



Strategic Intelligence Monitor on Personal Health Systems (SIMPHS): Report on Typology/Segmentation of the PHS Market

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TABLE OF CONTENTS

THIS REPORT	3
1 ON THE PROCESS OF CLASSIFICATION: TYPOLOGY AND MARKET SEGMENTATION	5
1.1 THE IMPORTANCE OF CLASSIFYING WELL.....	5
1.2 TYPOLOGIES	6
1.3 MARKET SEGMENTATION	7
2 BLURRED CONCEPTUAL AND MARKET BOUNDARIES IN THE PHS DOMAIN	9
2.1 A SET OF OVERLAPPING ICT DRIVEN "LABELS".....	9
2.2 LOOKING FOR CLEAR CUT TYPES FROM THE HEALTHCARE AND USERS PERSPECTIVE	12
2.3 LOOKING FOR CLEAR CUT TYPES FROM THE INDUSTRY OBSERVED BEHAVIOUR	17
3 CONCLUSION: 'HYBRID' CLASSIFICATION AND IMPLICATIONS FOR SIMPHS 2	19
3.1 DISCLAIMER AND ILLUSTRATION OF DIMENSIONS CHOSEN.....	19
3.2 THE TYPES BRIEFLY EXPLAINED	20
3.2.1 <i>Most sophisticated solutions are still the domain of R&D</i>	20
3.2.2 <i>First generation RMT and Telecare</i>	20
3.2.3 <i>Integrated home-based telemanagement</i>	21
3.2.4 <i>Out-of-pocket mobile health for worrying well and fitness</i>	21
3.3 IMPLICATIONS FOR SIMPHS PHASE 2	23
4 ANNEX I: EXAMPLES	25
4.1 BASIC RMT/ CHRONIC DISEASE MANAGEMENT (CDM)	25
4.1.1 <i>From SIMPHS D3.1: Regional examples - Italy</i>	25
4.1.2 <i>From SIMPHS D3.1: UK</i>	25
4.1.3 <i>From SIMPHS D3.1: Germany</i>	27
4.1.4 <i>From SIMPHS D3.1: Spain</i>	28
4.1.5 <i>Aerotel's Heartview and Heartone</i>	29
4.1.6 <i>Bodytel's GlucoTel</i>	29
4.1.7 <i>Philips' Motiva</i>	29
4.2 ADVANCED RMT	30
4.2.1 <i>MyHearth (FP6)</i>	30
4.2.2 <i>PERFORM (FP7)</i>	31
4.2.3 <i>DIAdvisor (FP7)</i>	31
4.2.4 <i>Metabo (FP7)</i>	31
4.3 WELLBEING AND FITNESS	31
4.3.1 <i>Card Guard's iTV Healthcare System</i>	31
4.3.2 <i>BodySinc</i>	32
4.4 PREVENTION	32
4.4.1 <i>PIPS</i>	32
4.4.2 <i>PANACEIA-ITV</i>	33
4.4.3 <i>SmartPiv</i>	33
4.4.4 <i>E-CARE</i>	33
4.5 LAB ON CHIP	34
4.5.1 <i>CD-MEDICS</i>	34
4.5.2 <i>TheraEDGE</i>	34
4.5.3 <i>SmartHEALTH</i>	34
4.5.4 <i>MicroActive</i>	35
4.6 BASIC INDEPENDENT LIVING	35
4.6.1 <i>Aerotel's "Skeeper/Geo/Keeper"</i>	35
4.6.2 <i>SHL Telemedicine's WatchMan</i>	35
4.6.3 <i>Telbios's Merlino</i>	35
4.6.4 <i>Tunstall's ADLife</i>	35
4.6.5 <i>Vigil Health Solutions' "The Vigil Dementia System"</i>	36
4.7 ADVANCED INDEPENDENT LIVING.....	36
4.7.1 <i>Tunstall's Lifeline home units (Lifeline 400, and Lifeline Connect+)</i>	36
4.7.2 <i>HearCom (FP6)</i>	36

4.7.3	<i>TeleCARE (FP5)</i>	36
4.7.4	<i>U-R-SAFE (FP5)</i>	37
4.8	AMBIENT ASSISTED LIVING JOINT PROGRAMME CALL 1/2008	37
4.8.1	<i>REMOTE</i>	37
4.8.2	<i>IS-ACTIVE</i>	37
4.8.3	<i>Happy Ageing</i>	38
4.8.4	<i>PAMAP</i>	38
4.8.5	<i>DOMEO</i>	38
4.8.6	<i>CARE</i>	38
4.9	AMBIENT ASSISTED LIVING FP6 PROJECTS.....	38

LIST OF FIGURES

Figure 1	– Example: typology of market strategies	7
Figure 2	– Example: different segmentation strategies	8
Figure 3	– The maze of labels in PHS and related domains	9
Figure 4	– Examples of PHS segmentations.....	10
Figure 5	– The Pyramid of Care revisited.....	13
Figure 6	– Survey identifying the worried well in the US population	15
Figure 7	– Types of users and related macro-segment.....	16
Figure 8	– What industry mostly does: ideal-type from a 50 company analysis	17
Figure 9	– Proposed hybrid typology.....	19

This Report

This deliverable D2.3 “Report on Typology/Segmentation of the PHS Market” is composed of the following three Sections and one Annex:

Section 1 sets the methodological background by illustrating succinctly but exhaustively the principles of classification and typology / market segmentation building.

In **Section 2**, we discuss the PHS field against such principles and highlight a number of challenges hindering the possibility to provide a clear cut and robust typology or market segmentation, identifying mutually exclusive and collectively exhaustive types / segments.

Against this background, in **Section 3** we present a pragmatic and 'work in progress' hybrid typology, discuss the identified types very briefly, and draw some preliminary indications and insights to be used as food for thought while scoping *Phase 2* of the *SIMPHS* project.

Section 4 (included as an Annex) contains a number of examples that will be mentioned in the discussion of **Section 2** and **Section 3**.

1 On the Process of Classification: Typology and Market Segmentation¹

1.1 The importance of classifying well

Classification stands to the methodology of research as electricity does to our daily activities: it is transparent (in the sense of being most often taken for granted) but ubiquitous and indispensable. Without good classification no sophisticated conceptualisation, reasoning and even research itself would be possible.

Classification can be defined as the process of ordering entities into groups (i.e. types in the case of typologies or "taxa" in the case of taxonomies) following the similarity principle in such a way as to: a) minimize within-group variance and maximise between-group variance; b) exhaustively catch all the possible instances. In other words in the ideal situation (never occurring as reality is complex and escape a perfect classification) if we classify a set of entities into three groups, the groups should be mutually exclusive and collectively exhaustive.

For instance, let us assume we are walking and a friend phones us asking to buy the following things: tomatoes, lettuce, olive oil, salt, shampoo, deodorant, a comb, knives, and plastic forks. We do not have a paper to write and to ease the work of our mind to remember what to buy we can group them into "vegetables" (tomatoes and olives)," dressing" (oil and salt), "utensils"(knives, forks, and comb), and "cosmetics"(shampoo and deodorant). All the items find a place and they find it in one and only one group. Alternatively we could have decided to order the item in terms of their function: for cooking (tomatoes, salt, olive oil, and olive), for eating (knives and forks), for personal care (deodorant, comb, and shampoo). Or we could have grouped them by materials: organic (salt, olive oil, tomatoes, and olive), metallic (knives), plastic (comb and the forks), other non organic composed materials (deodorant and shampoo). All of these choices produce exhaustive and mutually exclusive groups. The items within each group are fairly related and similar along the dimension chosen for the classification and this may help us better remember what we have to buy. If we, however, grouped the list into red and non red items, we can still place all of them in one of the two groups (in the red group: tomatoes plus shampoo and deodorant, assuming for the sake of argument that these two comes into red packages; all the other in the non red group), but we end up putting together things that are not so similar and especially meaningful and useful for helping us remember better.

Beside the requirements of mutual exclusivity and exhaustiveness, this exemplification tells us that: a) fundamental in the process of classification is the dimension(s) chosen to order entities; b) entities can be classified according to alternative dimensions and each classification is only as good as the dimensions or variables upon which it is based. Yet, as shown by the example of grouping the list of things to buy into red and non red, one can follow the rule of mutual exclusivity and exhaustiveness perfectly and still produce a trivial classification if a trivial dimension is used. Good non-trivial classification, to offset the inevitable simplification it imposes on the complexity of the world, should produce the following benefits:

- **Descriptive power:** providing an exhaustive and hopefully definitive list of types to be analysed;

¹ The following discussion is selectively based on a few classics in the literature on the methodology of socio-economic research, which includes among others: K. D. Bailey, Typologies, in E. F. Borgatta and M. L. Borgatta (eds.), *Encyclopedia of Sociology*, New York, MacMillan, 1992, pp. 2188-2194; K. D. Bailey, *Typologies and Taxonomies: An Introduction to Classification Techniques*, Thousands Oaks (Cal), Sage; A. H., Barton, The Concept of Property-Space in Social Research, in P.F. Lazarsfeld and M. Rosenberg (eds.), *Language of Social Research*, Glencoe (IL), Free Press, 1955, pp. 40-53; C. G. Hempel, Typological Methods in the Natural and Social Sciences, in *Proceedings , American Philosophical Societies*, 1 (1952), pp. 656-686.

- **Reduction of complexity:** grouping by similarities 100 entities into 4 more salient types enable to achieve parsimony in empirical research and analysis;
- **Identification of similarities and differences:** classifying together similar cases allows to focus the analysis on them and not loosing time on very different cases of no interest, or alternatively to differentiate between different cases so to treat them separately in the analysis instead of remaining mixed together.

In short a good classification is both a heuristic tool and a way to define and prioritise a research agenda. The only way to avoid trivial classifications and produce valuable tools is by being capable to ascertain and select the fundamental characteristics of the entities to be classified. To put it differently we must be able to identify the **defining** characteristics of the entities to be classified. Especially if we want to classify concepts, the best situation is when an "intentional" definition (alternatively termed also connotative) is available. An intentional definition specifies the necessary and sufficient conditions for a "thing" being a member of a specific set. The situation is further complicated when, as it is often the case, only an "ostensive" definition is available, which is a definition by pointing and exemplification. In this case one provides meaning to a concept by pointing out examples. Whereas in the first case we could easily produce mono-dimensional classifications, in the second one we must use more than one dimension to classify, which is usually done using **typologies** or **taxonomies**. We treat below the former and do not go into the details of its relation with the latter.²

1.2 Typologies

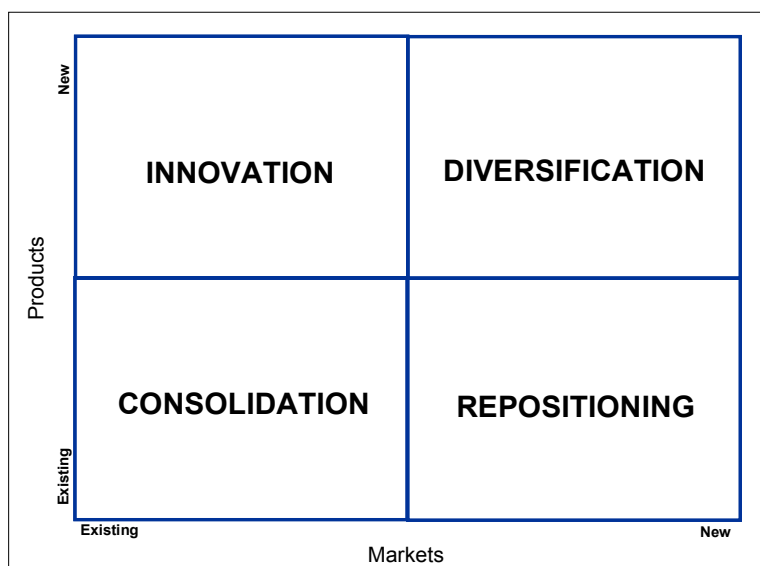
Two defining characteristics make a typology into a specific form of classification and distinguish it from generic classifications: **typologies are conceptual and multidimensional**. They are constructed using discrete and non continuous dimensions/variables (most often dichotomies such as in high/low, yes/no, but could also be ordinal scales such as low, medium, high, very high) and as such they should identify monothetic types.³ The complexity of typologies grows exponentially with the number of dimensions used to construct them. Assuming for the sake of simplicity that all dimensions are dichotomies (two possible values), the total number of types identified is equal to 2^N , where N is the number of dimensions. So with two dimensions we identify 4 types, with three dimensions 8 types, with four dimensions 16 types, with five dimensions 32 types, etc. We have, thus, an evident trade off between accuracy and parsimony: more dimensions may enable us to better reflect all the defining characteristics but reduce the parsimony effect and do not help us reduce complexity. Moreover, as typology is an ex ante conceptual tool, using many dimensions may result in identifying types that turn out to have no empirical relevance. Whenever possible a 2x2 typology

² In very simplistic way the differences between typologies and taxonomies (see for instance the treatment in Wikipedia) are summarised as follows: typologies are conceptual and mainly used in the social sciences, whereas taxonomies are empirically grounded, hierarchical, and most commonly used in the natural sciences. In reality, however, the two can be re-compacted (a typology can be applied to empirical reality or can be derived inductively from data via cluster analysis) and the two terms are often used interchangeably (see K.D. Bailey, *Typologies and Taxonomies: An Introduction to Classification Techniques*, op. cit., p. 6). Moreover, though only conceptually and ex ante, also typologies can include within each type a hierarchical order of super and sub types. Probably the most distinguishing element between typologies and taxonomies is in that the former uses monothetic classes derived from discrete/ nominal dimensions/variables and the latter instead uses polythetic classes derived from continuous dimensions/ variables. Monothetic classes contain cases that must be identical on all the dimensions used for the classification. Polythetic classes contain group of cases aggregated by the overall greatest similarity. To put it differently monothetic classes must include cases to have a set of properties that are both necessary and sufficient. A polythetic class A instead is one where cases share as much as possible although they are not entirely identical: a) in a given class defined by X properties each case possesses a large number of such properties; b) each one of the properties in the class is possessed by a large number of cases; but c) none of the properties defining A is possessed by all cases in aggregate (that is in all the other classes of the classification), otherwise such property would no longer be defining.

