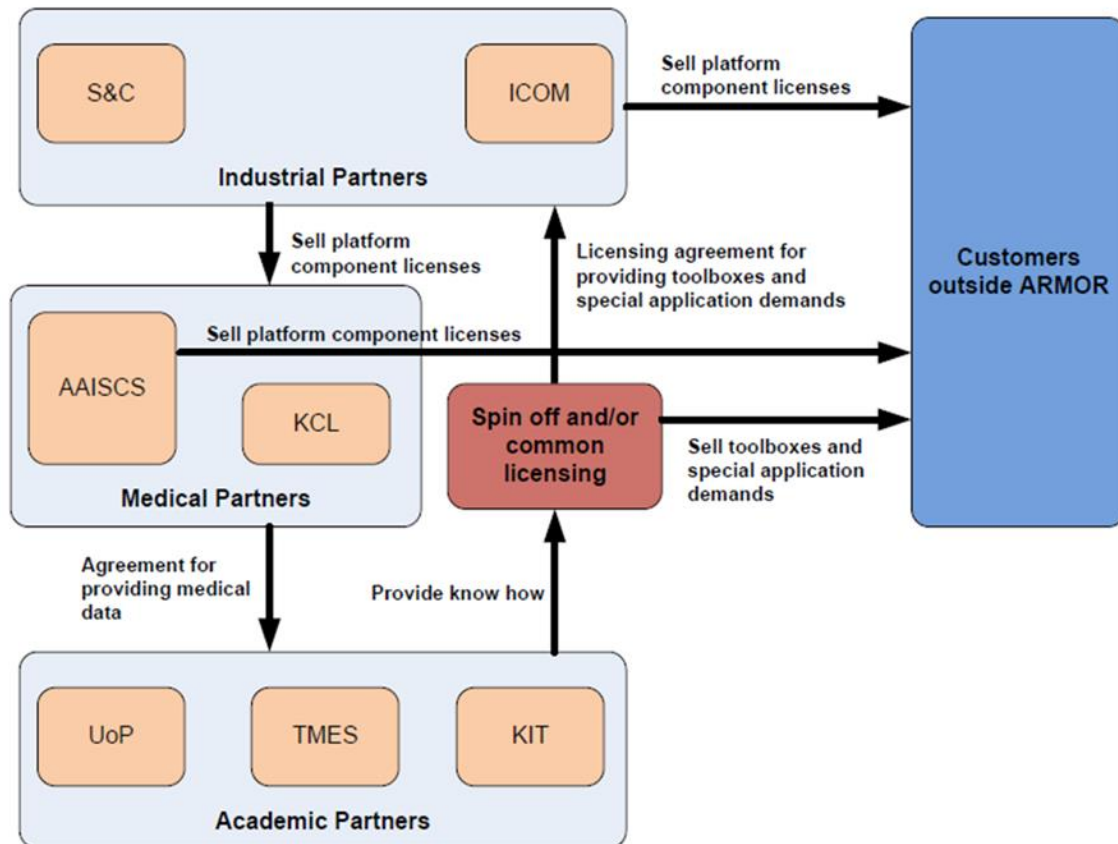
- **Backhaul communication efficiency:** new communication protocols for the data transmission of massive amounts of medical data (e.g. multi-sensory EEG data captures) have been developed both for automatic/programmatic as well as manual upload/download to/from the PHR platform. The data proposed protocol combines the programming flexibility of the WEB Service approach with the data transmission reliability and speed of the torrent-like, fragmented data transmission. The latter allows minimizing the need for retransmission of the whole data file in case of any problem with network connectivity, reducing the problem to a retransmission of a much smaller part of it. Reconstruction is done at the recipient side. The WEB service approach allows also for simultaneous transmission of additional metadata describing the sensor data for direct use in the PHR.
- **Handling data in the home gateway.** The entity of the ARMOR MW and the operations it offers is an innovation offered by ARMOR. Exploiting state-of-the-art tools such as xAffect and StreamInsight and the automatic upload to central server (PHR) without user intervention, , etc. area innovative ways of using existing tools. The most important innovation within the home gateway is the way the data is being handled from sensors to on-line processing algorithms that can be implemented within ARMOR's StreamInsight. Online data stream management and analysis capabilities explored in the context of ARMOR are useful and will be exploited in other areas as well (such as smart energy, etc). The communication within the middleware is based on IP connectivity, thus allowing creating multiple instances of processing algorithms running within StreamInsight in separate IPs, thus instances can run in the same home gateway or can run in different machines, which opens the way to introduce distributed computation within ARMOR, assuming the communication bandwidth and QoS between the home gateway (sensors) and the instances of on-line algorithms are valid. Distributed computation through the developed instances of StreamInsight within ARMOR will take advantage of cloud infrastructure in near future, once the official release of such a technology is available from the supplier, so it aligns home gateway to take advantage of huge amount of resources at affordable price. On the other hand, the home gateway maintains permanently a link to a central server (PHR) where all data from modalities are stored in automatic way, by schedule or triggered by an event signal coming from the online algorithms or sensors. In this way, sensor data is always almost 'on-line' for doctors and/or caregivers. Moreover, home gateway provides means of communication of important events from the patient to caregivers and/or doctors, offering the way to maintain a direct link between them. Based on the events reported from the home gateway, and the protocol defined, doctors can provide instant attention to those events/patients that requires special type of assistance. Once again not typically considered as innovation but, defining and putting in a document a set of "Data Management Processes" and defining an "Ethics Blueprint" could be considered an innovation since they both may

contain already existing information but these information are not found somewhere else in a concentrated, well defined manner.

- **In the context of the PHR, the innovation is focused on the change in the inherent use context of the platform.** Commonly PHR systems are used as means of storing personal physiological measurements, treatments, prescriptions, etc. No group based data management has been performed in PHR/EHR systems yet. The ARMOR project shows a new way of looking at the PHR as an enabling technology for supporting medical research on data coming from the large patient base. Approaches to analyzing individual health condition based on rules derived from data of a group of patients is also an innovative approach with respect to PHR that has been pursued by the whole ARMOR consortium.
- **Recording Data Management.** In the context of offline data management a database for storing the available data and meta-data within the multimodal recordings was developed. The innovation of this database is the transition from the current file-oriented data management to a more complete approach through a relational database management system. The corresponding database schema is an outcome of the collaboration between the ICT and clinical/medical partners, since it integrates both the data management requirements of the latter and supports a large number of possible queries performed by the analysis algorithms. In contrast to the current management processes, this database expands the data-access capabilities by allowing clinical/medical partners to perform analytical queries and easily acquire data and summaries of interest. Furthermore, ARMOR's database supports content-based queries, i.e. give a waveform of interest find the most similar in the database. Although this concept is popular in the database research community, its application in ARMOR's multimodal, time series data is an important innovation for two main reasons: a) it will be a useful tool for clinicians since they will be able to search the recordings from a large number of patients for specific waveforms of interest and b) the utilization of this function by offline analysis algorithms in order to accelerate the computations by querying sequences of pre-calculated features. The database schema and the extended functionalities it provides including analytical capabilities, are useful not only in the context of ARMOR and epilepsy but also in other brain disorders and diseases and medical contexts and will be exploited further in other domains as well. Compared to the database designed and developed during the EPILEPSIAE FP7 project, ARMOR's database can track the analysis performed on the available data by storing the recordings on which the analysis was performed and the corresponding result files. Furthermore, ARMOR's database treats the annotations as an output of a manual analysis process, fact that allows having in parallel annotations from multiple researchers that were performed for different analysis types. Annotations of certain events of interest are also provided through automatic tools developed in ARMOR. The database holds both manually annotated and automatically annotated data.

#### 4. EXPLOITATION SCENARIO OVERVIEW (DOW)

A potential exploitation scenario, which could form the basis for a commercial co-operation between the ARMOR partners, is illustrated in Figure1.



**Figure 1** The possible exploitation scenario of ARMOR results (DoW)

The main idea is to offer ARMOR platform services to the medical partners of ARMOR but also to customers outside the ARMOR consortium. In this scenario, the exploitation of the whole system/technology as a service will be offered to hospitals and companies/organizations offering medical services. The idea is that these companies are offering the real-time monitoring and diagnosis service 24 hours a day, 365 days. The end-customer will have an on-line service in case of alarm and additionally periodical reports with the evolution and comparison with historical data and other patients. The end-customer will pay a monthly flatten rate for the basic services and some additional fee for extra service. The company/companies that will provide the technology (consortium companies) will get money based on three items:

1. Onetime payment amount for the delivery of the hardware;
2. Onetime payment for the setup of the service once the medical organization has a new patient/customer;
3. A monthly payment for the use of the software (service) and maintenance.

Alternative scenarios that are possible are:

- All partners owning the project outcomes separately and as a whole under a specific contract of exploitation in different target markets

- Partners may initiate a new company, where each one participates with a specific capital share and responsibility.
- Relevant results of the project will be patented on behalf of the ARMOR partners. For that purpose, an activity will be established as part of the Project Management work package

The exploitation plans obviously vary between the different (industrial, academic) types of organizations within the consortium. In general, universities and research institutions provide the technology transfer to the industrial partners. The main directions for the exploitations of the ARMOR project results are:

- Scientific publications
- Royalties from inventions made
- Reuse of the knowledge acquired for further RTD contracts, in particular from the industry

The academic partners in this project also intend to exploit the project to raise the level of education, both by giving Master and PhD students the opportunity to work on cutting-edge research in a European collaborative effort as well as by using the research results in the teaching process of undergraduate and graduate students, allowing courses and seminars to be taught using current technology and research results.

The previous scenario is an ideal exploitation scenario, however it is also challenging because:

- Requires the engagement and motivation of all the partners for exploitation and some of them have not the profile for it.
- It is not an S/T scenario, previous to this scenario an intermediate stage is necessary where the services offered by ARMOR results develop and are completed before to be launched to the market. In other words, after the finalization of ARMOR the resulting services will be not ready for commercialization, but will be completed for exploitation.

We have been collectively working in a short term action plan to globally exploit ARMOR results considering the previous two premises. We define the exploitation phase in 2 sub-phases: 1.-an intermediate phase where the results of ARMOR will be translated to a marketable services/product; 2.- the commercialization phase. The most relevant conclusions are:

#### 1) Consortium

This may be a big obstacle through the commercialization. Therefore our main priority has been to be pragmatic and to consider the motivations and expectations of each organization. We have not yet a definitive model, however we have already defined the basis for a global agreement, that will be further refined later in the intermediate phase. A preliminary Memorandum of



Understanding has been agreed among the different partners forming the consortium for a common exploitation framework after project termination:

- After project development it will be created an “exploitation task group” with representative members of each organization with the aim to keep ARMOR alive after finalization.
- All the organizations will have the right to exploit the ARMOR results or to grant the rights to a different organization in the consortium. After project termination, if a partner decides not to participate in the exploitation process, the partner may opt to receive a monetary compensation once the first results arise. Concrete figures should be negotiated.
- Once the project finalises an intermediate phase will start where the main priority will be to translate the project’s results in a marketable product/service. At the moment to write this deliverable it is difficult to calculate a precise figure, however based on our experience and a preliminary investigation, an interval ranging between 5M€ and 15M€ could be a reasonable expectation depending on the time to market, the scope pursued and the ambition of the exploitation strategy.
- The added value provided by each organization will be accounted with regard to three different assets: 1.-the background provided in the project; 2. - the foreground created by the organization, both independently or together with other/s partners; 3. - the contribution that each organization will provide after project termination with the purpose of commercialization, both in terms of monetary investment and/or other resources. This step will be a key as it will determine the “% of rights” of each organization during commercialization phase.
- During the last phase of the project development and after finalization, a set of the dissemination actions will be addressed to potential investors for a later commercialization phase.

## 2) Leadership

It is of vital importance to establish a leadership into the exploitation process. Most of the trials fail due to a bad structure among the partners and also for a missing leadership in the actions.