³ See previous footnote.

is the best starting point, provided it does not miss any defining characteristic. Especially if we consider that a well constructed typology can effectively introduce order where chaos reigned and, thus, help turning the complex and blurred congeries of eclectic entities into a few fairly homogeneous types along a property-space⁴ consisting of few and fundamental dimensions. A robust typology provides the building block for both theorising and for empirical research.

Figure 1 – Example: typology of market strategies



Source: Author's elaboration.

Figure 1 above provides a clear example of a robust and quite useful typology to guide the analysis of market strategies. The two dimensions (products and markets) used define mutually exclusive and exhaustive types and help us heuristically to identify and clearly name four types of strategies. So the typology already contains a hypothesis (about how companies may act) and especially a blueprint for the focus of empirical research. Empirical evidence may then bring to light the importance of additional dimensions such as for instance supply chain or logistics that can identify different successful strategies (so leading to a revision of the theory) or be the basis to construct sub-types in each cell of the matrix.

1.3 Market segmentation

Having clarified the basics of classification and typologies/taxonomies, we can move to the issue of market segmentation. Indeed, market segmentation is a particular case of typology (if built conceptually ex ante) or of empirical taxonomy (if constructed through statistical cluster analysis).⁵

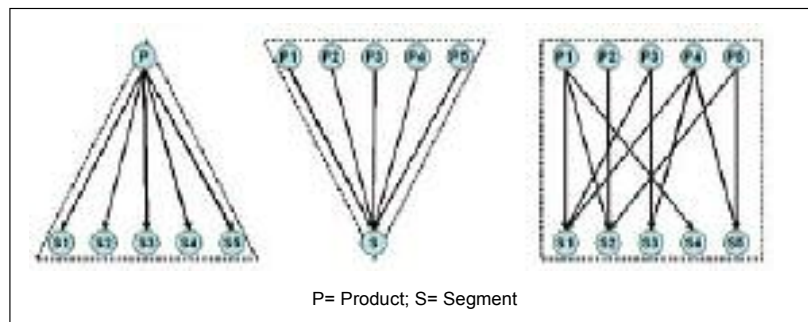
Assuming the use of two dimensions, one related to demand and another to supply, identifies four market segments; each segment is equivalent to a type of a typology and should include individuals (consumer markets) or organisations (industrial markets) that are similar on both dimensions so as to

⁴ Typologies use 2 or more dimensions. When these dimensions are combined they are said to define a "property of space" (see, for instance, A. H., Barton, *The Concept of Property-Space in Social Research*, *op. cit.*). In case of typologies using discrete variables the property of space takes the form of a matrix such as the one in Figure 1. If the variables are continuous (usually done for empirically based taxonomies but at times used also for typologies) than the property of space takes the form of a classic coordinate space with horizontal and vertical axes.

⁵ On market segmentation, see among many others: M. McDonald, and Dunbar, I, *Market Segmentation: How to do it, how to profit from it*. Butterworth-Heinemann, 2004; M. Wedel, and W.A. Kamakura, *Market Segmentation: Conceptual and Methodological Foundations*, Amsterdam, Kluwer, 2000; F. Webster, *Industrial Marketing Strategy*, Third Edition, John Wiley & Sons, 1991.

have similar product and/or services needs. Applying the principles of typology construction as specified earlier (i.e. mutual exclusivity, exhaustiveness, monothetic types, etc.), a true market segment should be: (a) clearly different from the others and internally homogeneous; (b) include entities reacting similarly to similar market stimuli; and (c) be reached by a market intervention. This latter element tells us that market segmentation, while also used in research, is mainly an instrument for tactical and strategic decision-making and action by companies. They must be useful and reliable to define the value propositions offered to different segments. In this respect, when used as a company tool segmentation can also try to act on the segments: for instance a company may want to further differentiate within a given segment to charge different prices (through product/services customisation) to consumers having the same products/service needs. The goal of market segmentation is to identify the most significant differences among current and potential customers that will influence their purchase decisions or buying behaviour, while keeping the scheme as simple as possible. This, in fact, allows marketers to differentiate their prices, programs, or solutions for maximum competitive advantage. This is usually achieved by choosing whether to have a limited number of products offered to many segments or many products offered to a limited number of segments, or to have a many-to-many approach (see Figure 2 below).

Figure 2 – Example: Different segmentation strategies



Source: Author's elaboration.

To define robust and practically useful market segmentation two criteria can be followed. First, use measurable dimensions (**measurability**) otherwise the segmentation might not be operational, although this is not always possible without costly and time consuming field research. Second, the dimensions used should be highly relevant for the various groups of customers (**substantiality**), which means the various segments should neither be too large (increase the chances of irrelevance of the dimensions for at least some sub-groups) nor too small (forego the parsimony and reduction of complexity effect).

Finally, it is worth recalling that robust and useful market segmentation is more complex for markets addressing organisations (industrial markets) than for consumer markets. This is due to more articulation in the buying and financing process, and to the complexity of industrial products/services themselves (often presenting instances of products/services complementarities).

2 Blurred Conceptual and Market Boundaries in the PHS Domain

2.1 A set of overlapping ICT-driven "labels"

Figure 3 below does not claim to be exhaustive⁶ with regard to all the terms and expressions one can find (e.g. for instance m-Health or mobile health does not appear⁷), yet it is quite representative. If read together with the two examples of market segmentation proposed by industry representatives (see Figure 4), it renders quite well the set of different "labels" and imperfect conceptualisations one can find in the domain of PHS and in related fields.

Figure 3 – The maze of labels in PHS and related domains

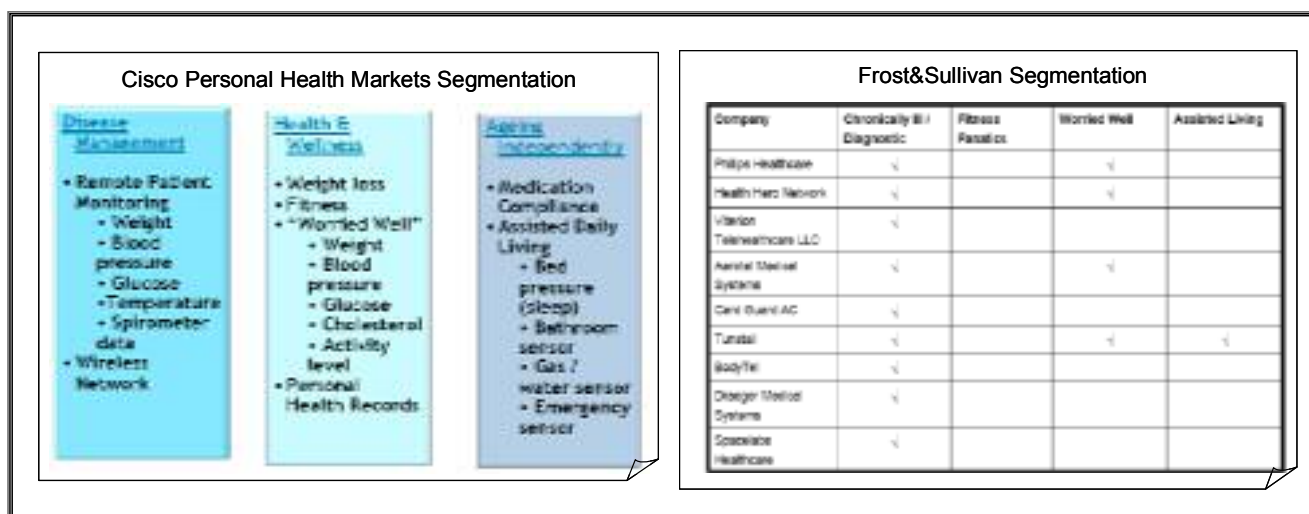


Source: Generated by the Author using www.tagcrowd.com

⁶ We selected a list of relevant documents (i.e. PHS2020 book, Lead Market Initiative report, presentation by industry and experts at IPTS February 6 2009 workshop, etc) and extracted those parts where concepts were listed, described or discussed. We pasted all these extracts together into www.tagcrowd.com, which returns the picture presented in the text. The size of each item reflects its frequency of use, but because our selection of documents is not statistically representative we raise no claim that this picture is representative of how often each item is used in general.

⁷ This is due to the fact that in the selected documents the frequency of this expression was too low for it to appear in the tag cloud.

Figure 4 – Examples of PHS segmentations



Source: See footnote⁸

We used the term 'label' for many of those in the two figures do not qualify as either concepts or market segments in the strictly defined way described in the previous section. As we will selectively show below, most if not all of these 'labels' do not presuppose, or are supported by, robust classifications identifying mutually exclusive and collectively exhaustive categories. This poly-semantics reflects different terminological choices in different domains (i.e. policy makers, ICT industry, scientific community) and in some case the clear need to create different label for different funding streams, a case in point of which is Ambient Assisted Living (AAL). In this respect it should be recalled that in the broader classification of the Lead Market Initiative we find the category termed "Telemedicine and homecare services" which intends to cover all health and social care services offered to out-of-hospital patients.

Below we will discuss some of the most evident conceptual dilemmas/inconsistencies in no particular order and so as to raise examples (so we will not touch upon all the items in the tag cloud). In doing so, we will at times refer to the examples presented in Section 4 (the annex at the end of this document). In that section the examples are placed under different headings taking the classification used in the sources, one of which is the one used in the Project PHS2020. PHS2020 project, acknowledging the problems of terminological and conceptual inter-operability existing in the field, opted pragmatically for a definition by pointing without defining the necessary and sufficient conditions that identify what is and what is not a PHS.⁹ Pragmatically building on such definition PHS2020 focused on three areas of application:

- **Chronic Disease Management** (basically coinciding with SIMPHS definition of RMT);

⁸ Sources: P. Wilson, presentation at IPTS Workshop Personal Health Systems Workshop, February 6 2009 (<http://is.jrc.ec.europa.eu/pages/TFS/documents/2WilsonCHASIMPHS090206.pdf>), p. 4;

S. Saha, presentation at IPTS Workshop Personal Health Systems Workshop, February 6 2009

(http://is.jrc.ec.europa.eu/pages/TFS/documents/10SahaFrostSullivanSIMPHS090206_000.pdf), pp. 5-6;

⁹ C. Codagnone, (2010), Reconstructing the Whole: Present and Future of Personal Health Systems, pp. 8-9, at: (http://ec.europa.eu/information_society/activities/health/docs/projects/phs2020/phs2020-book-rev16082009.pdf). The definition combines the goal of PHS and its components. One could read this definition as at least excluding applications not directly related to healthcare ('personalised health services') and, thus, distinguishing PHS from Telecare. Yet, the definition does not talk only about 'patients' and refers to empowered individuals. An elderly can feel more empowered and independent if (s)he can push a button at any time in case of emergency instead of being cared daily by a nurse, or in the same way by getting daily measures of some vital parameters.

- **Life-style management**, including:
 - Prevention,
 - Early detection (mainly Lab on Chip for Point of Care),
 - Wellbeing and Fitness.
- **Independent living**:
 - Simple applications (basically corresponding to what many refer to as **Telecare**),
 - Full care support applications (basically with much overlapping with **AAL**).¹⁰

Looking at the examples contained in Section 4 we can make at least four initial statements. First, let us assume (but this is already a big assumption) that **AAL** is a wider concept which includes **Independent Living** and **Assisted living** (broadly defined alternative sub-types). Which if any is the dimension that would allow distinguishing in a clear cut way the use of **AAL** from that of **Telecare**? It could not be the target (elderly patients for both), nor could it be the objective (assist in the broadest sense of the world), nor the mobile dimension (as this can be found both in **AAL** research projects and in market products sold as **Telecare**). Possibly the only dimension that may be used is the level of technological sophistication (i.e. **Telecare** could be provided through technologically less advanced services as compared to **AAL**). In this case, where to draw the line between more or less technological sophistication is nonetheless very problematic.

Second, if one looks at some of the **AAL** example projects (see § 4.8 and § 4.9), identifying clear cut differences with some of the most advanced PHS research projects addressing chronic diseases (see §4.2) is difficult. For instance, two of the **AAL** Joint Programme 2008 Call 1 projects – namely REMOTE see 4.8.1 and IS-ACTIVE see 4.8.2 – both have as a main component the monitoring (and possibly support to action and/or direct actuation) of vital signs exactly as in similarly defined PHS projects. Again one possibility is to distinguish them in terms of the number of different functionalities, with the underlying difficulty as to where to draw the line.

Third, going down from R&D to products and services available in the market how do we distinguish between **Remote Monitoring and Treatment (RMT)**, a component of **PHS** and broadly defined **Telecare**? Aerotel's Skeeper had been classified in *PHS2020 State of Play*¹¹ as a basic Tele-assistance and Tele-surveillance device for the provision of **Telecare** services, yet the company considers it also suitable for remote monitoring (see § 4.6.1). The same applies to Telbios's Merlino (see § 4.6.3). Leaving aside the technology, it may be argued that the former concerns Health Care and the latter Social Care. Yet, social and health care are by definition blurred and this is increasingly recognised at national level policy making. In the UK a new joined up NHS and Social Care approach has been developed to support people with long term conditions.¹² Indeed a long term condition can mix both mild impairments and chronic diseases. So from a conceptual and market segmentation perspective it is difficult to find a discrete dimension, either from the demand (end consumers, or intermediate buyers such as the public social and health care systems) or the supply side, that categorically and unequivocally place **RMT** and **Telecare** into two absolutely separate types or segments.

Fourth, a clear overlap is also evident between products/projects (so both in the market dimension and in the R&D one) classified as RMT which others consider as part of broadly defined lifestyle management (which encompasses, in the PHS2020 classification applications that range from fitness

¹⁰ See C. Codagnone, (2010), *Reconstructing the Whole*, op. cit, p. 207, and *PHS2020 State of Play*, (http://ec.europa.eu/information_society/activities/health/docs/projects/phs2020/phs2020-stateofplay.pdf) pp. 23-32.