Internally we have discussed in a plenary meeting the most suitable management structure for the ARMOR exploitation phase, concluding in the following:

- a) It will be a group of drivers on the exploitation lead by S&C. This group a part of S&C will be composed of KCL, ICOM and AAISCS because:
  - The experience of S&C in porting IP from research to market is an add value for the management of the different actions to be addresses during exploitation.
  - KCL is the key partner for exploitation. KCL is a channel to end users and also has the market experience. This means that they can provide the necessary specifications to make the services af-

fordable for the users. Moreover KCL knows the different stakeholders interested to invest in ARMOR results.

- ICOM is a successful industry with resources and experience on ICT market. They will increase the participation in the exploitation as far as a clear picture of expectations are drawn-
- AAISCS will balance the research and the market approach; it is a small SME with clear objectives of exploiting the know-how that has been growing, thus providing the motivation to succeed in the market.

- b) A second group will be composed of “followers” which will provide the scientific and organizational support to complete a successful exploitation phase. This group will be integrated by the rest of partners: UoP, KIT and TMES. They will aim at a royalty when the commercialization phase achieves the break-down.

### 3) Business Volume

Epilepsy is a common, devastating and still incurable disorder. Although in most cases its symptoms can be ameliorated by life-long pharmaceutical treatment, still this treatment needs continuous adjustment and change to retain its efficacy. Due to its multifactorial causes and paroxysmal nature, epilepsy needs multi-parametric monitoring for purposes of accurate diagnosis, prediction, alerting and prevention, treatment follow-up and presurgical evaluation. The incidence of epilepsy is age related, higher in children; Epileptic seizures occur in 1-2% of the general population and in 4% of children. During the periods of childhood and adolescence non-epileptic paroxysmal events (NEPE) also occur more frequently than in adult life with similar clinical features. It is important to note that 30% of people with epilepsies have also NEPE. Furthermore, epileptic seizures differ with respect to motor, cognitive, affective and autonomic and EEG manifestations. Their recognition and full understanding is the basis for the optimal management (including additional diagnostic tests and genetics) and treatment. The total cost of epilepsy in EU is counted upwards of 15 billion euros per year, with the severe impact on the patient of the social stigma and the feeling of unpredictably seized, being unaccountable.

Considering this numbers, the total market volume world-wide comes to a total of more than 60 million. Considering only Europe, the total figures offer a potential market of 5 Million and if we extend to industrialized countries the total market is near to 30 Million users.

The price for the services resulting of ARMOR is not yet defined as it depends in several technical factors and also on the study of the price that are ready to pay the users of the services. Considering a recurrent model, we can estimate a monthly fee ranging between 5€ and 40€, which translate to the most likelihood market (industrialized countries) sums a potential revenue ranging 1,8 billion to 14,4 billion yearly.

If we accelerate the market introduction, we may have an advantageous position into the market and expect a market share of 20%-30%, after 5 years of exploitation which results in turnovers ranging 360 Million € and 4,3 Billion €.

4) Steps to a marketable solution.

**a) Business Strategy**

We will challenge the underlying assumptions of our current business idea with the aim of delivering a more accurate and convincing value proposition to potential customers, partners and investors. Strengths, weaknesses, opportunities and threats should be exposed. The features of our innovation will be benchmarked against competing solutions. Key milestones for the next 5 years should be reviewed and refined and strategies will be implemented to reach them. We should purchase professional market reports to gain reliable insights into six initial target markets. A. Relevant market aspects include: target customer segments, customer expectations, desired services and features and their willingness to pay ARMOR services. Moreover we should carry out thorough research regarding competing solutions currently available or expected to be launched, market share of each player, estimated rate of adoption for similar solutions, service costs, support costs, distribution costs, marketing costs, among other variables. We should adjust our revenue and expense forecast along with our strategies for pricing, funding and geographical expansion.

**b) Enrich the User Experience**

In order to attract customer interest and hence boost market penetration for the service, it is very important to provide them means of using the solution in the most friendly and convenient way possible. We target mobile phone and tablets to provide the best user experience. Starting from the current market/design trends in user interfaces, this task will deliver graphic design guidelines and will create mockups of user interfaces.

**c) Multi-channel Marketing Strategy and dissemination plan**

In order to reach a large number of potential clients and investors, we should grow an aggressive marketing. We should target to demonstrate our innovations at annual exhibitions in Europe, including large international events. A high quality company image will be maintained throughout all visual communication channels. A company website will be continuously improved and updated. Social media campaigns should be stepped up. To effectively follow-up and measure the impact of our actions, a professional *Customer Relationship Management* software should be implemented.

**d) Protect Intellectual Property and Commercial Interests**

A third part agency will be subcontracted to elaborate a complete intellectual property protection strategy. This will ensure that our innovations and business model delivers a sustainable competitive advantage, thereby lowering risk for investors and increasing confidence among commercial partners. Various protection instruments will be evaluated including: patenting, freedom to operate analysis, trademark registration, documentation of trade secrets and reserving product domain names. Additionally, our non-disclosure agreements and existing partnership contracts will be reviewed and amended to fully protect the company's trade secrets. Finally, a preliminary analysis of service contracts,

licensing agreements and regulatory issues will be conducted to minimize our exposure to risk during the commercialization phase. Relevant standards and protocols for data security, data privacy, communication and safety will be investigated and a plan for compliance will be prepared for each target country.

**e) Plan for adopting Information Technology Infrastructure Library (ITIL) method**

Adopting the ITIL method into the future organizational model is a key issue: both for improving the management of IT operations and processes and then for providing the organization with additional tools to accomplish business goals. During exploitation phase we should use the ITIL method in order deliver the best service to our customers. We should divide the efforts in: a) assess the business processes benefited from ITIL, b) define objectives and goals, c) define the corporate service's structure, d) select roles & role owners, e) define interfaces and control tools.

**5) Financial Resources**

To make possible to launch ARMOR services into the market, funding is necessary. Most of the participants in ARMOR are either research centers, Universities or SMEs with no financial resources to invest in the exploitation of ARMOR, therefore the consortium will address the efforts to search external funding.

A set of actions have been established that can be divided in two categories:

- 1) Public funding: we will apply for H2020 funding programs, targeting either Research & Innovation Actions or Innovation actions. We will give priority to innovation actions. In parallel and when the structures of the exploitation organization are firm, the consortium will apply for specific programs like Fast Track Innovation and/or SME Instruments, more oriented to launch IP to the market in form of marketable products/services. We will investigate the integration of new technologies in ARMOR that help to approach the services to the customers. In concrete we are investigating the use of ARMOR services by means of serious games. One of the actions is to promote ARMOR project and to find partners/technologies in the brokerage event of the Gamesmatch 2014 held in Köln between 11-15 August, where a part of the exposition and congress events a B2B session between technology suppliers and technology purchasers will be held.
- 2) Private funding: we will approach investors to attract the necessary funds for the commercialization. We will be more accurate in the potential of the services we are going to launch and also on the impact they may have in monetary terms. Although SME Instrument already contemplates this possibility, we will approach private investors individually.

## 5. INDIVIDUAL EXPLOITATION PLANS

The draft version of the ARMOR partners' individual exploitation plan, both reported in the DoW and updated in month 19, is reported below:

### 5.1 S&C (SME)

*DoW:* The system proposed by the ARMOR Project will greatly complement our existing technology and allow us to directly target the currently growing eHealth market leading to good commercial benefit for ourselves, our partners and through promotional activities, the wider European ICT community. We would like to exploit the technology based on the services that could be provided by the software. Main purpose is to receive a % of selling the hardware and a monthly fee for the use of the software.

*Updates on M19 and 30:* We would like to exploit the technology based on the services that could be provided by the software, more concretely the middleware carried out during the project. Main purpose is to receive a % of selling the hardware and a monthly fee for the use of the software.

- 1) Services/Functionalities:
  - a. Telecare (transmission of messages): Real-time alarm situations;
  - b. Monitoring Services, anytime everywhere: To monitor (smartphone, PC, tablet...) biometric constants and uploaded it into a database.
- 2) Movisens Sensors + xAffect + Middleware: A sensing and data management unit capable to collect, pre-process, store and show health sensor data information in any smart device.

**S&C will link ARMOR services to the Smart/Digital Home concept.** The enControl product developed by S&C is offering services for security and energy management and wearable devices and health monitoring represent the next steps for the S&C Business plan.

### Why Smart Homes?

Smart home solutions consist of a wide range of hardware and software technologies. As a result a complex ecosystem is emerging comprising whole-home solution vendors, product OEMs and smart home platform vendors. Traditional whole-home solution vendors such as Crestron, Control4, Gira and Jung are facing new competition as telecom operators, security service providers, energy companies and other vendors are entering the industry. This is leading to a rapid increase in consumer awareness which is benefitting all players. At the same time, the market is undergoing a major transformation. New entrants such as Vivint, ADT, Comcast and Vera Controls in North America as well as eQ-3 and SFR in Europe have already managed to establish themselves among the top five whole-home solution vendors in their respective regions. The product OEM category consists primarily of incumbents with decades of experience such as Honeywell, Whirlpool, ASSA ABLOY, Somfy, Philips and Sony. However, connectivity is giving birth to new device categories

and redefined value propositions in several application areas such as interactive security and smart thermostats, enabling companies such as D-Link, Sonos, Belkin, Ecobee, Nest, and Numera to enter the market. The smart home software platform category is today led by specialized technology vendors such as iControl, Alarm.com and AlertMe. These vendors have primarily competed against in-house development efforts from smart home solution vendors, but are now also starting to face competition from large technology companies such as Arris, Amdocs and Technicolor that have entered the smart home platform market

Smart home systems can be grouped into six primary categories: energy management and climate control systems; security and access control systems; lighting, window and appliance control systems; home appliances; audio-visual and entertainment systems; and healthcare and assisted living systems. North America is the most advanced region in the world for smart home solutions with an installed base of 3.5 million systems in 2013. An estimated 0.7 million of these were multifunction or whole-home systems whereas 2.8 million were point solutions designed for one specific function such as climate control or security. As some homes have more than one smart system in use, the installed base represents a total of around 2.9 million smart homes. Market growth has been very strong during 2013 and North America is on track to reach an installed base of 6.5 million smart home systems by the end of 2014. Between 2012 and 2017 the installed base is forecasted to grow at a compound annual growth rate (CAGR) of 55.0 percent to reach 31.4 million smart home systems. Berg Insight, a recognized company specialized worldwide in providing business intelligence to the telecom industry, estimates that the North American market was worth EUR 1.2 billion in 2012, including revenues from hardware, services and installation. The market is expected to grow at a CAGR of 42 percent between 2012 and 2017, reaching EUR 7.1 billion in yearly revenues. The European market for smart home systems is still in an early stage and approximately three years behind North America in terms of penetration and market maturity. At the end of 2012, there were a total of 1.06 million smart home systems in use in the EU27+2 countries. Around 0.15 million of these systems were multifunction or whole-home Systems whereas 0.91 million were point solutions. This corresponds to around 0.93 million smart homes when overlaps are taken into account.

Smart home market growth has been solid during 2013 and Europe is on track to reach 2 million smart home systems by the end of 2014. Berg Insight forecasts that the installed base of smart home systems in EU27+2 will grow at a CAGR of 56.0 percent in the next five years to reach 17.4 million systems by 2017. Smart home solution revenues in EU27+2 reached an estimated EUR 0.39 billion in 2012. The market is expected to grow at a CAGR of 46.0 percent between 2012 and 2017 to reach EUR 2.6 billion at the end of the forecast period.

Homes, and the way we live and behave in them, have changed dramatically in the past ten years. Today, fundamental trends have emerged to drive the take-up of Smart Homes:

- Societal trends – Society is ageing; in 2020, a fifth of the European population will be over 65 years old and single parent families are expected to represent 21 percent of total families, increasing demand for new services in the home.
- Digital addiction – Forecasts predict there will be on average 3.6 screens per person in Europe in 2015 (including smartphones and tablets) versus 1.7 in 2000. This development is a strong enabler for Smart Home applications as portable devices are the perfect counterparts (as controllers) for smart applications in the home.
- Strong push by large players positioning homes at the centre of the digital ecosystem – A wide range of leading players are entering the Smart Home market, including Over-the-top players (such as Google and Microsoft) offering applications and operating systems, telecom and utility service providers (such as Telefonica, E.ON and GDF Suez) managing the customer relationship, and appliance manufacturers (such as Philips, and LG with the LG Homnet) providing Smart Home devices

There is a window of opportunity today for ARMOR services integrated in a Smart Home solution, as these trends are developed enough to make Smart Home a potential business. Consultants experts like Arthur D. Little or Deloitte estimate that Smart Home revenues will grow by 12 percent a year until 2020 in Europe. This revenue sizing includes both direct revenues, such as home automation services/products, and indirect revenues, such as the maintenance of the new devices/services. Smart Home markets are still in an embryonic phase and many players are entering the market. Telcos and utilities are one of them, and should act now in order to capitalize on the opportunity.

For smart home healthcare, we should also consider the learning curve of individuals ready to install system for the purpose of comfort and energy savings. For these application areas the benefits are quite clear and increasingly people are willing to invest money. At a later stage when some additional care is needed the backbone to offer services is already available. It therefore only requires a little additional investment to acquire the needed healthcare services. Furthermore people are already used to operating the system so the learning curve for a new service is shorter. Specialized equipment and also equipment that people might only use for a limited amount of time could in this case be rented or leased.

### **Business model of S&C for ARMOR results**

ARMOR resulting platform could be exploited integrated in the current platform of S&C enControl, which offers security, comfort, automation and energy management services. Sensing & Control has a commercial product into the market devoted to Smart Homes, offering services for remote monitoring and control in the areas of security, safety, energy management and home automation. The business strategy S&C is aligned with the expected results of ARMOR and also with the exploitation aim of the project. S&C would like to

incorporate the services created in ARMOR in its product/service offer in order to keep and enlarge competitiveness in the market.

Based on the smart homes markets, two different approaches of business models will be analysed during the framework of the project commercialization by S&C, with the aim to select the most feasible or both. In concrete it will be analysed the following models:

- 1) A personalized Health care business model where the main value is the shift in the healthcare industry towards a patient-centred approach in care delivery**, treating patients not as passive recipients of care but as active participants of personal care management, with the ability by patients to decide the level of interaction and anonymity in any interaction with 3<sup>rd</sup> parties. At the core of this patient-centred care approach will be patient engagement, which involves patient interaction during and after care episodes and promotes long-term behavioural changes that lead to better health outcomes. The objective is that the healthcare industry uses Health platform services to deliver more personalized care and cut wasteful spending via this patient-centred approach.

The ARMOR platform will be exploited by medical institutions and insurance companies that will provide the services associated to ARMOR. Basic services provided by the tool and the tool analytics (for instance physical activity, seizures, alarms, etc.) may be offered by free and the most professional services will be charged according to the service required.

In addition the platform will allow to medical institutions and insurance companies offering to healthcare service providers to be promoted in the platform in a selective way: the individual's profiles will provide to healthcare service providers the concrete needs they have and therefore the offering of services can be much more efficient and therefore the value of advertising will be higher.

- 2) The platform will be integrated as smart home services environment and will be offered to main business drivers: telecom, utilities and other services providers (for instance homeland security).**

Two main target customers will be considered in this business model that will be investigated in the framework of ARMOR commercialization utilities and telecom:

- Several telecom companies have announced recently new healthcare initiatives dedicated to providing healthcare services. For example, last year AT&T launched AT&T ForHealth, a collection of services dedicated to accelerating the delivery of wireless, networked, and cloud-based systems specifically for the healthcare industry. Verizon unveiled the Verizon Health Information Exchange, a cloud-based service that consolidates clinical patient data and makes it available over the Internet. Last year also saw Sprint enter into a partnership with mobile medical software developer AirStrip Technologies to transmit medical data over wire-



less networks. As telecom operators shift toward increased data usage, they are looking to exclusive, value added services as new sources of revenue. Mobile data represents a fundamental shift where the new, fully integrated capabilities demand a reorganization of the business model and value chain to support and drive growth for the newly generated consumption patterns. This transition will be operational, requiring seamless integration of the mobile platform channel into the operational model, adding new levels of complexity but creating untapped revenue opportunities. Within health care, this type of integration would allow patients to receive patient care remotely and improve self-care, centralizing important resources and reducing the strain in underserved regions. New stakeholders are now entering with innovative business models, forcing entrenched players to compete with entrants who have designed mobility into their initial business model. Platform developers and operators that connect these new audiences are emerging to consolidate the market and take advantage of their collective transaction volumes.

- For utilities, deregulation of the electric and gas utility industry is creating new opportunities for the healthcare industry to manage and reduce costs. Energy industry executives are implementing new product and service offerings to retain and attract customers, as well as to maintain overall profit margins. As a traditional intensive user of electric, gas, and other utility services, the healthcare industry is positioned to become a prime beneficiary of utility restructuring initiatives.

S&C has already commercial contracts with telecom companies around the world offering current services. Telecom providers are a clear target for the exploitation of the services created in ARMOR.

In addition the business model of S&C is compatible with the exploitation aims of the rest of partners. The core business of S&C is the license of the platform's services charging a monthly fee per smart home. Sensing & Control provides to their customers (telecom for instance) a complete solution, including HW devices (or other IPs) and ancillary services. All the devices are purchased to partners of the company. In this sense the different outcomes (foregrounds) generated into the project maybe integrated in the solution of Sensing & Control, receiving the corresponding revenue for the use of it.

#### **Interoperability at business level**

S&C will also implement in the commercialization phase an interoperable business model. Adopting principles of interoperability and standardized business processes and systems is necessary for a successful business model that depends on the delivery of eHealth services in different countries / areas. In ARMOR commercialization we will leverage interoperability to transform customized approaches to repeated deployment of proven business processes and systems across multiple regions and/or countries. To do that we will implement:

- 1) Semantic Understanding
  - Define common message set for the demand and the offer.
  - Define common mechanism of extracting messages from different market signals
  - Define a scheme of addressing the platform and functionalities depending on message type and content
- 2) Business Context
  - Define a metric for QoS qualification and quantification.
  - Define performance attributes for the demand (%share, number of inquiries).
  - Adopt standard validation practices.
  - Define common staging and commissioning practices
  - Define business performance operational metrics
- 3) Business Procedures: Establish business infrastructure to acquire demand
- 4) Business Objectives
  - Fix common objectives for business at different stakeholders.
  - Long term purchasing contract foster long term alignment of objectives for the stakeholders in the resource supply-chain
- 5) Economic and Regulatory Policies: Identify and integrate Policies and market rules at global and local level.

### **Business volume forecast**

The business volume ambitioned by the exploitation outcomes of ARMOR is expected to grow in the coming years by 42%-46% CAGR. As we have described in a previous section, we believe that the key of a successful market penetration is the adoption of the system by consumers; therefore we have modelled a smart-home enabled by prosumers, as starting point of our exploitation roadmap. Nowadays the potential benefits enabled by eHealth services have not begun to be exploited in a massive way and there exist barriers for their adoption, both from the consumer side and from the distribution side.

With ARMOR we will develop value-added services for both the consumer and the health service distributor/provider, offering the consumers' data at an affordable price and through the deployment of new services and novel business models.

We will customize different business plans for each potential customer, customers will be charged a monthly fee ranging from 5€-15€ in exchange for value-added services defined in ARMOR for smart home ehealth services. Target customers, for instance medical institutions or insurance companies, will produce turnover based on this fee, and the HW installed, which in turn may have also two different business models (either rental or selling). In our analysis we will consider only the fees generated by the 1st concept, considering as average an initial penetration of 2.000 home & business consumers and a CAGR of 40% yearly, with an average monthly fee of 10 € of which 3€ will be the royalty for the ARMOR exploitation. In the following table is shown a plan for 6 years in €.

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Customers adopting the ARMOR ehealth solution	2.000	2.800	3.920	5.488	7.683	10.756
Monthly fee (assuming average 10€)	240.00 0	336.00 0	470.40 0	658.56 0	921.98 4	1.290.7 78
Royalty for ARMOR	72.000	100.80 0	141.12 0	197.56 8	276.59 5	387.23 3

For the calculation of the Return of Investment we will consider 3 levels of investment, including the investment of ARMOR development and the resources invested after project termination for the commercialization phase: 18 M€, 28M€ and 53 M€ (including the operational costs and structure costs of the years we are contemplating) . For each of these 3 figures we will associate different rates of customer acquisition: 50%, 80% and 150% (penetration rate for this purpose is the number of customers acquired in one year starting by 5, 8 and 12 respectively). Here customer refers to the target customers of the ARMOR platform. The following table shows the expectation of this rough analysis of the volume forecast.

Turnover	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
<b>Investment 18M€</b>						
<b># Customers</b>	5	7,5	11,3	16,9	25,3	38,0
<b>Turnover</b>	360.000	756.000	1.587.600	3.333.960	7.001.316	14.702.764
<b>Investment 28M€</b>						
<b># Customers</b>	8,0	14,4	25,9	46,7	84,0	151,2
<b>Turnover</b>	576.000	1.451.520	3.657.830	9.217.733	23.228.686	58.536.289
<b>Investment 150M€</b>						
<b># Customers</b>	12,0	30,0	75,0	187,5	468,8	1171,9
<b>Turnover</b>	864.000	3.024.000	10.584.000	37.044.000	129.654.000	453.789.000

Operational costs and further investment have not been included as they need a deep analysis to be carried out during the commercialization of ARMOR. In any case, the Payback Period may be reached in year 5/year 6 with a conservative penetration rate assumed.

## 5.2 TMES (academia/ research))

*DoW:* TMES plans to make use of the work conducted in ARMOR so as to extend its research activities in the area of medical systems. Having many years of experience in embedded systems, telecommunication and security; it plans to combine it with the results of ARMOR. More specifically, the security algorithms, which will be developed and implemented in ARMOR, will be used to develop the next generation embedded devices for securing seamlessly the

data of the patients, both during transmission and storage. TMES has already contacts with local and European industry, which plans to strengthen through the results of ARMOR as far as security is concerned. Moreover, TMES will take advantage of the ARMOR results regarding multi-parametric data analysis algorithms and their speed up through hardware implementations. In that direction, in co-operation with UoP, it will promote the research in the relevant areas and it will pursue future research co-operations in the common fields.

As an academic organization, the main focus of TMES is promoting research in ARMOR related areas. In parallel, TMES is also looking into the possibility of exploiting ARMOR research results by pursuing new collaborations for improving and extending the technology developed at ARMOR. The exploitation paths currently used by TMES are both *academic* and *industry* oriented.

Regarding the academic exploitation of ARMOR results, TMES has established collaborations with major Greek and European research institutes and universities, attempting to extend ARMOR work in other similar areas of interest e.g. elder monitoring. To that extent, and in order to guarantee the continuity of the research conducted in ARMOR, TMES is collaborating with the following research entities:

- National Centre for Scientific Research “Demokritos”, Greece
- Ruhr Universitaet Bochum, Germany
- Robotnik Automation SLL, Spain
- Fondazione Santa Lucia, Italy
- Frontida Zois
- Fundació Hospital Asil de Granollers, Spain

TMES is also taking advantage of ARMOR technology in order to train junior engineers. For that purpose, TMES has included ARMOR related topics to graduate and post-graduate courses, while is has extensively presented ARMOR in summer schools organized by Computer and Informatics Engineering Department like ATHENA summer school.