¹¹ In PHS2020 classification these were items falling into the market/chronic disease management category. See *PHS2020 State of Play* (http://ec.europa.eu/information_society/activities/health/docs/projects/phs2020/phs2020-stateofplay.pdf), pp. 136-155.

¹² See UK Department of Health, *Supporting People with Long Term Conditions*, 2007, (http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/Browsable/DH_4100317).

to advanced early detection ones). For instance, **Philip's Motiva** (see § 4.1.7) is certainly an RMT product which contains also a quite important component addressing the management of lifestyle and physical activities; the same applies to **Bodytel's Glucotel** (see § 4.1.6).¹³

Also, looking at the two "segmentations" proposed by industry representatives (see Figure 4 – Examples of PHS segmentations) the following observations can be made:

1. the Cisco segmentation places **Worried Well** (see content in § 2.2) and **Wellness** together as part of the same segment (**Health and Wellness**), whereas for Frost&Sullivan (henceforth F&S) these are separate;
2. in both proposed segmentations **Early Detection** applications such as **Lab on Chip** (included in PHS2020 as Lifestyle Management) are not mentioned;
3. in the Cisco segmentation **Disease Management** and **Health&Wellness** mostly contain the same items, only under a different label; while this would mean discarding the segmentation from a theoretical point of view, it is indicative of the industry's perspective of packaging the same things in a different way to sell it to different customers(see more on this *infra*);
4. in the Cisco segmentation 'medication compliance' is mentioned only within the Ageing Independently segment, whereas this functionality can be, without any doubt, part of RMT also; this is a clear overlap between disease management and independent living, or to put it differently between PHS and Telecare (accepting the idea that Telecare is the broader umbrella concept, under which one can include as a particular case independent living);
5. in the Cisco segmentation, two components, namely remote monitoring (a function) and wireless network (a component), are included together as sub-component of the same disease management segment although they are conceptually of a totally different nature; this is clearly flawed and we take the opportunity to stress that technological components cannot be the basis of a classification (all the more so when considering the **mobile** characteristic of some of the services which is horizontal to many of the examples provided in Section 4).

In general, it can be concluded that there are no grounds for a robust and clear cut typology or segmentation in the way the various terms, contained in Figure 3 – The maze of labels in PHS and related domains and Figure 4 are used by most practitioners working mainly from the ICT perspective.

2.2 Looking for clear cut types from the healthcare and users perspective

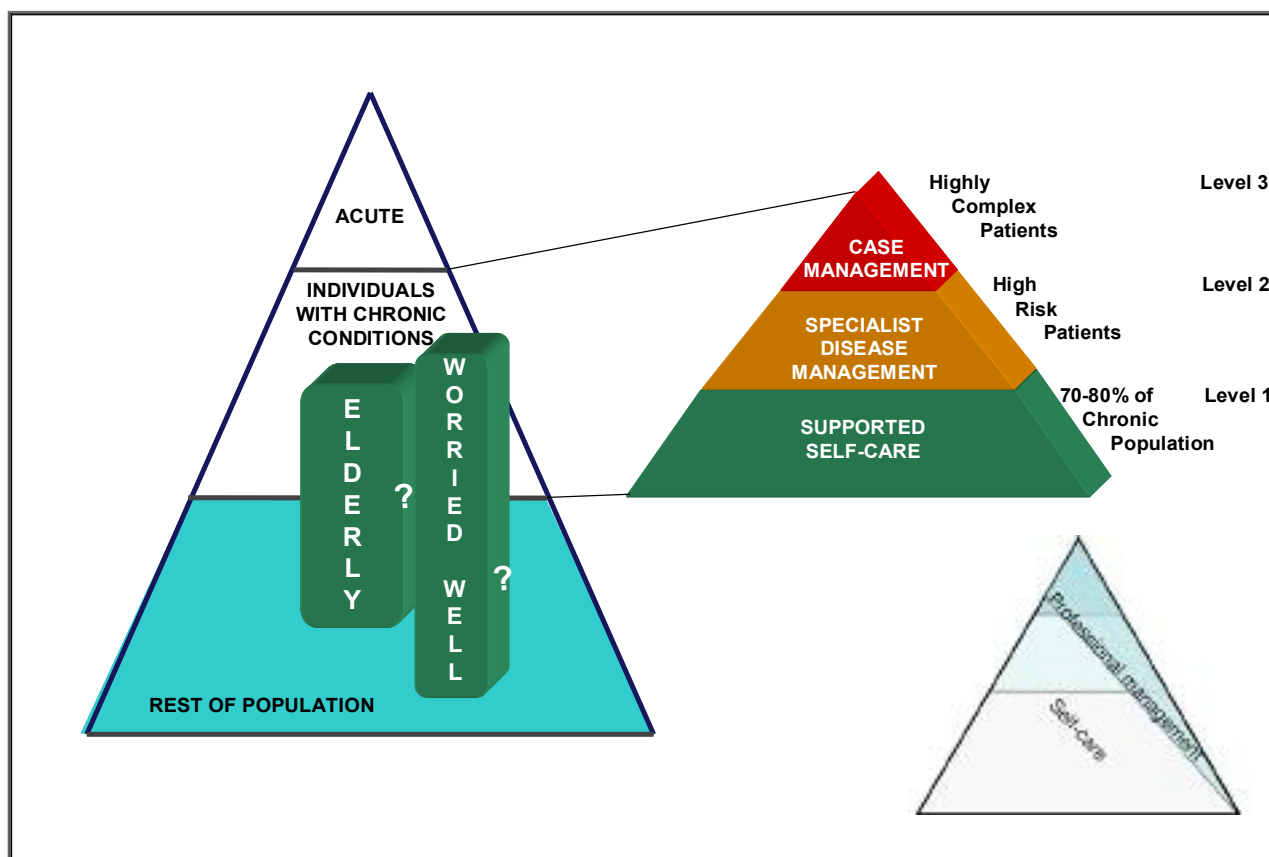
In this sub-paragraph a better way to establish a clear cut classification that could place the key terms of Figure 3 in, as clearly as possible, separate boxes starting from the perspective of health and social care needs, will be presented.

To this purpose, taking the user perspective into account, we start by describing the Kaiser Permanente Pyramid of Care.¹⁴

¹³ More evidence of RMT vs. lifestyle management overlap can be found in examples (see research projects in 4.2, 4.4) classified as addressing chronic disease management and others considered as lifestyle or prevention management.

¹⁴ Kaiser Permanente is one of the pioneering health maintenance organisations founded by businessman Henry J. Kaiser and Doctor Sidney R. Garfield (1906-1984) in the USA.

Figure 5 – The Pyramid of Care revisited



Source: Author's elaboration and adaptation on the sources in footnote¹⁵

From the bigger pyramid representing all the population, the middle part coinciding with the individuals with long-term conditions (mostly related to chronic diseases) are further sub-divided in 3 different groups (3 levels as illustrated in the smaller 3D pyramid). According to the UK prescriptive application of the Pyramid¹⁶ in reverse order:

- **Level 3 patients** include top "hospital returners" who are heavy users of unplanned secondary care. These patients, once identified, should be the target of a case by case management approach, involving a "community matron" and other professionals to anticipate, co-ordinate and join up health and social care focusing on the patient;
- **Level 2 patients** are people who have a complex single need or multiple conditions and should receive responsive, specialist services using multi-disciplinary teams and disease-specific protocols and pathways;
- **Level 1 patients** are individuals (making up a total of 70-80% of the total middle layer population of the pyramid of care) at an early stage of a disease or having it in less complex

¹⁵ UK Department of Health, *Supporting People with Long Term Conditions*, 2007, (http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/Browsable/DH_4100317); D. Singh and C. Ham, *Improving Care For People With Long-Term Conditions: A Review of UK and International Frameworks*, Birmingham, University of Birmingham Health Centre Management Services (HCMS) and NHS Institute for Innovation and Improvement, 2006 (http://www.improvingchroniccare.org/downloads/review_of_international_frameworks_chris_hamm.pdf).

¹⁶ UK Department of Health, *Supporting People with Long Term Conditions*, 2007, chapters 1 and chapter 4 (http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/Browsable/DH_4965951).

forms, so they and their carers should be helped to develop the knowledge, information, skills and confidence to care for themselves and their condition effectively.

The smaller pyramid in the bottom right corner of the figure conveys visually the ratio between professional management and self-care across the three levels (with the implication being that some self-care is also possible for Level 2 patients). From this, part of the figure it is easy to discern that the majority (70-80%) of the professional effort goes into servicing a small part of the patients those having the more severe problems (roughly 20%).

If we could stop at this level, we could have identified most of the potential segments for RMT. However, the UK approach presented considers health and social care of chronic patients jointly, so this is a first hint that even such a perspective does not provide us with a dimension whereby PHS and AAL fall into totally different boxes. The picture gets further complicated when we try to consider as dimensions, not only the objectively ascertained health status, but also **age** and especially the **perceived health status**. The **Elderly** may have or not long term conditions, and if, in general, in a healthy status could have some minor impairments, etc. So they could be the target of different intervention, leading to overlaps in the classification.

However, the group defined as the "Worried Well" group also deserves a further brief but sufficiently clear definition. The oxymoron "Worried Well" has been allegedly coined by co-founder of Kaiser Permanente, Doctor Sidney Garfield. In recent years the topic, falling at the border between the health and psychology sciences, has attracted much attention. Our exploratory search only in the PubMed database yielded 326 hits.¹⁷ Some authors based on field research actually argue, creating a new oxymoron, that worried well suffer from "Minor Acute Illness":

Many high-use patients with medically unexplained symptoms have a syndrome characterized by minor but recurring symptoms that we call minor acute illness. Minor acute illness has not been previously described as a research entity, but there are some similarities to what is referred to as the "worried well".¹⁸

There are two slightly different understanding of the "worried well" concept:

- (a) the first and original one defines the worried well as "*users of healthcare services who are not suffering from any diagnosable disease*" which in other words means that they have symptoms but primary care physicians cannot pinpoint to a physical problem;¹⁹ and
- (b) the second understanding of the "worried well" is less benevolent and basically equates them to the hypochondriac: individuals in low risk population who are concerned that a minor symptom can trigger a dreaded disease.

It is interesting to report here an extract from a patient discussion forum placed by one online medical dictionary as exemplification of the worried well in this second understanding:

I am 48 years old and I have developed the symptoms such as decrease in energy and vigour, poor sleep, decreased memory, behavioural changes etc., I am worried about getting old. Are you feeling the same and what kind of elderly person do you think you will be? I mean for example, I'll be in my back garden guarding my tulips when waving

¹⁷ Among some of the most interesting articles we signal: R. Smith et al, " Minor Acute Illness: A Preliminary Research Report on the "Worried Well", *Journal of Family Practice*, January Vol. 51, No. 1, 2020, pp.24-29; W. Peggy and P. Curran, Health beliefs and physician identified "worried well.", *Health Psychology*. Vol. 3(5), 1984, 459-474.

¹⁸ R. Smith et al, " Minor Acute Illness: A Preliminary Research Report on the "Worried Well", *op. cit.*, p. 24.

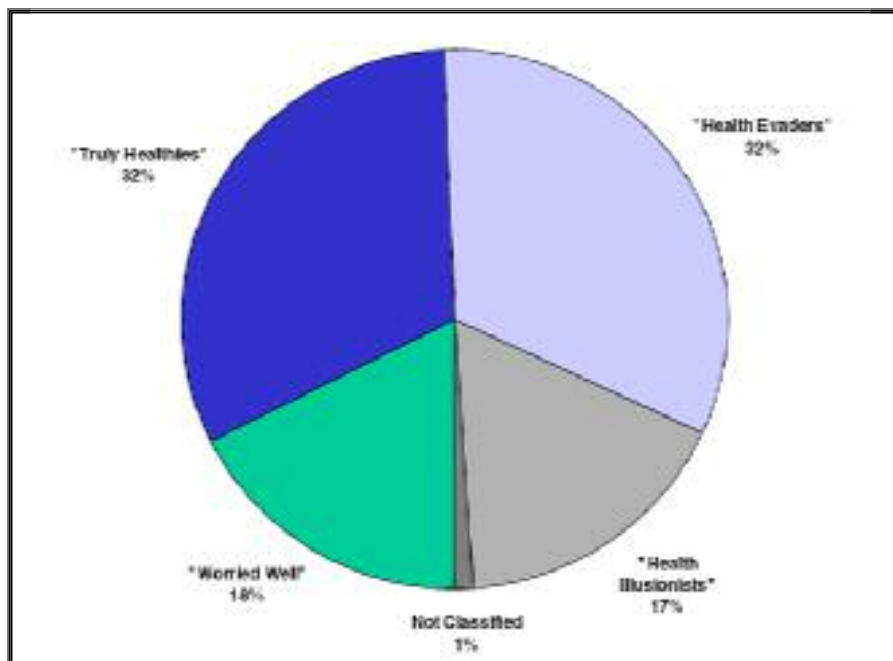
¹⁹ F. Diamond „How To Manage the Worried Well, *Managed Care Magazine*, 2003 (http://www.managedcaremag.com/archives/0306/0306_worriedwell.html).

*my cane at anyone who gets close! Do you know the ways to keep fit at this age and above?*²⁰

Whether they have some real symptoms that cannot be diagnosed or they simply worry too much (and maybe they personify their worries) there is consensus that they tend to be heavy users of healthcare and are a clear "cost centre". In some way we could make the analogy between the worried well and those customers of banks who use a lot the branches but keep little money in their account. Slowly but surely the banks have managed to implement a channel shift strategy and migrated some these customers to less expensive remote channels. The same may be attempted with the "worried well".

As to who they are and how many they are we have found at the moment only one but very interesting source that regards the US population. A survey of the US population asking individuals about their behaviour (eating, smoking or not, physical activity, etc) and about their self perceived health status identified the four groups illustrated in Figure 6. From this graph, the "worried well" group represent almost 18% of the working age population and are characterised as: 'individuals reporting few unhealthy behaviours but having a low perception of their health conditions'. Their counterparts are the "truly healthies" (32% of the population) who also report limited unhealthy behaviours and accordingly feel full healthy.²¹ The interesting fact is that there are no statistically significant differences between "worried well" and "truly healthies" in terms of socio-economic and demographic characteristics, except a slight difference in average income: "worried well" average income is \$61.600/year and that of the "truly healthies" group is \$67.400/year.