Apart from pursuing research collaborations for extending ARMOR Technology, TMES is also exploring the possibility of commercially exploiting the research results of ARMOR. In this direction, TMES is in contact with Greek and European SMEs in an attempt to establish collaborations for the potential commercialization of ARMOR results. So far, there are ongoing discussions with the following SMEs, which are members of ARMOR consortium:

- Sensing & Control Systems S.L.
- AAI Scientific Cultural Services Ltd, Laboratory for Human Brain Dynamics, SME, Cyprus and

In parallel, TMES has also discussions with Greek SMEs that have shown strong interest on ARMOR results. More specifically:

- *NOESIS Technology* (<http://www.noesis-tech.com>), an SME providing high performance silicon IP solutions, is highly interesting in the encryption module developed by TMES in the context of ARMOR and there are ongoing discussions how to include the specific solutions to the portfolio of components offered by NOESIS.
- *Diaplous Electronics* (<http://diaplous-electronics.com>) is an SME company that develops appliances enabled with visual perception and has also shown strong interest in the preprocessing/filtering hardware component developed by TMES for ARMOR online patient monitoring.

In order to better support the aforementioned exploitation activities, TMES is currently working for patenting ARMOR results and for that purpose the legal department of TMES is evaluating the available patent possibilities.

Finally, TMES is also exploring the possibility of establishing a spin off company that will take over the task of moving forward the ARMOR research prototypes to commercial products that will be commercially available within 1-2 years after the end of ARMOR.

### 5.3 UoP (academia/research)

*DoW:* UoP plans to exploit ARMOR in (a) their on-going research which investigates the mutual relationship between epilepsy and sleep micro and macro-structure with EEG recordings and brain connectivity analysis, (b) in the training of graduate students of neuroinformatics and neurology and clinical neurophysiology residents, (c) their on-going research on spatiotemporal data mining, pattern recognition and intelligent information systems, and (d) in the training of graduate students of computer engineering and informatics.

UoP consists of two research groups: UoP/CEID team of the Computer Engineering and Informatics Dept. and UoP/NU Neurophysiology Unit team of the Medical School, with research interests in data mining and sleep data analysis respectively. The exploitation plans of UoP mainly focus on using the final ARMOR system or parts of it in:

- (a) expanding into home monitoring their on-going **research** which investigates the mutual relationship between epilepsy and sleep micro and macro-structure with EEG recordings and brain connectivity analysis (more below),
- (b) in advancing diagnostic capabilities in the local health system by **training** of graduate students of neuroinformatics (MDs and engineers) and neurology and clinical neurophysiology residents (more below),
- (c) their on-going research on spatiotemporal data mining, pattern recognition and intelligent information systems, and
- (d) in the training of graduate students of computer engineering and informatics.

For the above purposes we anticipate that one or more sets of ARMOR in its final form and licenses to use will become available to us through specific

agreements between UoP and the ARMOR partners consortium (most probably at the cost of our research grants).

There is no doubt that society stands to gain a lot from developments in sound basic research (especially in challenging and important fields of neuroscience and informatics) and from improvements in the citizens health. In the long run both are reflected in the economy. In addition the development of ARMOR belongs to those innovations (neuroinformatics) which the most authoritative OECD considers as instrumental for sustainable economic growth (see "Market Overview", reference (3)).

The UoP/CEID team plans to exploit ARMOR by strengthening their ongoing research on multi-parametric data management and analysis. The specific modules that UoP plans to exploit (together with other partners involved in their development – please see Section 6.2) are:

1. the compression tools for data storage
2. the on-line tools for multiparametric data analysis and pre-processing
3. the off-line tools for multiparametric data analysis and pre-processing
4. the risk assessment and decision support tools for diagnosis
5. the computer-assisted diagnosis tools
6. the models of epilepsy/personalized models
7. the data management component of ARMOR with analytical functionality

In addition, the software infrastructure and the data collection acquired from the ARMOR project will be used for the training of the undergraduate students, the post-graduate students and the PhD candidates of the CEID team. Moreover, the software infrastructure will be used as part of an overall software framework of the CEID team for future research and development purposes as well as for dissemination of CEID's work to data mining and machine learning communities. Finally, the multidisciplinary of the ARMOR project offers the ability to CEID's students to be trained on applied problems of data mining, in our case medical ones, and develop tools and applications on real-data.

Together with ICOM, UoP/CEID plans to explore possibilities of integrating components of the database that it has developed with the analytical functionality it provides, to ICOM's Electronic Health Record and Care Management Platform making the platform more competitive in the market.

A major goal of UoP/CEID is to use various components of ARMOR that has developed or participated in their development, together with other partners, to develop new products and services for home monitoring of epileptic patients but also elderly or people with disabilities. Several of the analysis tools that UoP has developed can be of interest to companies such as Mentis Cura ([www.mentiscura.com](http://www.mentiscura.com)) that are interested in automatic analysis of large EEG datasets for the study of several brain diseases or disorders. KCL has been already in contact with the company to explore possibilities for collaboration.

UoP/CEID has already performed contacts with industrial partners (MEAZON: <http://www.meazon.com>) and has started collaboration on smart energy technology solutions. In particular, since real-time data management and analysis

solutions are of interest in these technologies, UoP plans to take advantage of the technology that has developed for ARMOR to address problems in energy management. In this application area benefits are quite clear and there is a lot of capital investment by several companies.

The UoP/NU team plans to exploit ARMOR to **strengthen ongoing basic research** on analysis of multi-parametric data by whole night sleep polygraphic recordings of healthy and epileptic subjects by applying the newly developed and existing methodology thus advancing and contributing to medical knowledge on the pathophysiology mechanisms underlying epilepsy. Our current research relates to brain mechanisms underlying the mutual relationship between the level of arousal/consciousness and specific elements of sleep macro- and microstructure to the elicitation of epileptic seizures. Both phenomena are underlined by complex and dynamically emerging conditions in the brain, as influenced by a multitude of conditions. Among such conditions, we already investigate the role of different sleep stages and micro-events as sleep spindles and K-complexes. With the help of analysis tools developed under ARMOR we start extending our medical research to the role of microarousals and to the general body condition (autonomic changes and movements). These research plans will exploit ARMOR's ability

(a) to analyze many synchronous data of different modalities and analyze their possible causal relationships.

(b) study important long term phenomena of sleep and epilepsy, which can better be observed at home environment,

(c) increase our labs potential for international research collaborations and exchanging data with other labs through the PHR system and the data security achieved through ARMOR.

(d) increase our labs potential for receiving funding from both national and international bodies. Specifically the ARMOR project has helped UOP/NU to accumulate know how on recording polysomnography data, various control and epileptic polysomnographic recordings and tools and methods for their analysis and finally valuable collaborations with labs of complementary expertise

(AAISCS, KCL). All these are highly exploitable benefits of our participation in ARMOR, since they are already forming the basis for a series of grant proposals which we are preparing to submit to Horizon 2020.

As explained in: "Market Overview", original neuroinformatics tools developed in academic environments are most often and appropriately shared to mutual benefits in their perfection and integration - at least for now. The data analysis tools originally and independently developed or adopted so far by UOP/NU in the frame of ARMOR research, belong to the type which are usually published in scientific journals rather than patented and exploited commercially, thus helping advance medical research. However the developers of tools at UOP reserve the right to commercially exploit future versions of these tools if and when the market and scientific trends change in this direction. In the event that these tools developed under ARMOR will be found useful to other partners in efforts to incorporate them in a commercially promoted ARMOR, UOP will gladly enter in relative discussions, collaborations and agreements. The latter

will then be overseen by the relevant office of the UOP. The same holds for contributions of UOP/NU to tools primarily developed by other partners.

The tools we developed at UOP/NU relate to analysis of sleep structure and brain connectivity. They helped us study several aspects of sleep and epilepsy relationships and also extend the scope of our relevant to ARMOR medical research

The UoP/NU will continue contributing with original publications to the medical and medical informatics field in peer-reviewed journals and conferences relevant to these fields. Moreover, the tools and concepts developed in ARMOR will be used for training epilepsy medical experts from the MDs trained in Neurology and Clinical Neurophysiology, graduate and undergraduate students (i.e. "Neuroinformatics Graduate Program" run by UoP), PhD candidates and Post-Docs, providing opportunities for future research and new collaborations while raising the level of education by adding courses and seminars based on ARMOR practical demonstrations in our existing courses in training of neurology residents and engineers working in hospital environment.

The UoP/NU lab is affiliated to University Hospital of Patras and is actively involved to the ongoing **training** of resident physicians, visiting and attending physicians of several hospital's departments such as Neurology, Neurosurgery, Psychiatry, Child and Adolescence Psychiatry, Radiology, Anesthesia and Intensive Care Medicine and Rehabilitation Medicine which are expected to benefit by the implementation of the tools and concepts developed in ARMOR to their clinical practice, increasing the diagnostic accuracy of the methods used so far and enabling collaboration for ongoing research within the clinical setting. Thus the final product is expected to be used for several future research projects as well as clinical applications concerning diverse patient groups with neurological/psychiatric disorders, obtaining more empirical evidence of ARMOR's applications.

The UoP/NU team plans to organize workshops and seminars targeting other local medical centers too (e.g. Saint George's General Hospital of Patras, Olympion Medical Centre) which could also implement the ARMOR platform with benefits of the tools and concepts developed in ARMOR, to their clinical practice.

As mentioned in the "Market Overview", the wide application of brain-monitoring systems like ARMOR are bound to demand more advanced training of end users (MDs, technicians etc.). ARMOR as of its nature can be exploited as both tool and object of training. We will therefore exploit ARMOR in training to its use and in advancing general epilepsy diagnostic capabilities in the local health system. The relevant local educational setting is appropriately rich and diverse. Candidate trainees include

- neurology and psychiatry residents (respectively 7 and 10 each year)
- graduate students of three graduate studies programs "Informatics for Life Sciences", "Biomedical Engineering" and "Medical Physics". These are inter-school programs enrolling both medical and engineering/physics graduates (about 15-20 each per year)



- hospital technicians from all over Greece in intense seminars. Thus, the UoP/NU team plans to incorporate ARMOR's concepts into its ongoing teaching activities which expand from undergraduate medical students to MSc and PhD candidates to postdoctoral fellows coming from the medical as well as other fields such as engineers, physicists and mathematicians.

Obviously all above activities which will exploit ARMOR in research and training are expected to substantially benefit UoP (and its Hospital) in terms of scientific prestige, attracting students and attracting collaborations with other Universities and national and international research grants.

Moreover, UoP together with KCL plans to exploit the database of epilepsy data that they have acquired and organized. The exploitation can follow paradigms as such the one by the project EPILEPSIAE where the data is sold to third parties (Universities, Research Centers, Medical institutions) for a price. In addition, UoP together with KCL will benefit from the multiparametric data analysis in their joint research effort to better understand epilepsy and related diseases with several benefits to the society.

Finally, UoP is considering the option of patenting several ARMOR results and has initiated discussions with research institutes and private companies related to ARMOR research in order to identify the potential market interest for the components that have been designed and implemented in the context of ARMOR. We have on-going discussions with the patent office of UoP in order to identify and evaluate the various patenting alternatives. The patent office is performing careful analysis of potential benefits vs costs involved for patenting several new technologies developed

#### **5.4 KCL (end-user)**

*DoW:* KCL (a) will apply ARMOR in their practice of epilepsy clinics anticipating great benefits for the patient, for the logistics of their clinics and for public health expenses. (b) will benefit from ARMOR multi-parametric data analysis in their research efforts to unravel long standing medical questions, i.e. conditions helping a seizure start and stop, EEG correlates of losing consciousness in some epilepsies etc.