Figure 6 – Survey identifying the worried well in the US population



Source: *The Oxford Health Plan Workplace Wellness Survey* (2002: p. 8).²²

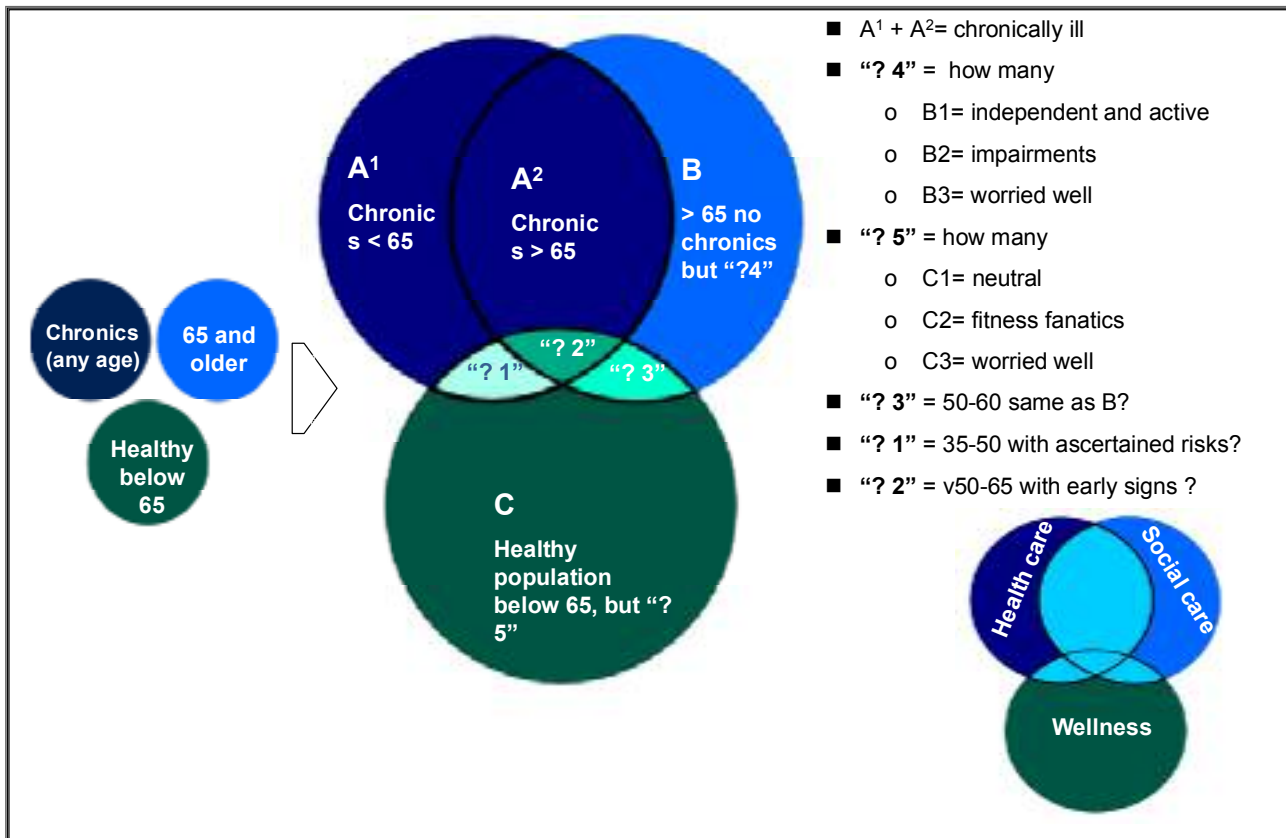
On the basis of the elements illustrated so far, this line of reasoning on identification of targets is continued with the support of the figure below.

²⁰ See <http://medical-dictionary.thefreedictionary.com/the+worried+well>

²¹ The other two groups are: "Health Evaders", Those with a relatively large number of unhealthy behaviours and low perceived health; and the "Health illusionists", those with a relatively large number of unhealthy behaviours but high perceived health.

²² https://www.oxhp.com/materials/press/wellness_survey_2002.pdf

Figure 7 – Types of users and related macro-segment



Source: Author's elaboration.

First, at the left hand side of Figure 7, the three small circles, distinguish three possible groups, using the dimensions of health status (objective) and age. Lack of granular data prevents us from providing a quantified 2*2 matrix. Objectively ascertained health status is more nuanced than simply healthy and ill and we cannot reflect the subjectively perceived health status. So, the next step suffers from these limitations.

Second, we intersected the three circles and tried to interpret the results (middle part of graph with large circles). Again, the only clear cut type is that composed of individuals with ascertained chronic conditions (most likely also above 65 (A2), but not necessarily (A1)). Out of the elderly, that do not have chronic disease, we could envisage many profiles but in the figure we limited ourselves to 3 (equivalent to group ?4): (a) independent and active (who may want some fitness/wellness services – probably paying out of pocket expenses); (b) with some impairments (who may need some form of ICT enabled assistance); and (c) worried well who may want both (fitness and assistance). Next, in the areas of intersections around the centre of the three circles, there exist more types needing further creative interpretation: (a) some individuals approaching their 60s who may be similar to the elderly (group identified as ?3); (b) younger individuals with ascertained risks (they may need both fitness/wellness applications and the use of early detection or diagnosis tool, identified as ?1); and (c) other individuals also approaching their 60s but with early signs of disease (who may need both RMT and wellness and fitness identified by ?2). Finally, most of the remaining working age population (identified as ?5) belong to three groups also, including healthy, fitness fanatics and worried well who are all potential high users of healthcare in need of RMT services and applications.

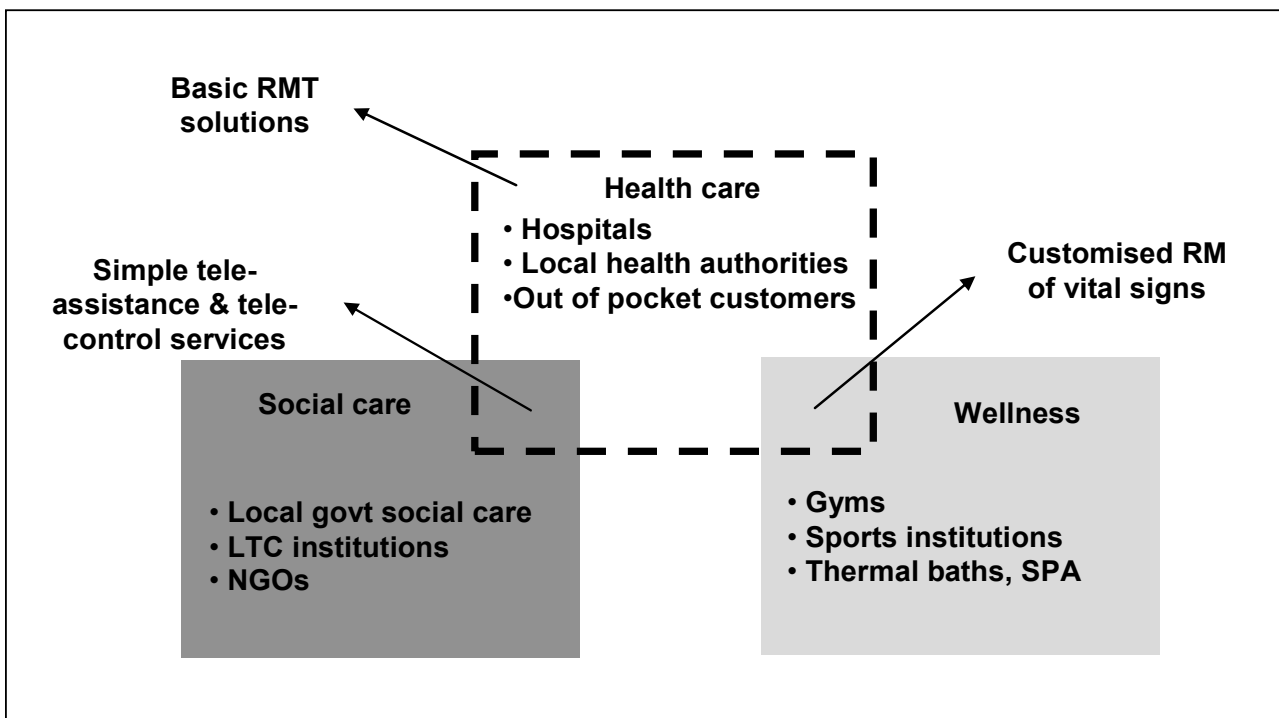
As a general conclusion of the analysis presented above considering the condition/perspective of the users as the way to distinguish a clear cut typology or segmentation, has also proven inadequate

since, as can be seen in the bottom right hand side of the graph, the small three circle intersection simply indicates that Health care, Social Care, and Wellness overlap and there is no way to separate them in a clear cut way.

2.3 Looking for clear cut types from the industry observed behaviour

In this paragraph, the perspective of the industry will be taken into account in trying to define a segmentation that is usable. The following is extracted in an ideal-typical fashion from the company analysis conducted in SIMPHS Phase 1 and is summarised in Figure 8 below.

Figure 8 – What industry mostly does: ideal-type from 50 companies' analysis



Source: Author's elaboration.

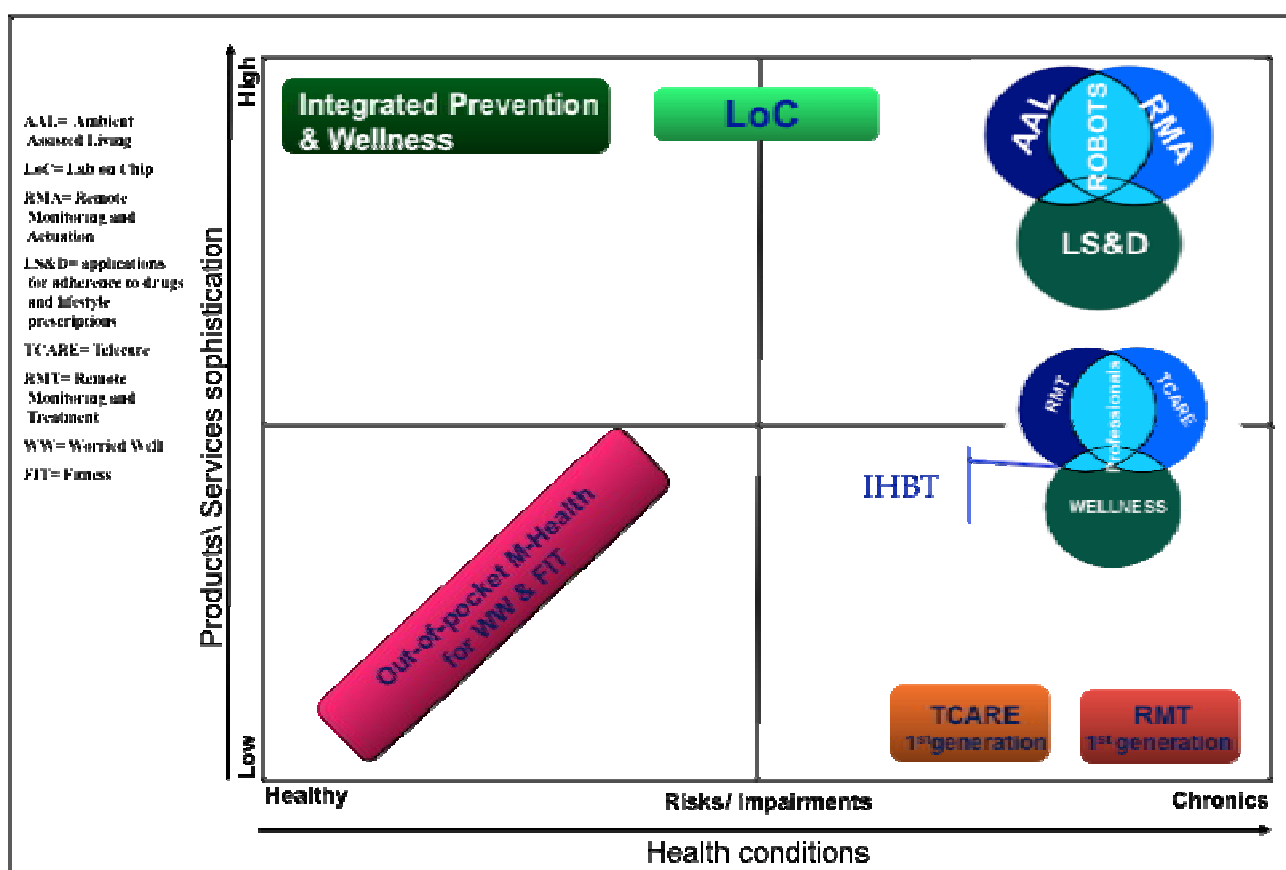
Simplifying considerably the nuances of the empirical evidence gathered we argue that what companies do and manage to sell are services packaged differently but created from the same basic technological components. More complex solutions and services remain to a large extent the focus of R&D efforts. As a general conclusion, this line of reasoning does not help us define a robust and widely accepted typology/segmentation, either.

3 Conclusion: 'Hybrid' Classification and Implications for SIMPHS 2

3.1 Disclaimer and illustration of dimensions chosen

We have amply documented in the previous section the blurred and overlapping issues characterising the domain at stake. Evidently it is not possible to re-group the various labels currently being used into a methodologically robust and clear cut typology and/or segmentation along the criteria and principles illustrated in **Section 1**. We, thus, opted for a pragmatic solution we consider a sort of a 'hybrid' typology (see Figure 9 below). First, while typologies use discrete variables and empirically based taxonomies use continuous variables, our matrix tries to combine a discrete and continuous perspective (the 2*2 matrix is integrated with a directional arrow). Second, while the four classes of the 2*2 typology should be monothetic (which according to footnote 2, p. 6, means entities can fall into only one type), our typology not only allows for overlaps but from them has created types that to some extent are prescriptive and future-oriented (how things could or will be) rather than empirical.

Figure 9 – Proposed hybrid typology



Source: Author's elaboration.

Despite the limits we ourselves have pointed out earlier, we have used as dimensions "health status" and "sophistication" of the products/services currently available in the market or being developed with R&D projects. It is worth recalling these limits: (a) health status is more granular than simply either healthy or ill – we attempted to address this by inserting in the middle also the possibility of

having ascertained²³ risks or impairments from early signs of disease or simply from ageing; and (b) the sophistication²⁴ of products/services can be quite arbitrary – where one sets the threshold and the evaluation of the level of sophistication remains a highly subjective judgement. The application of these two dimensions has produced the typology in Figure 9 above, whose types we discuss next.

3.2 *The types briefly explained*

In this section we only explain the types and we refer the reader to specific parts reported in Annex I in Section 4.

3.2.1 **Most sophisticated solutions are still the domain of R&D**

The upper part of the figure, both on the left and on the right hand side, is still mostly the domain of R&D and we will not spend much time on it, for our focus both in Phase 1 and Phase 2 of the SIMPHS project is on the actual market and innovation dynamics and we have found no evidence so far of such sophisticated solutions being integrated in the practice of delivering care. Given the earlier discussed overlaps, in the top right hand corner we placed the intersection of AAL (see examples in § 4.7 and § 4.8) and Advanced RMT (see § 4.2). Advanced RMT solutions (signalled as RMA) are those that: (a) provide for multi-disease monitoring (addressing also co-morbidities); and/or (b) address diseases other than the usual ones (CHF, diabetes, COPD); and/or (c) provide closed-loop solution with actuation. This is also combined with robotic services and applications to provide evidence of adherence to drug and lifestyle prescriptions. In a way this is not only an empirical segmentation but also the envisioning of a likely future convergence. In the middle of the upper part we have positioned solutions for early detection and diagnosis based on very sophisticated Lab on Chip projects (see § 4.5), whereas more advanced and integrated prevention and wellness applications are at the left top corner. The horizontal positioning of these two discreet segments attempts to distinguish the difference in targets, assuming that Lab on Chip will be used more for individuals with ascertained or assumed (family history) risks or with early signs of such risks, while the prevention and wellness part is intended for targets that do not present such risks.

3.2.2 **First generation RMT and Telecare**

First generation RMT forms the majority of the cases and products we found and analysed in Deliverable D3.1. These are very basic solutions with no multi-sensor or multi-disease capabilities (so typically one sensor per disease) and with no closed loop from remote monitoring directly to actuation (see § 4.1). The treatment component is one requiring traditional human intervention. So we kept RMT as an expression but we must stress that this does not mean actuation. On the basis of the evidence found it is possible to define within RMT two sub-types:

- **Pure RMT stand alone services** provided only through ICT and call centres, which forward the data gathered and processed to the healthcare provider in charge. The monitoring and the professional intervention are two separate and non integrated components; and
- **Disease Management Integrated RMT services**, whereby RMT and the traditional disease management activities of nurses and professionals are fully integrated. This is for instance the approach of HTN in Lombardy, but also of the Veteran Health Administration in the USA. In

²³ Moreover, one can distinguish between objectively ascertained and subjectively felt health status; not considered in this typology.

²⁴ To a large extent the sophistication can be assessed in terms of the technological components (i.e. basic one sensor/ one disease solutions versus multi-parametric sensors solutions, or simple monitoring versus closed loop with actuation and/or automatic feedback), and/or of the number of functionalities (i.e. only monitoring and actuation, or monitoring, actuation and surveillance of physical activity), and/or of the level of integration of the ICT enabled solution into traditional disease management activities.

the literature this second model is also referred to as **Home Based Tele-management (HBT)** of chronic disease.²⁵

First generation Telecare are simple tele-assistance and tele-surveillance services with push buttons connected to call centres and/or localisation services also connected to call centres, such as for instance WatchMan of SHL Telemedicine (see § 4.6.2) or Tunstall's ADLife (see § 4.6.4).

3.2.3 Integrated home-based telemanagement

We coined the expression for this type, taking from the literature the concept of Home-based Telemanagement to convey the idea that ICT-supported solutions are integrated into disease and case management programmes (as in the cases of services for CHF reimbursed by the Lombardy Region). The connotation in "Integrated", however, also indicates that RMT, Telecare, and Wellness are combined as is beginning to happen in cases such as in the UK (see § 4.1.2) and to some extent in Veneto (see § 4.1.1). Although technologically this may be happening still with simple solutions, we have placed this type higher with respect to the sophistication dimension in light of the more articulated and integrated approach.

3.2.4 Out-of-pocket mobile health for worrying well and fitness

As we anticipated, using a technological characteristic to classify types or segment is an imperfect approach, for it is likely that such characteristic will be horizontal to many and possibly very diverse products/services. As a matter of fact, a mobile component can be found in several projects across all the different examples in the Annex **Section 4**. This type, therefore, has been identified (clearly forcing sound concept building principles) reasoning on the targets and on the level of sophistication and adding a consideration on the way it is or can be marketed in the near future. The type includes very simple and basic monitoring of vital signs that can be delivered onto a mobile phone or any other small portable device for individuals while they exercise and/or for the worried well whenever they feel the necessity to use it. They do not foresee a necessary and direct connection to a physician or nurse, but such monitored data can be stored and discussed at a later stage with the professionals. These are services currently being provided mostly for out of pocket payment within a consumer electronics business model. As we did not include them in Section 4, a few examples are reported below:

1. a 2009 report published by Berg Insight²⁶ stresses that while mHealth solutions have a huge development potential they still face important challenges, the most prominent being that of financing. Leading telecom and IT companies have started to see business opportunities on the consumer segment though, and offer services directly to patients and caregivers, in addition to running the related networks and data centres. In particular health related applications for smart phones have started to generate revenues;
2. Apple drives mHealth applications, with about 900 medical applications and almost 1700 health and fitness applications, which are downloadable from the Apple Store. The MYLEStone Health's Glucose Buddy²⁷ is the most popular application provided on the iPhone for remote monitoring which allows user to enter data on glucose, exercise, food, medication and view curves of glucose levels etc. About 450.000 uploads had been made by users for this application by September 2009. While there is currently no direct transfer

²⁵ See for instance A. Giordano et al. Multicenter randomised trial on home-based telemanagement to prevent hospital readmission of patients with chronic heart failure. *International Journal of Cardiology* 131 (2009) 192–199.

²⁶ Anders T. Ryberg: "mHealth and Home Monitoring", Second Edition, 2009, Berg Insight.

²⁷ <http://www.glucosebuddy.com/>

possibility from glucose monitors, MYLEStone Health is working on a future integration in cooperation with Roche, but the process seems to be slow and difficult;

3. There seemed to be a lack of mHealth products for Nokia smart phones at the time of research (Autumn 2009); Nokia having virtually no monitoring products with the exception of an application for mobile diabetes management, which enables a variety of Nokia smartphones to wirelessly upload blood tests from a glucose meter to the MyGlucoHealth portal. The application is downloadable from the OVI store, it features an automatic alarm to formal and informal carers in case thresholds are exceeded and enables orders for the replacement of test strips of the glucose meter attached. However because of their market position, Nokia is expected to play a major role in mHealth in the future. The Finnish company eHIT, backed by Nokia, has developed a patient sensor and smart phone-based monitoring system to deliver round-the-clock vital signs measurement, which uses Bluetooth to connect patient sensors to the smart phone. The solution utilises eHIT's Health Gateway; a tool that transfers and analyses data from diverse sensor devices via both a mobile platform and wireless GSM/GPRS networks;
4. Blackberry is another typical candidate for the provision of consumer out-of-pocket mHealth services. They seem to have only about 70 health and medical applications available, and none actually performing medical monitoring. However Blackberry devices are used in a number of trials for data collection processing and transfer;
5. Ericsson's mHealth solution, which has been tested in a number of trials since 2001, as well as further initiatives (i.e. partnerships with the Pharma industry in Sweden, with Hospitals in India, or with Red Cross in Australia)²⁸ they are developing which are expanding demonstrate the importance of this sector for Ericsson;
6. Some Telco position themselves at the crossroads between the mHealth professional and the end-consumer markets. An example is Orange Healthcare, the healthcare division within the France Telecom Group. In June 2009, Orange Austria and charity Arbeiter-Samariter-Bund Österreich (Workers Samaritan Federation Austria) announced²⁹ a trial to pilot implement a mobile e-health solution for monitoring blood sugar levels and blood pressure, using Alcatel-Lucent TeleHealth Manager solution, an off-the-shelf e-health platform. Orange's strategy on the mobile health segment focuses on 3 priority areas: at the hospital, at the doctor's office and at the patient's home. In terms of end users, Orange targets remote assistance of patients suffering from chronic disease and the provision of data systems and intelligent software adapted to specific conditions. While the Orange business model is not targeted exclusively at the out-of-pocket end-consumer segment, the latter may be part of the equation in generating revenues from the mHealth segment;
7. Also, Telefonica R&D have been involved for some years in remote monitoring pilots and trials particularly in Spain, but also through participation in EU-funded initiatives (e.g. EC-funded mobile health project HealthService 24);
8. Recent advances in mobile positioning systems and telecommunications are providing the technology needed for the development of location-aware Telecare applications. CAALYX (Complete Ambient Assisted Living Experiment) is an EU-funded project which successfully developed a prototype system comprising a home monitoring system, a mobile roaming

²⁸ See:

http://www.ericsson.com/ericsson/corporate_responsibility/our_most_relevant_issues/communication_for_all/making_communities_mobile/stimulating_social_and_economic_development/mobile/index.shtml

²⁹ Via http://www.ehealthurope.net/news/4970/orange_austria_targets_mobile_e-health

monitoring system and a caretaker centre. The CAALYX team has already launched two follow-up projects to help bring the technology to the market;

9. Another class of mobile health services are those where the mobile is used not only as a sensor for monitoring, but also for the analysis/storage/transmission to the clinician. Examples are AT&T's "device certification lab" that tracks health along high-speed broadband networks and sends results to a family physician, specialist, or electronic medical record, depending on the wishes of the patient;
10. The company Triage Wireless has a "wearable" monitor that records vital signs and transmits them to physicians. It records blood pressure on a continuous basis, thereby providing regular information for health care providers. Another example of 'wearable' monitor is Lifewatch's ACT Sensor. Each heartbeat is recorded and transmitted wirelessly to the ACT Cellular Phone Monitor where it is analyzed. If an arrhythmia is detected, the Cellular Phone Monitor automatically sends it to one of three LifeWatch Monitoring Centres for review and medical notification, if required;
11. Remote monitoring devices at home, record glucose levels instantaneously and electronically forward them to the appropriate health care provider using mobile technologies. Patients are using FDA-approved "Glucos Phones" that monitor and transmit glucose information to caregivers while also reminding patients when they need to undertake glucose tests. This puts people in charge of their own monitoring and keeps them out of doctor's offices until they need more detailed health care.
12. St. Francis Hospital in Roslyn, New York uses a wireless pacemaker made by St. Jude Medical connected to a home monitoring device to track heart rhythms and vital signs. Patient information automatically is transmitted to his medical office, which allows him to see which patient has abnormal heart beats and therefore is in need of immediate treatment.

A number of references relating to m-health research projects, trials and applications have been identified and are reported below:

Santosh Krishna, Suzanne Austin Boren, E. Andrew Balas; "Healthcare via Cell Phones: A Systematic Review"; *Telemedicine and e-Health*. April 2009, 15(3): 231-240. doi:10.1089/tmj.2008.0099.

Christian Alis, Carlos del Rosario, Bernardino Buenaobra, Carlo Mar Blanca; "Lifelink: 3G-Based Mobile Telemedicine System"; *Telemedicine and e-Health*. April 2009: 241-247

Carlos Martínez-Ramos, María Teresa Cerdán, Rodrigo S. López; "Mobile Phone-Based Telemedicine System for the Home Follow-Up of Patients Undergoing Ambulatory Surgery"; *Telemedicine and e-Health*. July/August 2009: 531-537.

Feder Lester J.; "Cell-Phone Medicine Brings Care To Patients In Developing Nations"; *HEALTH AFFAIRS* 29, O. 2 (2010): 259–263 Project HOPE2010— The People-to-People Health Foundation, Inc.

Jones Val, Gay Valerie, Leijdekkers Peter; " Body sensor networks for Mobile Health Monitoring: experience in Europe and Australia"; *The Fourth International Conference on Digital Society, ICDS 2010, February 10-16, 2010 - St. Maarten, Netherlands Antilles, CPS 2010*

3.3 Implications for SIMPHS Phase 2

As a result of the discussion on segmentation, a number of points have been raised that could help shape the scope of research for Phase II of SIMPHS. First, it is worth stressing that the most advanced RMT types identified are mostly still a matter of R&D with limited real life applications and as such have little economical impact in shaping the market. Secondly, while the PHS definition produced by PHS2020 represents today, at least at a conceptual level, increasingly shared and used

by the PHS community of practice, it does not reflect adequately the market reality. Given the conceptual difficulties we have amply illustrated, SIMPHS Phase 2 could produce an added value by pursuing an incremental concept building exercise.³⁰ Finally it is quite clear that both emerging applications of out of pocket Mobile Health for worrying well and fitness and Integrated Home Based Telemonitoring should become the focus of research. The first will enable us to assess how fast these emerging solutions/services are spreading in terms of both supply and take up and to what extent they can work as a Trojan horse for further take up of the whole PHS field (i.e.: scale and critical mass lowering costs in this areas and allowing vendors to sells at more economic prices in different areas; possible contagion and word of mouth effects among users). The second will allow looking also at disease management programmes and how these are integrated with ICT supported solutions, as was suggested by many during the November 2009 SIMPHS validation workshop. These two types should be used in a flexible way and not sticking strictly and exactly to their delimitation as provided above, so as to avoid spending time and resources analysing and measuring an excessively small unit of analysis. Finally, both should be approached with depth of analysis as a priority: that is to say with a solid qualitative case study component and an optional quantitative one.