Since the ARMOR project commenced, KCL has taken an internationally-leading position as an innovator in out-of-hospital management of epilepsy. In work separate from the ARMOR project, KCL has established a novel approach to obtaining long-term video-EEG monitoring data in patients with epilepsy. Called "Kings@Home", the approach is extremely simple: rather than bring the patient into a specialist monitoring unit in a tertiary hospital, we take the monitoring equipment and personnel to the patient's home. We have shown (14) that, in comparison to data collected in hospital, Kings@Home provides data of similar quality to in-hospital data, is acceptable to clinicians, preferred by patients, and substantially cheaper; furthermore, the use of hospital inpatient resources is reduced with consequent increase in activity in other areas. Kings@Home won the UK National Health Service (NHS) Innovations Challenge Prize in 2013. KCL currently carries out >300 video-EEG monitoring

studies in the patient's home per year in our catchment population (3.5million), and is rolling-out a nationwide pilot study.

The following tables demonstrate the comparison between HVT and IVT regarding their diagnostic yield and costs.

Outcome of initial feasibility study of 5 patients studied with both inpatient video- EEG telemetry (IVT) and home video-EEG telemetry (HVT).		
	Inpatient telemetry	Home telemetry
Habitual seizures recorded (n cases (%))	4 (80)	4 (80)
Interictal discharges (n cases %)	4 (80)	4 (80)
Ictal assessment (n cases (%))	3 (60)	3 (60)
Events in sleep (n cases (%))	4 (80)	5 (100)
Mean time to 1st event (days)	2	2.5
Total events observed	24	36
Electrode quality during events rated "good"	24/24 (100%)	34/36 (94%)
Video quality during events rated "acceptable"	19/24 (79%)	30/36 (83%)
Clinical outcome conclusive (n cases (%))	4/5 (80)	4/5 (80)

The direct costs of HVT (home video telemetry) are 66% of the direct costs of inpatient video telemetry -IVT (£1083 versus £1639 per case, assuming 3 days of data collection). In our setting, the surplus generated per case was doubled, from £561 per case for IVT to £1117 per case for HVT.

Costs (British pound)	IVT	HVT
Inpatient stay costs, 3 days @ 300 per day	900	-
Technician time to review data, 8 hours at 39 per hour	312	312
Technician time away from the hospital, 6 hours @ 39 per hour *	-	234
Consultant time, 4 hours @ 88 per hour	352	352
Consumables	75	75
EEG equipment lease (5000 per year) **	-	50
Travel costs	-	60

Total direct costs	1,639	1,083
Income per patient (HRG AA20Z) ***	2,200	2,200
Surplus	561	1,117

### Supplementary Online from Brunnhuber et al. Seizure 2014

Economic model of HVT based on the Pre-Implementation Pilot Study.

\* includes travelling time

\*\* assumes 100 cases per year

\*\*\* fixed income tariff for video-EEG telemetry in UK NHS

Kings@Home uses conventional portable EEG and video from commercial vendors; data is collected locally and stored locally without transmission; data are physically transferred back to the hospital for analysis using portable media; and data analysis at the base hospital uses conventional tools only. Hence the innovation is merely the relocation of a diagnostic monitoring service to the patient's home. This provides a crucial and well-demarcated opportunity for ARMOR: the principle of home monitoring in epilepsy is now fully accepted by the UK NHS, but the current Kings@Home service is extremely limited in its functionality – ARMOR can provide a vastly improved service, with automated remote monitoring, analysis and alarms.

At the current time, ARMOR is not yet a commercialisable product. In the view of KCL, as typical end-users, there are still considerable steps to make before ARMOR could be brought to market as a full system. Essential steps include:

#### (1) Hardware.

The ARMOR project was funded by a programme which specifically did not allow the design of new devices, hence off-the-shelf components were used. For development of the system, these have served their purpose, but for future development, epilepsy-specific hardware with proven and wider capabilities should be sought. In particular, we would seek to integrate dry electrodes into the system, and to seek opportunities to make use of signals collected from invasive devices currently used by epilepsy patients (such as Deep Brain Stimulation, cortical / hippocampal stimulation, Vagus Nerve Stimulation); any of these devices could supply a brain or cardiac signal to the ARMOR platform. Epilepsy-specific and proven movement sensors have been described in the Initial Market Survey, and should be integrated into the ARMOR platform. More recent innovations such as ProGuardian (Cyberonics) could also be integrated. Progress towards developing a platform using superior hardware will require the development of partnerships with device manufacturers. KCL has already introduced Lifelines (<http://www.lifelines.com>) to ARMOR, and the platform has integrated their TrackIt EEG system. Further work will be needed to incorporate optimal sensors for other modalities from other vendors.

According to our experience, hardware companies, such as those that currently work in partnership with KCL, are keen in initiating new cooperations with big medical partners and will be supportive throughout the integration and usage procedure. Hardware companies' technical experts and ARMOR technical partners have shown that they can efficiently collaborate for the adjustment of different sensor types and their integration and implementation in the whole ARMOR platform,

## (2) GUI

The current interface for clinical users and patients at the home gateway serves its purpose for the development of ARMOR, but would need specific work to become optimized for routine use. KCL is aware of products already on the market which could be readily incorporated to the ARMOR platform. For viewing signals remotely and in real-time, Lifelines has worked with Kvikna (<http://www.kvikna.is/>) to develop and implement software and a highly usable GUI for EEG and related signals in epilepsy. In initial conversations with KCL, Lifelines and Kvikna are both potentially interested in further work with ARMOR. A GUI for patients needs to be further developed, and there is enormous potential to integrate this with collection of other data which might be uploaded to PHR and itself be analyzed for signals which might warn of impending problems: for example, the patient could enter data to a smartphone app regarding sleep, mood, taking medication, stress etc. A highly relevant product is in development with Curelator (<http://www.curelator.com>), who have indicated to KCL their interest in future work with ARMOR.

The cooperation of ARMOR with other companies to deliver an innovative and user friendly graphic environment service is expected to produce shared income from the exploitation of a competitive commercialisable product that will be widely used by state and private hospitals, epilepsy centers/ outpatient clinics and neurology practitioners.

## (3) Online real-time signals processing

A relevant feature for the success of ARMOR is its potential to combine an enormous capacity for data storage with analysis. It is unlikely that any of the current partners could themselves provide this massive up-scaling themselves. However, a commercial entity already exists whose business model is to provide rapid analysis of large EEG datasets automatically online (Mentis Cura, <http://www.mentiscura.com>). Mentis Cura currently provide online automated EEG diagnostics in the fields of Alzheimer's and ADHD, but initial conversations with KCL suggest they would be interested to develop a service in epilepsy. MentisCura has a supercomputing platform of unlimited scalability and in-house expertise in algorithm development.

KCL intends to lead the next phase of ARMOR development, so that it is absolutely focused on the needs of clinician and patient end-users. KCL

envisages the further development and commercialization of a low-cost high-efficiency epilepsy monitoring platform in the patient's home environment.

The complete final ARMOR platform will widely used in patients with different types of epilepsy, non-epileptic seizures and vasovagal syncope and will be directly compared to the conventional diagnostic methods in a sufficiently large number of patients. Such great scale exercise will give the opportunity to identify weakness and strengths and build on the latter to develop a state-of-the-art diagnostic and clinical research tool that will be ARMOR and ensures successful commercialization. In particular, the ARMOR platform will be fully evaluated in terms of quality of data recorded, accuracy and reliability of detection tools, overall clinical diagnostic yield, costing, and patients' satisfaction. During this period we are planning to cooperate with other leading projects such as Epilepsiae and share experience and data, and also explore suitable hardware as explained above

### 5.5 AAISCS (SME)

*DoW:* AAISCS intends to participate in a concerted future commercial implementation of ARMOR. AAISCS is also keen to promote both planned uses of ARMOR (clinical and home) for epilepsy management, monitoring and diagnosis within Cyprus. AAISCS will also promote extensions of ARMOR to other clinical conditions, e.g. stroke management. Finally AAISCS sees ARMOR as an integral part of its effort to use wireless EEG as a tool for applications and research in biofeedback methods and health monitoring.

AAISCS operations cover the spectrum from basic research to applications and services in electrophysiological measurements. AAISCS is based in Cyprus, one of the smallest countries in Europe. Thus, the market volume within Cyprus is limited, and AAISCS approaches exploitation of its basic and applied research in two ways. Within Cyprus AAISCS targets applications that enhance its ongoing activities and services by providing added value to its ongoing capabilities. In parallel, through large penetration of the small market, it can provide a good testing ground of entries to the other countries with larger population. At the international scene AAISCS can operate as a single provider of services to partners from other countries in specialized areas of neurophysiological signal processing.

AAISCS plans to exploit ARMOR and its components in Cyprus assuming that a working ARMOR platform will be available. The full ARMOR platform, or some of its key components will allow AAISCS to complete the set of services it provides within Cyprus with ARMOR home-monitoring capabilities. This will include sale or lease of ARMOR hardware, and monthly/annual fees for the provision of specific ARMOR services. These services will enhance the neurofeedback services already provided by AAISCS, allowing objective monitoring of brain activity between neurofeedback sessions. Further, AAISCS has identified two additional exploitations involving collaboration with some of the biggest medical service providers in Cyprus, e.g. Intensive Care Unit (ICU) of the Nicosia General Hospital and Cyprus Institute of Neurology and Genetics (CING). The first and obvious one is the diagnosis and home monitoring of epileptic patients, the primary purpose of ARMOR. The second is home monitoring of patients leaving

the ICU. As a preparation for this future application of ARMOR services, until the end of ARMOR project (October 2014), AAISCS will carry out a set of examinations with wired and wireless EEG (resting state measurements) on patients from the above two main state and non-profit clinical organizations. Using the methods adapted by AAISCS for ARMOR, AAISCS has already started analyzing data from a small number of whole night EEG from epileptic patients recorded at the CING and data from 5-10 patients released from ICU. These patients have been classified by the ICU doctors as patients worth monitoring at home after release from the ICU. Given the small size of Cyprus, the total number of patients to be recruited is limited to around 200 per year. The AAISCS benefit from the added value of the ARMOR-related services will be twofold. First at least 50% of these patients will add to existing clientele and they will involve a wider range of services than the services provided by the ARMOR home monitoring capability. Based on the existing charges, the cash value for the new clientele will be in the range of €100,000 to €200,000 per year. Second, the ongoing collaboration between AAISCS with CING and ICU makes the implementation of these exploitation options immediate and practically with no additional cost, something that immediately generates following benefits: (1) The new services strengthen the research collaborative links with CING and ICU, and through them the possibility of adding the results of the work to ongoing international databases that these two organizations are helping to create with other EU hospitals (e.g. PROACTIVE project). (2) The comprehensive services and the access to large databases will allow AAISCS to work closely with other ARMOR partners for wider penetration in Europe and world-wide with lower entry cost and with ready-made examples of applications of the ARMOR platform.

It is understood that while at the end of the current project, ARMOR and its components (i.e. hardware, software, data analysis tools and set of services) may be beneficially exploited by partners in various manners (see the Individual Exploitation Plans), the ARMOR platform will not be a completed commercial product. Additional efforts will be necessary for the commercialization of ARMOR. AAISCS intends to fully participate in any such efforts directed towards the commercial implementation of ARMOR. Some of the key points along this path will be (1) to identify ARMOR components and technologies that will be included in the commercial product, (2) to identify additional components (currently not included within ARMOR) that are essential for the commercial product, and (3) seek resources in the short term, starting before the end of the current project, for the commercialization of ARMOR. Such resources may be in the form of European and/or National funding, investors etc. Currently, AAISCS is applying for grants at both national (Cyprus) and European level where a working ARMOR platform or some of its components could be used.

## **5.6 ICOM (Industry)**

*DoW:* ICOM intends to exploit the disease specific knowledge and validation related feedback acquired from the piloting of its Electronic Health Record and Care Management platform within the ARMOR aiming at rendering this platform into a unique product. The company intends to exploit this knowledge towards

the delivery of novel HIT solutions. The exploitation activity of the project work plan will form an important part of ICOM's project activities and will provide factual assessment of the market assessment, opportunities offered by ARMOR, associated risks and possible ways of deploying the out coming solutions on the market, etc.