³⁰ This could be achieved top down by a meta-analysis of relevant documentation and by gathering for Europe survey data (such as those found for the US, see pp. 13-15) and statistics enabling to better segment the population in terms of socio-economic and demographic characteristics, ascertained health conditions, perceived health conditions and behaviours and as well as bottom up through a consultation of experts and stakeholders during a few workshops and through an online exchange platform.

4 Annex I: Examples

For obvious reasons of structuring and presentation, the various examples in this Annex have been placed under different headings. We must stress, however, that we pragmatically adopted for the heading of the various paragraphs the classification used in the sources from which the examples have been taken. These sources are basically three: (a) SIMPHS Deliverable D3.1; (b) the mapping of market products and research projects used in PHS2020; and (c) the AAL Joint Programme and FP6 for AAL projects. In other words, the different headings of what follows should not be considered in any way a typology or market segmentation, since the careful reader will spot easily the macroscopic overlaps between items placed in different paragraphs. This list of market products and research projects serves the purpose of providing the background and repertoire examples for the reasoned discussion presented in the previous sections and should, thus, not be read and taken as the classification we are proposing.

For solutions mainly addressing chronic diseases the sources used are SIMPHS Deliverable D3.1 and PHS2020 State of play,³¹ which use different expressions to refer basically to the same group of items (Remote Monitoring and Treatment in SIMPHS and Chronic Disease Management in PHS2020). So, considering this similarity, we simply use the expression RMT, distinguishing between basic and advanced solutions. Basic RMT contains examples from SIMPHS D3.1 and from the list of market products classified in PHS2020 as Chronic Disease Management. Advanced RMT coincide with the list of R&D projects classified in PHS2020 also as Chronic Disease Management.³²

We repeat again for reasons of transparency that what follows is only meant for illustrative purposes and raises no claim to be either exhaustive or representative.

4.1 Basic RMT/ Chronic Disease Management (CDM)

4.1.1 From SIMPHS D3.1: regional examples - Italy

In Lombardy, the regional administration reimburses remote monitoring services, including related intervention by nurses and physicians, for Chronic Heart Failure patients. In Piedmont the same approach (with nurses and physicians intervention) will be launched in 2010 for CHF, diabetes, and COPD patients. In Veneto we have an example of simpler Telecare services including also some remote monitoring of vital signs (but only the monitoring and no professional intervention): from 2010 the region will provide integrated Telecare services (including an RMT component) for a maximum of €25.000 per day over five years.

4.1.2 From SIMPHS D3.1: UK

In the UK, Telecare and TeleHealth form part of a major randomised control trial across three demonstrator sites (the Whole System Demonstrator (WSD) programme).³³ WSD is considered the biggest single Telecare/ TeleHealth convergence pilot in the UK.³⁴ An important aim of trial is to build the evidence base for the use of these technologies as part of integrated health and social care support for people with long term conditions. Criteria for enrolling up to 6000 patients in the WSD TeleHealth trial are those diagnosed with one or more of the long term conditions such as chronic

³¹ In PHS2020 classification these were items falling into the market/chronic disease management category. See PHS2020 State of Play (http://ec.europa.eu/information_society/activities/health/docs/projects/phs2020/phs2020-stateofplay.pdf), pp. 136-155.

³² See PHS2020 State of Play, op. cit, pp. 156-172.

³³ http://www.dh.gov.uk/en/Healthcare/Longtermconditions/wholesystemdemonstrators/DH_084255

³⁴ http://ec.europa.eu/information_society/events/cf/document.cfm?doc_id=7253

heart failure, type 1 or 2 diabetes and Chronic Obstructive Pulmonary Disease (COPD) or co-morbidities, and, in addition, people that have had at least one or more unplanned events in the last 12 months in relation to their long term condition, such as unplanned hospital admission, intermediate care/ rapid response service use, treatment following call out of ambulance services or accident and emergency visit.

In Scotland, Scotland NHS Lothian TeleHealth programme (Telescot) is considered one of the largest of its kind in the UK and will provide in-home care for patients with chronic obstructive pulmonary disease (COPD) and other chronic conditions. The NHS Lothian programme is part of an ongoing collaboration between NHS Lothian and the Scottish Government, implemented by Intel and Tunstall (it is using the Intel Health Guide personal health system, launched in the UK in November 2008). It follows a small-scale pilot of 30 patients with COPD launched in March 2008, also using the Intel Health Guide. The large scale programme started with 200 COPD patients and will later include those with other chronic conditions including cardiac diseases and diabetes across Edinburgh and the Lothian regions.

Connected Health & Care Northern Ireland strategy (ECCH)³⁵ represents a major investment in chronic disease management and public procurement of a remote Telemonitoring service for 5000 people (heart disease, COPD, diabetes) by 2011 in Northern Ireland (NI). ECCH was set up in January 2008 within Department of Health, Social services and Public Safety (DHSSPS), following a feasibility study carried out in 2007, to promote improvements in patient care through the use of proven technology and to fast track new products and innovation in the local health and social care system in Northern Ireland. Providing a strategic focus for the local health and social care economy it seeks to bridge the gap between market solutions that are available and which offer significant potential for improving the quality and efficiency of services and the lack of awareness about these solutions among practitioners and policy makers. It is funded by the DHSSPS. The initial focus of the ECCH is the development procurement and implementation of a remote monitoring service for chronic disease in Northern Ireland. This is a system-wide solution that actually goes beyond pilots, as the latter are fragmented in nature and limited in duration. The aim of the ECCH initiative is to embed technology in healthcare so as to leverage its potential to catalyse change, not only at technology level but in working practices. The current focus of the services in the process of being procured is CHF, COPD and diabetes patients, both home-based and mobile. In the future further conditions may be tackled such as stroke prevention, hypertension, Telecare services (e.g. fall detection), medicinal compliance or dementia, depending on the results of the evaluation of the current services. The future strategy will include the promotion of health and well being, independent living, early intervention etc. ECCH also aims to build an evidence base in relation to the use of remote monitoring in support of the management of chronic disease.

Besides the WSD programme and regional initiatives, in the UK, there are also over 300 Telecare services provided by local authorities, housing associations, independent, voluntary and third sector organisations as well as commercial providers. A small number of primary health trusts have been testing TeleHealth systems that can monitor respiratory and heart conditions at home. These services include regular home monitoring of blood pressure, blood sugar, weight and other vital signs. If these measurements are outside of certain levels, healthcare professionals (e.g. specialist nurses, community matrons) are alerted and will take appropriate follow-up action. In 2008, the Commission

³⁵ <http://www.eu-cch.org/>

for Social Care Inspection (CSCI) collected information from 150 social care authorities³⁶ and reported on Telecare outcomes and mainstreaming.³⁷

There is also a Chronic Care Management (CCM) programme (comprising three projects) operating across Wales - Carmarthenshire, Cardiff and North Wales – launched in 2008 and focused on chronic conditions such as arthritis, chronic obstructive pulmonary disease, diabetes and chronic heart conditions. Each of the three projects is focused on different aspects of healthcare and social care.

Finally, a major two-year pilot programme has been announced by the Department of Health to test and evaluate a range of models of integrated care. The programme which consists of 16 Integrated Care Pilots (ICP) is designed to explore different ways in which health and social care could be provided to help drive improvements in local health and well-being. Integration refers to partnerships, systems and models as well as organisations - crossing boundaries across primary, community, secondary and social care. The pilots³⁸ vary from developing new models of long-term condition management to help patients choose their end-of-life care, to enabling people to self-manage COPD care. Pilot sites are working across primary, secondary, community and social care services, public and third sector organisations to forge new partnerships, systems and care pathways. A number of these pilots also deal with innovative approaches for chronic disease management.

4.1.3 From SIMPHS D3.1: Germany

There are a number of small and large-scale pilots and projects underway in **Germany**. As an example the health insurer **Techniker** in cooperation with the German Association for Chronically Ill People is piloting telemedicine applications for people with heart failure and people with asthma. The programme for people with heart failure is running for 27 months. The **Asklepios Future Hospital (AFH)** runs a project for developing a Telemonitoring centre for chronically ill people to enable monitoring of vital signs and necessary check-up of medical parameter at home. Medical specialists can access and monitor patient data remotely and communicate with patients. The project describes itself as “among the world’s largest healthcare system innovation programs” and involves a partnership network of 20 major industrial companies and healthcare cost carriers. Planning of the project started in 2004 and routine operation in 2006. The **TeleMom** – Telematic Modules and Services for Out-Patient Health Monitoring Project - develops a homecare platform for secure and interoperable exchange of patient data with the objective of enabling effective Telecare services at home. The project makes use of wireless connections for a number of monitoring systems.

CorBene is a programme aiming at better care for people with heart failure. People who are insured within the BKK can participate in the CorBene programme which, amongst others, includes Telemonitoring of patients and also provides a mobile alarm with locating functionality. PHTS which is one of the main service providers also has co-operations with the IKK health insurance and several other health care insurances. Cooperation with the IKK health insurance for example started in 2004. The programme has been operational since October 2009.

RMT programmes like CorBene benefit in Germany from the availability of a legal framework (statutory health insurance - SHI) which gives incentives for sickness funds to implement Disease Management Programmes. The SHI was created in 2002 and the first DMP started in January 2003. Up to September 2007, a total number of 14,000 DMPs¹ (17 regions, more than 200 sickness funds)

³⁶ <http://www.networks.csip.org.uk/telecareprofiles>

³⁷ Telecare performance reports from social care authorities (2008) at [http://www.dhcarenetworks.org.uk/IndependentLivingChoices/Telecare/TelecareOutcomes/?](http://www.dhcarenetworks.org.uk/IndependentLivingChoices/Telecare/TelecareOutcomes/)

³⁸ http://www.dh.gov.uk/prod_consum_dh/groups/dh_digitalassets/documents/digitalasset/dh_098912.pdf

were registered for various diseases (diabetes mellitus type 1 and 2, breast cancer, coronary heart disease and asthma/chronic obstructive pulmonary disease). In September 2007, the number of patients voluntarily enrolled in DMPs reached almost 3.6 million. DMPs for coronary heart diseases (CHD) constitute a prominent share of all programmes.

Besides the above, there are some well established RMT service providers in Germany like **Vitaphone** that offers services to patients with cardiac arrhythmia, hypertension or chronic heart failure. The solution consists of a hub, a telemedical service centre, medical equipment and services to connect patients with the call centre and the call centre with medical care centres. Vital signs are transmitted from an ECG card worn by the patient to a mobile phone or via a normal telephone. Alternatively in the Vitaphone integrated care model, a “Vitaphone Telecare Monitor” is used. Vitaphone runs its own telemedical service centre with cardiologists. In case of emergency the patient is handed over to the local emergency services. For Chronic heart failure, weight data is gathered using special scales and transmitted to a Bluetooth-capable mobile phone. The phone then automatically sends the data to the Vitaphone service centre. The above mentioned Vitaphone Tele-Care-Monitor is also used as a central gateway for collection of data from peripheral monitoring devices (blood pressure, weight, glucose, ECG) and automatic transmission to the telemedical service centre. Remote configuration allows interactive communication with patients: reminder function, individual questioning e.g. questions regarding clinical symptoms, current medication or quality of life.

4.1.4 From SIMPHS D3.1: Spain

In **Spain**, Emminens (a subsidiary of Roche Diagnostics) offers a monitoring solution to diabetes patients, via three distinct telemedicine services:

- *Emminens Responde* is a call-centre service offered free of charge to insulin patients, supporting primary care and enabling patients to seek advice from specialists although the latter are not entitled to give any diagnosis, nor change treatments.
- *Emminens Conecta* is a telemedicine service provided via mobile for Type I diabetic patients (10% of all diabetic patients, around 180,000 patients in Spain). It consists of a specialised software for the patient's mobile phone (alternatively, an Internet solution called Accu Check Smart Pix is offered) which processes the information and a glucose meter Accu-Chek® produced by Roche Diagnostics; and for the doctor a Web application that allows processing the data sent by the patient. The patient sends the results of his/her glycaemia tests with Accu-Chek via infrared waves to the mobile phone, which in turn sends the data automatically to the webpage of Emminens ConectaPlus via SMS. The doctor can thus monitor the patient status and recommend the best action (e.g. increase or reduce the insulin levels) to the patient via SMS.
- In addition, there is a specialised call centre in Barcelona operating 24/7 for insulin pump users, mainly for children.

Emminens outsources the call centre activity to one of the specialised companies providing this service in the market. Doctors and nurses access patient data on the web platform and patients can also view and print their data.

Saludnova is a small company created in 2008 as a spin-off from the University of the Basque Country which provides mobile solutions for people requiring monitoring of biometrical signs and/or real time detection of alarm situations, in particular for hypertension, heart failure, respiratory diseases and co-morbidity. Currently, it offers its services in the Basque country in cooperation with two public hospitals. Saludnova addresses social care through its CarelineH@me & Assism@bile products, which focus on preventive medicine and social care. Specific healthcare services are provided through CarelinePr@) which enables the monitoring of discharged patients by hospitals.

The products comprise automatic sensors for measuring hypertension, respiratory, heart and co-morbidity vital signs, and transmission is done via Bluetooth. In addition, a set of qualitative questions allow capturing data manually about the person's condition (e.g. how they slept etc.) and a manual sensor is used for transmitting temperature and glucose levels. The Saludnova solution is based on software integrated in a mobile system that allows the local analysis of vital signs. Data gets transferred once a day unless an alarm is triggered in which case the transfer is done real-time. Patients do not receive feedback or alarms, only their doctors do and they then decide whether to take action or not (i.e.: sending an ambulance or a nurse to the patient). Customisation of the solution enables taking care of the needs of the institution providing the service and can also be done for each end-user. Call centre activities are outsourced to specialised companies.

4.1.5 Aerotel's Heartview and Heartone

Heartview comprises a range of personal, 1 to 12 lead transtelephonic or digital ECG devices for various remote diagnostic and emergency service applications. The recorded ECG signals are transmitted through either telephone, the Internet or mobile phone to a medical centre, where a PC-based ECG receiving station receives the transmitted ECG and displays it for analysis and evaluation.