*Updates on M19:* The main individual exploitation results of Intracom are the enhancements to the range of features implemented into the intLIFE PHR platform through the collaborative work with ARMOR project partners. The main enhancement corresponds to the addition of new capabilities of dealing with EEG sensing devices and offering respective medical diagnosis. Provisions for direct integration of PHR repository in 3<sup>rd</sup> party data analysis applications (also remote ones) has been introduced and seen as a way to open the PHR to 3<sup>rd</sup> party developers for building PHR-based applications and services. Those are expected to become part of an integrated solution in cooperation with other partners and might even lead to the provision of actual services.

Furthermore thanks to close collaboration with medical research institutions, the PHR system has been geared to support wider access to medical data whereby information may be provided anonymized and under close control to authorized 3<sup>rd</sup> parties.

Regarding rights to exploitation Intracom cannot make claims on creation of spin-offs since this is more applicable to academia and not to industry. From Intracom perspective it is ready to support such initiatives by offering its technologies on OEM or other licensing conditions.

Regarding patents a careful analysis of potential benefits from patenting different new technologies in ARMOR might justify such expenses, but this is not expected to be pursued during the ARMOR project.

### **5.7 KIT (academia/research)**

*DoW:* Projects that include development of medical systems and applications have many promising application areas providing many future project opportunities. The ARMOR proposal gives the opportunity to enlarge KIT-activities in this field, strengthening its position in the development of medical electronic systems

KIT will use publications about the different aspects of the ARMOR project where KIT is involved to increase the visibility and reputation of the institute in the community of biomedical technology. Furthermore the publications help us to attract other scientific researchers to collaborate with us in new biomedical projects. The ARMOR project is already part of current lectures at KIT. It is used to illustrate state of the art in technology which also attracts more students to work in this field.

KIT will continue the research in the field of biomedical technology and especially in mobile monitoring of epileptic patients and patients with other brain related disorders. The improvements and adaptations made in the sensors will also be part of future projects. Currently we are exploiting cooperation with the

clinic for epileptology at the university hospital in Bonn where the outcomes in form of adaptations, synchronization and data analysis are applied. In a second cooperation with leading neuro-psychiatrists in the field of narcolepsy and Gilles-de-la-Tourette syndrome KIT used some developments from ARMOR to submit a project proposal for a national research project at the BMBF. Finally we used the gained knowledge to do a further cooperation with AAISCS and some SMEs specialized in brain science. This cooperation led to the project proposal of NeuWeb at the European Commission.

The ARMOR sensor system consists of commercial sensors and adapted sensors, received from a KIT spin-off-company, movisens GmbH in Karlsruhe, Germany. These sensors were adapted to the special needs of the ARMOR project and integrated in the ARMOR platform. The sensors could be used by other medical research institutes who are interested in a modular mobile monitoring system. They are already used in a pre-test in the clinic for epileptology at the university hospital in Bonn. KIT plans to license the development to sensor manufacturers and to rent the sensors to other researchers. The existing sensors will be part of a sensor pool that is usable for researchers from KIT and other institutions who are renting the devices. The fees from renting the sensors allow renewing and improving the sensor pool.

The ARMOR Home gateway middleware was built by using the open source framework xAffect. Open source projects like this help research facilities and SMEs to develop products, prototypes and components without the costs of licensed software or without building it from scratch. KIT will therefore share the sensor libraries, developed to integrate the new Sensors modules, with the xAffect project.

KIT will also exploit the results of the software package by licensing the on- and offline algorithms to the sensor manufactures and to other research facilities. Furthermore KIT plans to license the results of the integration of hardware in existing Bluetooth sensors to the sensor manufacturers. Finally KIT will license together with the other partners EEG diagnostic and long term monitoring as well as the complete set of ARMOR services to hospitals and research and academic facilities.



## 6. LIST OF EXPLOITABLE RESULTS AND CLAIMS

### 6.1 List of Exploitable results

This draft list of Exploitable Results is obtained from an evaluation of the most relevant progresses obtained in the first 30 months of the ARMOR project. Each ARMOR partner was invited to modify the contents of such list, also removing or adding other relevant results that can be considered “Exploitable”.

Each single result can be exploited in different application fields and the owner of the result can be a single partner or a group of partners. ARMOR kits and services represent the final and complete outputs of the project, including almost all the previous results and obtained through the collaboration of all the partners, so involving common/jointly Exploitation Strategies. “Responsible” is the partner who had a relevant role in the development/achievement of such result and being in charge to collect answers of the questionnaire reported in chapter 7.

N°	Exploitable Results	Responsible
1	ARMOR sensors kit (medical electronic system – Modification of movisens sensors)	KIT
2	Integration of hardware in existing Bluetooth sensors	TMES/KIT
3	ARMOR Security/encryption module (algorithms)	TMES
4	Selection of sensors	AAISCS
5	Compression algorithms (WSN communication)	TMES
6	Compression algorithms (storage or analysis)	UoP/TMES
7	ARMOR Home gateway middleware (Data collection and communication + StreamInsight integration)	S&C
8	Enhanced intLIFE PHR platform and its innovative use	ICOM
9	ARMOR software package (on-line tools – Multiparametric analysis and pre-processing algorithms)	UoP
10	ARMOR software package (off-line tools – Multiparametric analysis and pre-processing algorithms)	UoP/KIT
11	Risk assessment and Decision Support System tool	UoP
12	Models of epilepsy/personalized models	KCL/UoP
13	Data management with analytical functionality	UoP
14	ARMOR database (data acquired)	KCL/UoP

15	ARMOR training package including medical knowledge/experience, discovered research results and knowledge for decision support for diagnosis	KCL/UoP/AAISCS
16	ARMOR monitoring service	S&C/UoP
17	ARMOR architecture	All
18	ARMOR EEG diagnostic and LTM service	All
19	ARMOR ambulatory EEG service	All
20	ARMOR complete services	All

## 6.2 ARMOR partners' claims

The Exploitation Claims are strictly related to each partner Exploitation Strategy and include both commercial and/or other types of exploitation, depending on the profile of each ARMOR participant. Even if a partner didn't contribute to the result, such partner can have a claim for the exploitation of such result/knowledge.

The Exploitation Claims can be defined (and abbreviated) as follow:

The intention of the partners to exploit the results by

- not interested in the exploitation (**No**). If other partners have claims on that result, the ownership and use will be shared amongst those partners
- making them and selling them (**M**)
- using them internally to make something else for sale (**U**). U applies also to universities willing to use the result in new research projects (proposals preparation).
- to license them to 3rd parties (**L**);
- to provide services such as consultancy, etc...(O).

Claims	ARMOR sensors kit	Integration of hardware in existing Bluetooth sensors	ARMOR Security / encryption module (algorithms)	Selection of sensors / methods to extract critical results	Compression algorithms (WSN communication)	Compression algorithms (storage of analysis)	ARMOR Home gateway middleware	New communication protocols (Backhaul communication)	New data management processes and ethics blueprint handbook
S&C	U,O	No	No	No	No	No	M	No	O
TMES		M,U,O			M,U,O				No
UoP				U,L,O		U,L,O			
KCL	No	No	No	U,L,O	No	No	No	No	U,L,O
AAISCS	U,O	U	U	M,L,U,O	U,O	U,O	U	U	U,O
ICOM	No	No	No	U,L,O	No	No	U,L,O	U,L,O	No
KIT	L	U,L	U	U	U		U,L	No	No

Claims	ARMOR software package (on-line tools)	ARMOR software package (off-line tools)	Enhanced intLIFE PHR platform and its innovative use	Risk assessment and Decision Support System tool	Models of epilepsy / personalized models	Data management with analytical functionality	ARMOR database (data acquired)	ARMOR training package including medical knowledge/experience , discovered research results and knowledge for decision support for diagnosis	ARMOR monitoring service
S&C	U	No	No	No	No	No	U (?)	No	M
TMES									
UoP	U,L,O	U,L,O		U,L,O	U,L,O	U,L,O	U,L,O	U,L,O	U,L,O
KCL	U,L,O	U,L,O	No	U,L,O			U,L,O	U,L,O	M, U,L,O
AAISCS	U,M,L,O	U,M,L,O	U	U	M,U,L,O	U,L,O	U,L,O	M,L,O	M,L,U,O
ICOM	U,L,O	U,L,O	U,L,O	U,L,O	No	No	U,L,O	No	U,L,O
KIT	U,L	U,L	No	No			No	No	U,L

Claims	ARMOR architecture	ARMOR EEG diagnostic and LTM service	ARMOR ambulatory EEG service	ARMOR complete services
S&C	No	No	No	U,O
TMES		M,U,O	M,U,O	M,U,O
UoP	U	U,L,O	U,L,O	U,L,O
KCL		M, U,L,O	M, U,L,O	M, U,L,O
AAISCS	No	M,U,L,O	M,U,L,O	U,L,O
ICOM	U,L,O	No	No	U,L,O
KIT		U,L	U	U,L

**7. CHARACTERISATION OF EACH EXPLOITABLE RESULT**

Each exploitable result is characterised through the following questionnaire, useful for the definition of the market (customers, size, industrialization plan, etc.), strategies for exploitation, business plans and agreements on ownership.

**Exploitable Result n° 1: ARMOR sensors kit (medical electronic system – Modification of movisens sensors)**

Describe the innovation content of result, added value respect of other commercial/existing products and benefits for customers/end-users	The movisens sensors were adapted so as to be used with disposable electrodes.
Who will be the customers?	Medical/research institutes
Who will be the potential competitors?	Sensor companies
Which is the estimated market size (in M€)?	
When is the time to market and costs to be incurred (industrialization plan)?	Adaptations already done. But up to now no industrialization plan is foreseen. The outcome will possibly be part of future projects.
What is the approximate price range of this result or price of licences?	Possibly a fee for renting them.
Who are the ARMOR partners involved in the result?	KIT
Who are the industrial partners interested in the result (partners, sponsors, etc...)?	S&C
Have you protected or will you protect this result? How (patents)? When?	No

**Exploitable Result n° 2: Integration of hardware in existing Bluetooth sensors**

Describe the innovation content of result, added value respect of other commercial/existing products and benefits for customers/end-users	New smart sensor enhanced with smart embedded devices for encrypting, compressing and even predicting ARMOR related activity
Who will be the customers?	Physicians, medical institute, sensor providers
Who will be the potential competitors?	Sensor companies
Which is the estimated market size (in M€)?	Around 250M€
When is the time to market and costs to be incurred (industrialization plan)?	1-2 years after the end of ARMOR project.
What is the approximate price range of this result or price of licences?	10-15% on top of the sale price of the sensor. For bulk sales, this can be reduced to 5-10%.
Who are the ARMOR partners involved in the result?	KIT, TMES
Who are the industrial partners interested in the result (partners, sponsors, etc...)?	Companies related to sensors e.g. companies working with KIT such as Movisens
Have you protected or will you protect this result? How (patents)? When?	Not yet. TMES legal department is currently evaluating different patent alternatives.

**Exploitable Result n° 3: ARMOR Security/encryption module (algorithms)**

Describe the innovation content of result, added value respect of other commercial/existing products and benefits for customers/end-users	Hardware encryption module offering AES based highly configurable functionality with competitive performance in terms of data throughput, low power consumption and low silicon requirements
Who will be the customers?	WSN radio manufacturers, embedded system developers interesting into integrating security modules
Who will be the potential competitors?	3rd party companies developing hardware modules accelerators
Which is the estimated market size (in M€)?	Around 250M€
When is the time to market and costs to be incurred (industrialization plan)?	1-2 years after the end of ARMOR project.
What is the approximate price range of this result or price of licences?	10-15% on top of the sale price of the sensor. For bulk sales, this can be reduced to 5-10%.
Who are the ARMOR partners involved in the result?	TMES
Who are the industrial partners interested in the result (partners, sponsors, etc...)?	Companies offering WSN nodes and embedded systems
Have you protected or will you protect this result? How (patents)? When?	Not yet. TMES legal department is currently evaluating different patent alternatives.