Heartone is portable application, thus maximizing patient mobility (**mobile**). It is a wireless small device, which easily fits into a pocket, making it readily available for use at any time and any place. Patients simply place two thumbs on designated electrodes and push one button to record heart beats.. Recorded results can be transmitted to a Heartline Receiving Station (HRS) from any standard telephone.

4.1.6 Bodytel's GlucoTel

Bodytel is a telemedical blood glucose monitoring for diabetes management with a built-in Bluetooth wireless technology module allowing the automatic transmission of measured parameters to a secure web database using the patient's cell phone as a transmission hub. Blood sugar levels are shown directly on the meter's LCD screen, and for those patients with impaired vision, the results can be read out loud via the cell phone. In addition, BodyTel **Mobile** (Java application) provides patients with the ability to easily add additional values into the cell phone, such as meals, medication and physical activity .The vendor claims the product can be used for both, monitoring health conditions and lifestyle guidance.

4.1.7 Philips' Motiva

Philips Motiva is a platform based on Interactive TV to connect patients with chronic conditions to their doctors. Besides monitoring vital signs, the platform provides patients with educational material and actionable feedback about their vital signs. Potentially, the doctors through the platform can motivate behavioural change and help patients meet a set of health targets as well as improve adherence to drugs



4.2 Advanced RMT

4.2.1 MyHeart (FP6).

Additional information on this project can be found at: <http://www.nexus-mems.com/projects-fp6/myheart.asp>

My Heart is an FP6 funded project involving common research effort of industry, research institutes, academic and medical hospitals, covering the whole value chain from from textile research, via fashion and electronics design, towards medical and home-based applications. The project developed an integrated solution to monitor patients suffering from cardio-vascular diseases. Some of the solutions include also early diagnosis and preventive lifestyle features. The pillar is an intelligent biomedical cloth that gathers multi-parametric data monitoring and analysis of vital signs, interpreting it to support diagnosis and detection of heart conditions. It includes feedback devices, able to interact with the user (i.e.: suggesting adjustments to their lifestyle) as well as with professional services so they can intervene when appropriate.

The five identified application areas are:

- CardioActive: Application cluster for improved physical activity,
- CardioBalance: Application cluster for improved nutrition and dieting,
- CardioSleep: Application cluster for improved sleep and relaxation phases
- CardioRelax: Application cluster for improved solutions to deal with stress,
- CardioSafe: Applications for early diagnosis and prediction of acute events.

4.2.2 HEARTCYCLE (FP7)

Additional information on this project can be found at: <http://heartcycle.med.auth.gr/>

HeartCycle aims to improve the quality of life for patients with coronary heart disease or heart failure by monitoring their condition and involving them in the daily management of their disease as well as by developing mechanisms to automatically report relevant monitoring data back to clinicians so that they can prescribe personalized therapies and lifestyle recommendations. Within this objective, the HeartCycle project aimed to develop: (1) An integrated care system for cardiovascular disease management linking health status monitoring, motivation and treatment assistance at home with the health care professional platform; (2) A closed-loop treatment system, empowering the patient, and giving motivating feedback to show the importance of working with the treatment program; (3) A tool for Health status Assessment for Patients at Home by integrating easy to use sensors for vital body sign measurement and feature extraction algorithms; (4) Methods that provide accurate daily measurements related to medication and lifestyle effectiveness.

The information is meant to be integrated into the clinical decision support system to warn the professional of unfavourable trends, and possible problems, enabling appropriate updating of the patient care plan. The system would also give feedback to the patient and inform him/her of his/her health progression as well as enable a more optimal lifestyle management). A personalised complete care system, integrating care at home with professional care in the hospital is also foreseen.

The HeartCycle system consists of two loops. An inner home-based loop directly interacting with the patient in his daily life, giving feedback, motivation and help, and an outer loop involving medical professionals, maintaining a personalised care plan for optimal therapy.

4.2.3 CHRONIOUS (FP7)

Additional information on this project can be found at: <http://www.chronious.eu/>

CHRONIOUS addresses a smart wearable platform, based on multi-parametric sensor data processing, for monitoring people suffering from chronic diseases in long-stay settings. It constantly monitors their activity using audio observation methods and activity sensors while at the same time tracking their medical condition via vital signs sensors. Any trait of abnormal health status and possible alerting incidents are detected by CHRONIOUS Intelligence. The system generates alerts in case of abnormal clinical data or if current activity and behaviour lay outside the well established activity patterns and physical behaviour.

4.2.4 PERFORM (FP7).

Additional information on this project can be found at: www.perform-project.com

The project is developing a sophisticated multi-parametric system for the continuous effective assessment and monitoring of motor status in patients suffering from Parkinson's disease and/or other neurodegenerative diseases. It aims to provide efficient remote health status monitoring, qualitative and quantitative assessment, and personalised treatment for these patients.

4.2.5 DIAdvisor (FP7)

Additional information on this project can be found at: <http://www.diadvisor.eu/>

The goal is the development of a prediction based tool, which uses past and easily available information to optimise the therapy of type I and type II diabetes. DIAdvisor™ is not dependent on specific sensor technologies and can be adapted to technologies like standard strip minimally-invasive continuous glucose sensors and emerging non-invasive methods. For patient safety reasons the project includes a self-assessment algorithm of the treatment.

4.2.6 Metabo (FP7).

Additional information on this project can be found at: <http://www.metabo-eu.org/>

A technological platform to improve the clinical management of diabetes is the goal of the project. The platform aims to connect the different actors involved in the process of gathering information, data processing and decision support that will allow the patient and the medical team to acquire and manage a higher level of information compared to the current clinical practice. The final goal of this closed loop involving data acquisition, data interpretation and clinical decision is to improve monitoring and treatment.

4.3 Wellbeing and fitness

4.3.1 Card guard's iTV healthcare system

More information on this initiative is available at: <http://www.cardguard.com/wirelesshealthcare>

Card Guard's iTV Healthcare System defines itself as the latest interactive digital TV, dedicated software and easy-to-use medical accessories used to monitor, diagnose and manage general consumer health, fitness and illness. Individuals will be able to perform medical tests on any of the T-Health medical accessories, and immediately upload their measurements to a web-based medical centre using a remote control. The medical data is displayed on the TV screen for review and can be stored or transferred to the healthcare provider for further actions. Physician feedback, compliance programs and educational materials are stored in the medical centre and can be displayed on the TV screen or any standard browser by the patient or designated caregiver.

4.3.2 BodySinc

More information on this initiative is available at: <http://www.bodysinc.com/>

It is a Personal Lifestyle Program made of an Armband, a multi-sensor monitor in the form of a band that continuously measures physiological parameters and data relevant to one's physical activity. Through specific patent-protected algorithms, it quantifies and identifies many other parameters, such as energy expenditure and calories, times and levels of physical activity, steps, movement, status of sleeping and waking up and so on. Data recording occurs in physiological conditions during normal activities and in any environment, from hospital to patient's home, in workplaces, at school, during physical activity, etc. The armband needs to be worn on the right arm in correspondence of triceps and it allows for continuously monitoring, even for some days. Data is acquired for a minimum period of 10 minutes and up to 2 weeks and store it in its memory for the following transfer to a PC. Then, collected data is analyzed, graphically shown and submitted on a report.

4.3.3 DirectLife

More information on this initiative is available at: <http://www.directlife.philips.com/>

DirectLife is an activity program, consisting of 12 week activity plans providing assistance to set and achieve realistic activity goals. This is done by showing how regular activities such as walking around the supermarket contribute to the user daily target. The application involves an [Activity Monitor](#), a necklace, a pouch and a USB-adaptor. To use the Activity Monitor, the user first needs to activate it on the DirectLife website and from that point the assessment period starts. During the assessment period it is important that the user follows his/her standard regular routines whilst wearing the monitor at all times. After the assessment has finished, connecting the Activity Monitor to the PC will provide the resulting assessment report. This report shows how the routinary activity level compares to the activity level recommended, including WHO recommendations as a benchmark. The DirectLife program will then suggest a personalized 12 week activity plan for the user. This plan has daily calorie goals that increase slowly week by week.

4.4 Prevention

4.4.1 PIPS

PIPS is defined as a multi-devices and multi-platforms solution to help health care Professionals deliver just-in-time personalised and prevention-focused services compliant with the user personal health state, preferences and ambient conditions. The user will have the ability to make informed decisions about therapies and nutrition at any time/place according to the real-time evaluation of their health state. Potentially, the health care providers/insurers could improve risk management and gather valuable information on prevalence and population health status through this application.

4.4.2 PANACEIA-ITV

More information on this initiative is available at: <http://www.itv4health.org>

The purpose of PANACEIA-ITV is to facilitate essential lifestyle changes and to promote compliance with scientifically sound self-care recommendations through the application of interactive digital television for family health maintenance through home care.

4.4.3 h-life (healthy life) project

More information on this initiative is available at: <http://www.h-life.org>

The objective of the h-Life (healthy Life) project is to develop an easy-to-use system, which provides patients and citizens in general with a tool, which can be used for the monitoring their lifestyle. It aims to create an intelligent environment, which can be used as a personal health assistant. It provides a technologically innovative platform for monitoring and interaction with the customer.

4.4.4 Development of an interactive integrated P.i.v. system, based on miniaturised optical sensor technology for implantable biomedical devices design (SMART-PIV)

This FP5 research activity aims to develop a multi-sensing integrated PIV system able to provide relevant advancement in the investigation of the quality of the blood motion field within biomedical devices for human implantation. Scientific objectives are associated to the ability of providing accurate blood flow characteristics modified by these devices. Specific innovations will relate the optimisation of integrated miniaturised optics for laser light sheet scanning inside small objects. Additional features aim to address image treatment and realtime processing based on parallel computing SW&HW, feedback from advanced numerical results and easiness of PIV data interpretation by suitable GraphicalUser Interface.

4.4.5 HEARTS

More information on this initiative is available at: <http://heartsproject.datamat.it>

The HEARTS (Health Early Alarm Recognition and Telemonitoring System) Research wants to create a new Family of Tele-Health Systems being: (i) nonintrusive – information will be acquired through “wearable” sensors; (ii) dynamic – the systems will be able to continuously monitor information and about the health status and relate it to the specific context in which the person is acting (activity, environmental conditions, history), individually adapting its behaviour; (iii) intelligent – capable to offer dynamic intelligent alert functions directly to the citizen; (iv) with advanced and adaptive decision support capability – integrating classical analysis techniques with new techniques and approaches, such as Neural Network Analysis and Non-Linear Analysis to reflect the specific healthy behaviour of each person; (v) interoperable – services must be available for people moving in a trans-national context; (vi) based on an open architecture – to be enhanced or expanded with the simple addition or replacement of existing components with the new ones available in the market; (vii) focused on disease prediction rather than diagnosis, thus offering classical and innovative services not only to ill and high-risk people, but also healthy ones making for instance highly stressing jobs.

4.4.6 E-CARE

More information on this initiative is available at: <http://www.e-care-ist.net/>

The ultimate objective of E-Care consists in generating a sophisticated collaboration model between patient, family, doctor, and care provider by means of an intelligent automated infrastructure incorporating the patient Electronic Health Care Record (EHCR), which can be implemented in a large variety of health monitoring scenarios.

4.5 Lab on chip

4.5.1 CD-MEDICS

More information on this initiative is available at: <http://www.etseq.urv.es/cdmedics/index.php>

The overall concept of the CD-MEDICS project is to develop a technology platform for point-of care diagnostics, capable of simultaneous genomic and proteomic detection, with embedded communication abilities for direct interfacing with hospital information systems. This will be achieved by exploiting breakthroughs at the confluences of bio-, micro- and nano- technologies to create a low-cost non-invasive intelligent diagnosis system.

4.5.2 TheraEDGE

More information on this initiative is available at: <https://www.theraedge.org/>

TheraEDGE is an industry-driven effort to accelerate the adoption of theranostics applications in Primary Care by pushing Point of Care Test (POCT) technology far beyond its current state-of-the-art by delivering clinical, analytical and operational breakthroughs. It envisions a universal diagnosis platform of small footprint and portable, capable of performing a personalized healthcare along the entire healthcare spectrum ranging from pre-clinical to post-clinical settings. TheraEDGE is built around the high-incidence clinical case of early diagnosing lower respiratory tract infections in Primary Care. Simultaneous testing for different pathogens and their antibiotic resistance will have a huge European impact: a) better clinical outcomes and standards of care through more effective and timely diagnosis and treatment; b) improved health economics through optimization of antibiotics prescription, infection control practices and reduction of clinical visits or hospital stays; c) substantial business for the In Vitro Diagnostics industry through the standardisation and commercialization of innovative POCT products and systems. TheraEDGE consists of three multidisciplinary platforms: 1) a core Lab-on-a-Chip supporting multi-marker assays using Single Molecule Detection (SMD) as an alternative to PCR-based molecular diagnostics. SMD removes the need for amplification and has the potential to become a key enabler for Nucleic Acid Testing at the Point of Care by providing less complex, faster, more sensitive and more specific assays; 2) an architecture that provides Plug and Play semantic interoperability and creates opportunities for the standardisation of POCT instruments and information systems, offering radical usability, robustness and vendor interoperability improvements. Practitioners will be able to run out-of-the-box multiple compliant devices from one single PDA-based operator interface; 3) a set of applications built on a convergent ITC platform that supports General Practitioners in their patient management and clinical decision-making, and provides therapeutic services for patient education and compliance monitoring in order to fight antibiotic misuse and abuse.

4.5.3 SmartHEALTH

More information on this initiative is available at: <http://www.smarthealthip.com/>

It aims at developing and delivering the next generation of smart diagnostic systems fully integrated into healthcare systems in Europe. Driven by key applications in cancer diagnostics, SmartHEALTH

will enable enhanced medical diagnosis leading to earlier and more precise results and thus contributing to an increased quality of life.