**Exploitable Result n° 4: Selection of sensors/methods to extract critical results**

Describe the innovation content of result, added value respect of other commercial/existing products and benefits for customers/end-users	Use of tomographic analysis for optimal claim of sensors/methods
Who will be the customers?	Any organization interested in minimally obtrusive monitoring with EEG
Who will be the potential competitors?	
Which is the estimated market size (in M€)?	About 200M€
When is the time to market and costs to be incurred (industrialization plan)?	1-3 years depending on hardware available. Cost around 200-300K€
What is the approximate price range of this result or price of licences?	About 50-100€ per licence/device
Who are the ARMOR partners involved in the result?	AAISCS, UoP, KCL
Who are the industrial partners interested in the result (partners, sponsors, etc...)?	EEG manufacturers, game machine designers, BCI
Have you protected or will you protect this result? How (patents)? When?	Part of patent within the ARMOR lifetime (to be submitted)



**Exploitable Result n° 5: Compression algorithms (WSN communication)**

Describe the innovation content of result, added value respect of other commercial/existing products and benefits for customers/end-users	Advanced specialized compression algorithms offering high compression rate, real-time operation and low complexity advocating hw implementation in embedded systems
Who will be the customers?	WSN node manufacturers interesting to increase the effective bandwidth of the WSN wireless medium or/and the capacity of the local storage
Who will be the potential competitors?	3rd party companies developing hardware modules accelerators
Which is the estimated market size (in M€)?	Around 180M€
When is the time to market and costs to be incurred (industrialization plan)?	1-2 years after the end of ARMOR project.
What is the approximate price range of this result or price of licences?	10-15% on top of the sale price of the sensor. For bulk sales, this can be reduced to 5-10%.
Who are the ARMOR partners involved in the result?	TMES
Who are the industrial partners interested in the result (partners, sponsors, etc...)?	Companies offering WSN nodes and embedded systems
Have you protected or will you protect this result? How (patents)? When?	Not yet. TMES legal department is currently evaluating different patent alternatives.

**Exploitable Result n° 6: Compression algorithms (storage of analysis)**

Describe the innovation content of result, added value respect of other commercial/existing products and benefits for customers/end-users	Advanced specialized compression algorithms offering high compression rate for smaller acquired storage size.
Who will be the customers?	Industries working on data storage and analysis
Who will be the potential competitors?	Industries working on data storage and analysis
Which is the estimated market size (in M€)?	
When is the time to market and costs to be incurred (industrialization plan)?	2-3 years. Industrialization plan will depend on the system's functionalities.
What is the approximate price range of this result or price of licences?	
Who are the ARMOR partners involved in the result?	UoP
Who are the industrial partners interested in the result (partners, sponsors, etc...)?	
Have you protected or will you protect this result? How (patents)? When?	Not yet. We are investigating possibilities for patents.

**Exploitable Result n° 7: ARMOR Home gateway middleware (Data collection and communication + StreamInsight integration)**

Describe the innovation content of result, added value respect of other commercial/existing products and benefits for customers/end-users	A sensing and data management unit capable to collect, pre-process, store and show health sensor data information in any smart device.
Who will be the customers?	Sensor providers, care givers, utilities/telcos, users of digital/smart home systems
Who will be the potential competitors?	Other ICT companies and sensors providers
Which is the estimated market size (in M€)?	Th eHealth industry in the EU was estimated to be worth close to €2 billion in 2006
When is the time to market and costs to be incurred (industrialization plan)?	2-3 years. Industrialization plan will depend on the hardware's functionalities.
What is the approximate price range of this result or price of licences?	Main purpose is to receive a % of selling the hardware and a monthly fee for the use of the software.
Who are the ARMOR partners involved in the result?	S&C, KIT
Who are the industrial partners interested in the result (partners, sponsors, etc...)?	S&C, AAISCS and KCL (users)
Have you protected or will you protect this result? How (patents)? When?	No, commercial exploitation

**Exploitable Result n° 8:****Enhanced intLIFE PHR platform and its innovative use**

Describe the innovation content of result, added value respect of other commercial/existing products and benefits for customers/end-users	<p>Enhancements to intLIFE PHR platform:</p> <ul style="list-style-type: none"> <li>- Addition of new EEG sensing devices</li> <li>- Medical diagnosis from EEG signal analysis</li> <li>- Direct integration of PHR repository in remote 3<sup>rd</sup> party applications</li> <li>- Added notification service</li> </ul> <p>Anonymised data access for research purposes</p>
Who will be the customers?	Service providers / medical institutions
Who will be the potential competitors?	Commercial PHR providers
Which is the estimated market size (in M€)?	To be confirmed
When is the time to market and costs to be incurred (industrialization plan)?	2-5 years
What is the approximate price range of this result or price of licences?	To be confirmed by company Marketing Department
Who are the ARMOR partners involved in the result?	ICOM
Who are the industrial partners interested in the result (partners, sponsors, etc...)?	To be confirmed
Have you protected or will you protect this result? How (patents)? When?	Legal protection not foreseen. Technical knowhow protected by company confidentiality.

**Exploitable Result n° 9: ARMOR software package (on-line tools – Multiparametric analysis and pre-processing algorithms)**

Describe the innovation content of result, added value respect of other commercial/existing products and benefits for customers/end-users	Novel methodologies for real-time analysis of multimodal and multisensory medical data
Who will be the customers?	Industries working on healthcare monitoring systems, academic/research institutes
Who will be the potential competitors?	Industries working on healthcare monitoring systems, academic/research institutes
Which is the estimated market size (in M€)?	Not estimated yet
When is the time to market and costs to be incurred (industrialization plan)?	2-3 years. Industrialization plan will depend on the system's functionalities.
What is the approximate price range of this result or price of licences?	To be confirmed
Who are the ARMOR partners involved in the result?	UoP
Who are the industrial partners interested in the result (partners, sponsors, etc...)?	To be confirmed
Have you protected or will you protect this result? How (patents)? When?	Not yet. We are investigating possibilities for patents.

**Exploitable Result n° 10: ARMOR software package (off-line tools – Multiparametric analysis and pre-processing algorithms)**

Describe the innovation content of result, added value respect of other commercial/existing products and benefits for customers/end-users	Novel methodologies for analysis of multimodal and multisensory medical data
Who will be the customers?	Industries working on healthcare monitoring systems, academic/research institutes
Who will be the potential competitors?	Industries working on healthcare monitoring systems, academic/research institutes
Which is the estimated market size (in M€)?	Not estimated yet
When is the time to market and costs to be incurred (industrialization plan)?	2-3 years. Industrialization plan will depend on the system's functionalities.
What is the approximate price range of this result or price of licences?	Licence depending on the parameters to be analysed
Who are the ARMOR partners involved in the result?	UoP, KIT
Who are the industrial partners interested in the result (partners, sponsors, etc...)?	Companies producing sensors (hardware)
Have you protected or will you protect this result? How (patents)? When?	Not yet. We are investigating possibilities for patents.

**Exploitable Result n° 11: Risk assessment and Decision Support System tool**

Describe the innovation content of result, added value respect of other commercial/existing products and benefits for customers/end-users	A configurable and extendable software tool for risk assesment and decision support for specific situations of interest.
Who will be the customers?	Industries working on healthcare monitoring systems
Who will be the potential competitors?	Industries working on healthcare monitoring systems
Which is the estimated market size (in M€)?	Not estimated yet
When is the time to market and costs to be incurred (industrialization plan)?	2-3 years. Industrialization plan will depend on the system's functionalities.
What is the approximate price range of this result or price of licences?	Not estimated yet
Who are the ARMOR partners involved in the result?	UoP
Who are the industrial partners interested in the result (partners, sponsors, etc...)?	To be confirmed
Have you protected or will you protect this result? How (patents)? When?	Not yet. We are investigating possibilities for patents.

**Exploitable Result n° 12: Models of epilepsy/personalized models**

Describe the innovation content of result, added value respect of other commercial/existing products and benefits for customers/end-users	Quantification of epilepsy-related information for the support of personalized health monitoring.
Who will be the end users/beneficiaries interested in such result?	Industries working on healthcare monitoring systems
Who will be the potential "competitors" (other institutes, research centres, etc.)?	Industries working on healthcare monitoring systems
Who are the ARMOR partners involved in the result?	KCL/UoP
Have you protected or will you protect this result? How (patents)? When?	Not yet. We are investigating possibilities for patents.

**Exploitable Result n° 13: Data management with analytical functionality**

Describe the innovation content of result, added value respect of other commercial/existing products and benefits for customers/end-users	Methodologies for management of polysomnographic medical data and analytical functioning for queries involving manual and automatically extracted annotations
Who will be the end users/beneficiaries interested in such result?	Industries working on medical data storage and analysis
Who will be the potential "competitors" (other institutes, research centres, etc.)?	Industries working on medical data storage and analysis
Who are the ARMOR partners involved in the result?	UoP
Have you protected or will you protect this result? How (patents)? When?	Not yet. We are investigating possibilities for patents.



**Exploitable Result n° 14: ARMOR database (data acquired)**

Describe the innovation content of result, added value respect of other commercial/existing products and benefits for customers/end-users	Unique dataset of carefully annotated events related to epilepsy.
Who will be the end users/beneficiaries interested in such result?	Researchers, Hospitals, Medical Institutions
Who will be the potential "competitors" (other institutes, research centres, etc.)?	EPILEPSIAE project, MIT (CHB-MIT EEG database, MIT-BIH polysomnographic database),
Who are the ARMOR partners involved in the result?	KCL/UoP
Have you protected or will you protect this result? How (patents)? When?	n/a

**Exploitable Result n° 15: ARMOR training package including medical knowledge/experience, discovered research results and knowledge for decision support for diagnosis**

Describe the innovation content of result, added value respect of other commercial/existing products and benefits for customers/end-users	New and / or enriched patterns of clinical and neurophysiological / biological changes during a wide range of disorders of consciousness
Who will be the end users/beneficiaries interested in such result?	medical practitioners; researches; students; academic institutions; state and private hospitals
Who will be the potential "competitors" (other institutes, research centres, etc.)?	Other epilepsy monitoring centres
Who are the ARMOR partners involved in the result?	KCL/UoP/AAISCS
Have you protected or will you protect this result? How (patents)? When?	n/a

**Exploitable Result n° 16: ARMOR monitoring service**

Describe the innovation content of result, added value respect of other commercial/existing products and benefits for customers/end-users	Telecare (transmission of messages) in terms of real-time alarm situations; Monitoring Services, anytime everywhere: to monitor (smartphone, PC, tablet...) biometric constants and uploaded it into a database
Who will be the end users/beneficiaries interested in such result?	Care givers, Hospitals, users of digital home services
Who will be the potential "competitors" (other institutes, research centres, etc.)?	Service providers in eHealth sector, i.e. Kings@home product, DigiTrace service, EPILEPSIA project
Who are the ARMOR partners involved in the result?	S&C/UoP
Have you protected or will you protect this result? How (patents)? When?	No, commercial exploitation

**Exploitable Result n° 17: ARMOR architecture**

Describe the innovation content of result, added value respect of other commercial/existing products and benefits for customers/end-users	Online detection of epileptic events or other disorders of consciousness from multiparametric recordings
Who will be the end users/beneficiaries interested in such result?	Researchers, Hospitals, Medical Institutions
Who will be the potential "competitors" (other institutes, research centres, etc.)?	Epilepsiae, Providers of eHealth sector
Who are the ARMOR partners involved in the result?	All
Have you protected or will you protect this result? How (patents)? When?	To be confirmed

**Exploitable Result n° 18: ARMOR EEG diagnostic and LTM service**

Describe the innovation content of result, added value respect of other commercial/existing products and benefits for customers/end-users	New and / or enriched patterns of clinical and neurophysiological / biological changes during a wide range of disorders of consciousness
Who will be the customers?	medical practitioners; researches; students; academic institutions; state and private hospitals
Who will be the potential competitors?	Other epilepsy monitoring centres
Which is the estimated market size (in M€)?	Not estimated yet
When is the time to market and costs to be incurred (industrialization plan)?	UoP to contribute please if algorithms are included here
What is the approximate price range of this result or price of licences?	Same as above (UoP to advise)
Who are the ARMOR partners involved in the result?	All
Who are the industrial partners interested in the result (partners, sponsors, etc...)?	Same as above (UoP to advise)
Have you protected or will you protect this result? How (patents)? When?	Same as above (UoP to advise) – if applicable

**Exploitable Result n° 19 ARMOR ambulatory EEG service**

Describe the innovation content of result, added value respect of other commercial/existing products and benefits for customers/end-users	New and / or enriched patterns of clinical and neurophysiological / biological changes during a wide range of disorders of consciousness
Who will be the customers?	medical practitioners; researches; students; academic institutions; state and private hospitals
Who will be the potential competitors?	Other epilepsy monitoring centres
Which is the estimated market size (in M€)?	Not estimated yet
When is the time to market and costs to be incurred (industrialization plan)?	After the final evaluation of the initial version of the ARMOR platform
What is the approximate price range of this result or price of licences?	Not estimated yet
Who are the ARMOR partners involved in the result?	All
Who are the industrial partners interested in the result (partners, sponsors, etc...)?	Epilepsy centres, hardware and database companies
Have you protected or will you protect this result? How (patents)? When?	n/a

**Exploitable Result n° 20: ARMOR complete services**

Describe the innovation content of result, added value respect of other commercial/existing products and benefits for customers/end-users	New and / or enriched patterns of clinical and neurophysiological / biological changes during a wide range of disorders of consciousness Software and implementation services
Who will be the customers?	medical practitioners; researches; students; academic institutions; state and private hospitals hardware and database companies
Who will be the potential competitors?	Epilepsiae, DigiTrace
Which is the estimated market size (in M€)?	To be confirmed
When is the time to market and costs to be incurred (industrialization plan)?	After the final evaluation of the initial version of the ARMOR platform
What is the approximate price range of this result or price of licences?	Not estimated yet
Who are the ARMOR partners involved in the result?	All
Who are the industrial partners interested in the result (partners, sponsors, etc...)?	Epilepsy centres, hardware and database companies
Have you protected or will you protect this result? How (patents)? When?	To be confirmed

## 8. EXPLOITATION OPPORTUNITIES

### 8.1. Expressions of interest

During the “Getting ready for Horizon 2020” event on 21st October in Tarragona, S&C had the opportunity to present ARMOR project to the representatives of the Universitat Rovira I Virgili, working also in the area of eHealth, available to provide contacts with the Hospital of Tarragona.

S&C also organized a meeting with TIC Salut on 10th September 2013 in Mataró. TIC Salut is a Catalan organization able to transfer into the market (hospitals, medical organizations, clinical experts and other stakeholders) the results coming from research projects. S&C discussed with them about other potential Demonstrative, Implementation and/or Validation projects. Possible collaborations between S&C and TIC Salut can include joint participation in further EU funded projects including “ARMOR2” proposal, CIP projects for ARMOR results and other related technological solutions, other Pre-Commercial Procurement (PCP) initiatives like the DECIPHER project.

S&C in collaboration with TMES and AAISCS submitted a proposal called EUCOLLED and coordinated by Prof Andreas Schulze-Bonhage from Freiburg, Germany and Francis I.Y. Tan, MD Head of longstay Kempenhaeghe (Director Hobo Heeze BV) in The Netherlands, under the COST funding scheme. The proposal didn't pass the second step and it had to take profit of the knowledge generated in the ICT part (data management, M2M) developed in ARMOR project.

During the ICT 2013 event in Vilnius, S&C took contact with a person from the Hospital de Vall de Hebron in Barcelona presenting the ARMOR project and discussing about their participation to further eHealth project proposals.

AAISCS was in a direct and continuous contact with all major clinicians that work on epilepsy in the three main centres in Nicosia (Nicosia General Hospital, including the ICU; The Cyprus Institute of Nuerology and Genetics; and the Neurology Department of the American Heart Institute).

AAISCS effort was to establish contacts with stakeholders from the big markets like Russia, China and Japan. AAISCS contacts include the National Rehabilitation Center for Persons with Disabilities in Japan, Bereich für Epilepsie at Universitätsklinikum Erlangen in Germany, and Cranfield University in UK.

AAISCS took contacts with the Copenhagen University and Center of Functionally Integrative Neuroscience (CFIN) in Aarhus, were also taken to discuss collaborative projects, including ARMOR-related research.

During the visit (5-6 March 2013) to Paphos, AAISCS discussed with local Chamber of Commerce and Research Directors of the newly established University of Neapolis about ARMOR specific initiatives: exploration of collaboration possibilities with the University of Neapolis and possibility of presentation of the ARMOR project to the local medical community later in the second half of the year.

KIT visited several partners with the aim to promote ARMOR and discuss about submission of future project proposals: University of Ulm, eMotion Lab, Ulm, (Germany), 14/05/2013; Dräger Medical GmbH, Lübeck (Germany), 06/11/2013; Bosch Healthcare, Karlsruhe (Germany), 15/05/2013; Vitaphone, Mannheim (Germany), 28/01/2013; hhp AG, Karlsruhe (Germany), 11/01/2013.

KCL has entered into discussions with several commercial entities with regards to the next steps in ARMOR exploitation, as described above in section 1.4. These organizations include: Kings@Home, Lifelines (<http://www.llines.com>), Kvikna (<http://www.kvikna.is/>), Curelator (<http://www.curelator.com>), and Mentis Cura, <http://www.mentiscura.com>.

TMES has initiated discussions with Greek SMEs that have shown strong interest on ARMOR results. More specifically:

- *NOESIS Technology* (<http://www.noesis-tech.com>), an SME providing high performance silicon IP solutions, is highly interesting in the encryption module developed by TMES in the context of ARMOR and there are ongoing discussions how to include the specific solutions to the portfolio of components offered by NOESIS.
- *Diaplous Electronics* (<http://diaplous-electronics.com>) is an SME company that develops appliances enabled with visual perception and has also shown strong interest in the preprocessing/filtering hardware component developed by TMES for ARMOR online patient monitoring.

## 8.2. Business model/implementation plan

One possible commercial exploitation scenario (business model) for ARMOR project includes Industrial ICT partners selling the platform components and/or the licenses to customers outside and inside ARMOR. In this scenario, the exploitation of the whole system/technology as a service will be offered to hospitals and companies/organizations offering medical services. The end-customer will pay a monthly flat rate for the basic services and some additional fee for extra service. The ARMOR industrial partners will get money based on three items:

1. Onetime payment amount for the delivery of the hardware;
2. Onetime payment for the setup of the service once the medical organization has a new patient/customer;
3. A monthly payment for the use of the software (service) and maintenance

The ARMOR system is tailored for the treatment of epilepsy, but other conditions such as sleep pathologies and dementia could probably benefit as well, opening the possibility for a service-type of business that could seriously impact on the organisation of medical practice itself. Besides the encryption module, the compression algorithms and communication protocols for massive data transfer present significant advances beyond the state of the art and could be of high interest for a wide range of application domains. For that reason another possible commercial exploitation scenario foresees all partners owning the project outcomes separately and as a whole under a specific exploitation agree-

ment in different target markets. Examples include home polysomnography for diagnostic purposes including differentiation between primary sleep disorders and epilepsy, particularly when these co-exist, as well as effective alarming systems in the monitoring of people with dementia and movement disorders. We envisage that monitoring of comatose patients after cardiac arrest may be a future application of the diagnostic capabilities of ARMOR.

The ARMOR academic partners also intend to exploit the project to raise the level of education, both by giving Master and PhD students the opportunity to work on cutting-edge research in a European collaborative effort as well as by using the research results in the teaching process of undergraduate and graduate students, allowing courses and seminars to be taught using current technology and research results. There is a number of specific research projects that can be undertaken within each of the participating academic institutions or in collaboration with international academic centres on clinical topics such as epilepsy, vasovagal disorders and sleep, or computational research such as signal processing. Teaching seminars will also involve the International League Against Epilepsy forum co-directed by KCL.

There is still a gap (implementation plan) between finalizing ARMOR project and starting its commercialization of 2-3 years, where several tasks have to be done:

- Define, test and validate (WP6) all the ARMOR functionalities/services
- Define which technologies/functionalities of ARMOR are going to be included inside a commercial product/service and decide a number of "ARMOR packages" (*see list of exploitable results*)
- Define exploitation agreements amongst the ARMOR partners both individual and/or collectives (between more than two organizations) having similar claims for the same results (*see table of claims*)
- Set up a strategy for the wide acceptance of ARMOR technology by users, medical doctors and other caregivers, health institutions (private and public), health insurance systems, government bodies.

One important short term action in the ARMOR implementation plan will be to look for financial resources for further field tests, demonstration and validation activities in hospitals and with a strong engagement of the end users. These resources could be found for instance through European or National funding, investors, etc.

### 8.3. Funding schemes for a ARMOR 2 proposal

ARMOR partners will further discuss procedures to apply for a new project proposal either individually or collectively. In order to explore the different possibilities that the EC offers, some H2020 calls were identified.

#### H2020 Calls – Work Programme Health 2014-2015

ARMOR may further development through one of several opportunities in H2020 in 2015. These include:

- PHC 25 – 2015: Advanced ICT systems and services for Integrated Care



- PHC 28 – 2015: Self-management of health and disease and decision support systems based on predictive computer modelling used by the patient him or herself
- PHC 30 – 2015: Digital representation of health data to improve disease diagnosis and treatment

## 9. LIST OF ABBREVIATIONS

CAGR: Compound Annual Growth Rate  
EEG: Electroencephalogram  
MEG: Magneto encephalogram  
MRI: Magnetic Resonance Imaging  
MRG: Millennium Research Group  
OSA: obstructive sleep apnea  
PLC: public limited company  
EU: European Union  
US: United States  
OECD: Organization for Economic Co-operation and Development  
sEEG: stereoelectroencephalography  
ECoG: Electrocorticography  
INCF: International Neuroinformatics Coordinating Facility  
HW: hardware  
SW: software  
PHR: Patient Health Record  
LTM: Long term Monitoring  
DVS: detection and video system  
AES: Advanced Encryption Standard  
WSN: Wireless Sensor Network  
MATLAB: Matrix Laboratory  
ECG: Electrocardiogram  
DSMS: Data Stream Management System  
IP: Internet Protocol  
QoS: Quality of Service  
EHR: Electronic Health Record  
ICT: Information and Communication Technology  
DoW: Description of Work  
RTD: Research Technology Development  
S/T: Self Titled  
SME: Small and Medium Enterprises  
NEPE: non-epileptic paroxysmal events  
ITIL: Information Technology Infrastructure Library

OEM: Original Equipment Manufacturer  
MD: Medical Doctor  
MSc: Master of Science  
NHS: National Health Service  
HVT: Home Video telemetry  
IVT: Inpatient Video telemetry  
ICU: Intensive Care Unit  
CING: Cyprus Institute of Neurology and Genetics  
HIT: Higher Information Technology  
BMBF: Federal Ministry of Education and Research (German)  
BCI: Brain Computer Interface  
PCP: Pre-Commercial Procurement  
PHC: Personalized Health and Care

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