4.5.4 MicroActive

More information on this initiative is available at: <http://www.sintef.no/microactive>

It develops an instrument for molecular diagnostics intended for use in the doctors' office. The instrument will first be used for patient screening for a group of viruses causing cervical cancer. Microfluidics and biotechnology form the basis for the development.

4.6 Basic independent living

4.6.1 Aerotel's "Skeeper/Geo/Keeper"

More information on this initiative is available at: <http://www.aerotel.com/en/>

A device equipped with a safety call button and built-in cellular communicator that can activate a warning signal when needed, enabling wearers to be immediately contacted from any caller or via a secure Web interface, PDA, smart-phone or through a remote monitoring centre. It is a typical tele-assistance solution for the elderly, their relatives and carers and it is a *mobile system*. It is worth stressing that Aerotel presents the product also *as a solution appropriate for the chronically ill, children, and lone workers*. Indeed they refer to it as the ideal solution for mobile Telecare, tele-assistance and medical alert applications.

4.6.2 SHL telemedicine's WatchMan.

The product is presented as an integral component of a Home Care Centre (HCC) personal emergency response system (PERS). It is multifunctional wristwatch that enables subscribers to initiate and carry out emergency communication with remote monitor centres staff from any location within their home. It is comprised of a panic button, sensitive microphone, and RF transmitter.³⁹

4.6.3 Telbios's Merlino.

It is a localisator using Wherify's technology and Wherifone to provide a real time GPS location capability and send information to Telbios' 24 x 7 Service Centre that will intervene in case of emergency. It is currently sold mainly for tele-assistance solutions to the elderly, but it is marketed also as a medical alert application (the market name of the service is "Merlino la salute sul telefonino": Merlino health on the mobile phone). It is evidently a *mobile* solution.

4.6.4 Tunstall's ADLife.

This product is marketed as a new unique Activities of Daily Living (ADL) system available for use in individual homes with a Lifeline Connect+ services. It utilizes some existing Telecare sensors to provide a combined ADL and Telecare solution, providing both proactive information via the web based viewing screen and immediate Telecare alarm alerts via the monitoring centre when required. The system is very simple and for the most basic ADL monitoring can be used with just 3 Fast PIRs

³⁹ Subscribers activate the system by simply pressing the WatchMan panic button that signals the HCC desktop unit to dial the remote monitor centre. Within seconds caller identification and retrieval of the subscriber's computerized personal and medical record occurs at the remote monitor centre. On-going subscriber-staff communication is carried out via the WatchMan microphone and the HCC desktop unit speaker which features remote volume control via telephone by monitor centre staff

(movement detectors) to unobtrusively monitor key ADL. ADLife can also be used to monitor ADL such as how often the person visits the kitchen, bathroom or whether they have got up in the morning. The ADLife web based screen then allows care professionals to view information on users to help manage their situation and ensure their care is tailored specifically to their individual needs.

4.6.5 Vigil health solutions' "The Vigil Dementia System".

This is a resident monitoring tele-assistance and tele-surveillance system for dementia care. This system provides residents suffering from dementia with a means of summoning help when they are no longer able to understand how to work a conventional nurse call system. The Vigil Dementia System continuously gathers data for each resident through passive sensors, including incontinence, bed-exit, and motion sensors located throughout a resident's room. Based on the data collected from the sensors, the system identifies patterns of behaviour for individuals. When residents depart from their normal behaviour, a silent page alerts the appropriate caregiver to respond. If a call is not responded to within an appropriate time, the call can be escalated to additional care staff. The data from the sensors is directed to a central computer where a record of all alarm activity, sensor activity and pages are recorded for further analysis. The Vigil Dementia System allows a care facility to offer quality care in a safe environment and meet residents' desire for privacy and independence.

4.7 Advanced Independent Living

4.7.1 Tunstall's Lifeline home units (Lifeline 400, and Lifeline Connect+).

These are intelligent centres at the heart of the home to help all kinds of people of all ages to live independently. Lifeline home units can be used to raise an alarm call from anywhere in the home by simply pressing a radio trigger, the large illuminated red button on the unit or automatically via the range of Telecare sensors, wirelessly linked to the home unit. The home unit can be linked to a broad range of home sensors placed around the home linked to a Lifeline home unit and monitored 24 hours a wide range of sensors are now available that can help to manage risks within the home enabling vulnerable people to live safely and independently for longer. The range of sensors provides greater reassurance and protection of users by monitoring for a diverse range of risks. Among those sensors, there are personal triggers (Amie and Gem, and Amie+ and Gem+), Bed Occupancy Sensors, Carbon Monoxide Detectors, Door Entry and Usage sensors, Enuresis sensor, Epilepsy sensor, Flood Detectors, Fall Detectors, Gas Detectors, and Gas Shut-off Valve Solutions, and Medication Dispensers.

4.7.2 HearCom (FP6).

More information on this initiative is available at: Hearcom.eu

This R&D project targets individuals with hearing impairments and, bringing together various strands of technological developments (audiology, communication acoustics, ambient acoustics), aims to provide home solutions allowing them to interact and communicate with the external environments from their homes.

4.7.3 TeleCARE (FP5).

The objective of this project was to develop a configurable framework and new technological solutions for tele-supervision and tele-assistance, based on the integration of a multi-agent and a federated information management approach, including both stationary and mobile intelligent agents, combined with the services likely to be offered by the emerging ubiquitous computing and intelligent home appliances, and applied to assist elderly people.

4.7.4 U-R-SAFE (FP5).

The objective of the project was to propose a Personal Health Care system, allowing convalescent and elderly to have a quasi-normal life, guarantying the same security as hospital structures and providing continuous monitoring. A Wireless Personal Area Network (WPAN) based on the Ultra Wideband technology will be used on the patient himself. This Network would be interfaced with the Home, Fixed and mobile (including satellite) Networks. Automatic continuous speech recognition is also considered to allow a dialog between the handset and the patient.

4.8 Ambient Assisted Living Joint Programme Call 1/2008

The Ambient Assisted Living Joint Programme (<http://www.aal-europe.eu/>) foresees a total budget of 700 M€, of which approx. 50% is public funding – from the AAL Partner States and the European Commission – and approx. 50% is private funding from participating private organisations (e.g. enterprises). The objective of the AAL Joint Programme is to enhance the quality of life of older people and strengthen the industrial base in Europe through the use of ICT. The motivation of the new funding activity is in the demographic change and ageing in Europe, which implies not only challenges but also opportunities for the citizens, the social and healthcare systems as well as industry and the European market.

The example below are taken from the presentations of some of the projects funded under Call 2008/1, which were delivered at the AAL FORUM Vienna 2009, 29 September - 1 October, 2009.⁴⁰

4.8.1 REMOTE

More information on this initiative is available at: www.remote-project.eu

The full name of the project is “Remote health and social care for independent living of isolated elderly with chronic conditions”⁴¹. It addresses, thus, both assistance and surveillance and health specific needs. REMOTE aims to advance beyond the state of the art enhancing the elderly’s home with audio-visual, sensor/motoric monitoring and automation abilities to trace vital signs, activity, behaviour and health condition, and detect risks and critical situations, as well as provide, Voice recognition, Face recognition – proactively and reactively, effective and efficient support at home. The platform, including both stationary and mobile devices (communication with Bluetooth and Wi-Fi over cell phones, PDAs, Netbooks, TV) will monitor a large range of vital signs, activities, risk factors, as well as treatment process and life-styles (among others: intra-oral wetness sensor, food consumption sensor, glucose meter, ECG, Blood pressure, oximetre, heart rate meter, etc).

4.8.2 IS-ACTIVE

Full project name “Inertial Sensing Systems for Advanced Chronic Condition Monitoring Prevention and Risk”⁴². It comprise a disease monitoring and prevention component for COPD (home as care environment, monitor and feed back to encourage daily activities) and one supporting and assisting daily life at home. It is based on a wireless sensor system with inertial sensors on persons and in objects, physiological sensors, and environmental sensors. It analyzes physical activity and condition and helps to manage chronic conditions with an easy to use interface for natural feedback and self-management.

⁴⁰ <http://www.ocg.at/AAL-F09/>

⁴¹ <http://www.ocg.at/AAL-F09/files/s1-tzovaras.pdf>

⁴² <http://www.ocg.at/AAL-F09/files/s1-havinga.pdf>

4.8.3 Happy Ageing

The project⁴³ targets older people with mild physical and cognitive impairment, who are encouraged to live at home. Their caregivers are also considered as a target group. The system will integrate sensors and technologies available on the market in a whole smart system (RFID), able to assure reliability and privacy of the user. It will be composed by three main modules: a) Lifestyle monitor (Recording activities in the home and compare with the habits of the subject; Reminding the user to perform important activities such as taking medicines; Monitoring lack of activity for an extended period and unusual behaviours); b) Navigation assistant (support user's mobility in close environment, extremely useful for older people with low vision or difficulties of orientation); c) Personal assistant (Support in performing usual actions, e.g. dialling a phone number; Support in searching for personal objects in the home, e.g. keys)

4.8.4 PAMAP.

Full project name "Physical Activity Monitoring for Aging People".⁴⁴ The proposed platform has three main components to infer the muscle activity of the targeted elderly: a) On-body sensor network MEMS: accelerometers, gyroscopes, etc; b) Bio-mechanical model of the body; c) musculoskeletal motion analysis. The data are then analysed in order to compare the actual physical activities carried out by the user with the level of activity prescribed for prevention purposes. The information is then communicated to clinicians, friends and family.

4.8.5 DOME0

The full project name is "Domestic Robot for Elderly Assistance".⁴⁵ DOME0 uses Human Robot Interaction for cognitive and memory assistance, for sending video stream for scene analysis in case of emergency alarm, for stimulation to do physical exercises and for watching user behaviour.

4.8.6 CARE

The full project name is "Safe private homes for elderly persons".⁴⁶ The target group are the elderly living alone. To support independent living for the elderly, it proposes the realization of an intelligent optical tracking and alarm system. It monitors and captures information on critical situations (e.g. fall) and unusual behaviour (e.g. not getting up in the morning).

4.9 Ambient Assisted Living FP6 Projects

Acronym and web site	Period	Description
ALADIN –Ambient Lighting Assistance for an Ageing Population http://www.ambient-lighting.eu Action Line: IST-2005- 2.6.2 Ambient Assisted Living (AAL) in the Ageing Society; Funded under 6 th FWP (Sixth Framework Programme)	2007-2008	The overall aim of the project was to extend the knowledge about the impact of lighting on the wellbeing and health of older people and translate this into a cost-effective open solution. Adaptive lighting can contribute considerably to sound sleep and a regular sleep-wake cycle, which are essential to preserve and enhance people's health and wellbeing. This will assist older adults in living at home autonomously for a longer time and contribute to their quality of life.

⁴³ <http://www.ocg.at/AAL-F09/files/s1-marcellini.pdf>

⁴⁴ <http://www.ocg.at/AAL-F09/files/s1-stricker.pdf>

⁴⁵ <http://www.ocg.at/AAL-F09/files/s1-zagler.pdf>

⁴⁶ <http://www.ocg.at/AAL-F09/files/s1-litzenberger.pdf>

Acronym and web site	Period	Description
<p>CAALYX – Complete Ambient Assisting Living Experiment Action Line: IST-2005- 2.6.2 Ambient Assisted Living (AAL) in the Ageing Society; Funded under 6th FWP (Sixth Framework Programme)</p>	<p>2007-2008</p>	<p>The main objective of the project was to develop a wearable light device able to measure specific vital signs of the elder or ill person, to detect falls and to communicate autonomously in real time with his/her caregiver in case of an emergency, wherever they are. The emergency information can be directed to the personal caretaker and/or the 112 Emergency Service. The emergency information provides the geographic position and health information of the elder in a sensible way for the caretaker or emergency service. The incorporation of largely non-intrusive new sensors for fall detection and highly sensitive positioning is expected to address many of the elderly concerns about adopting technology. The monitoring device for the caretaker can range from a mobile phone and/or a more complex system so that an integrated caretaking service can be created to look after groups of elders. In this case, when monitoring the elder at home, the system can be complemented with other devices such as cameras in a way that personal services can be established for the elder. The system was tested in a real usability site arranged through a social programme for the elderly, in order to obtain reliable assessment by gathering real end user's feedback.</p>
<p>EASY LINE+ - Low cost advanced white goods for a longer independent life of elderly people http://www.arenque-ks.com/easynet/ Action Line: IST-2005- 2.6.2 Ambient Assisted Living (AAL) in the Ageing Society; Funded under 6th FWP (Sixth Framework Programme)</p>	<p>2007-2009</p>	<p>The project foresees using the integrated RFID, Neuronal Networks and HMI technologies to build a system that can capture data of the home environment, and can control via wireless communication (Zigbee) or the mains electricity (EMS PLC), any white good in the home. The users, elderly persons, may actuate by himself/herself any white good in the home, or may leave the "e-servant" to do the actuation. The e-servant will be a white good control system, based on the sensor information and the habits of the user that can program any application without/or with user cooperation. The e-servant, also will be a learning system that detects the loss of abilities of the user and tries to compensate them.</p>
<p>EMERGE – Emergency Monitoring and Prevention Action Line: IST-2005- 2.6.2 Ambient Assisted Living (AAL) in the Ageing Society; Funded under 6th FWP (Sixth Framework Programme)</p>	<p>2007-2010</p>	<p>EMERGE by supporting elderly people with innovative emergency monitoring and prevention. Humans are bio-psychosocial beings, whose character is to follow typical behaviour. Especially elderly people have this character. The innovation is to algorithm this behaviour by a holistic approach in order to detect deviations from typical behaviour patterns and to reason on acute disorders in their health condition in case of strokes, falls or similar emergencies.</p>
<p>ENABLE – A wearable system supporting services to enable elderly people to live well, independently and at ease Action Line: IST-2005- 2.6.2 Ambient Assisted Living (AAL) in the Ageing Society; Funded under 6th FWP (Sixth Framework Programme)</p>	<p>2007-2009</p>	<p>The project develops a personal, user-centred enabling system, with services, for use by an elderly person in or out of the home, to mitigate the effects of any disability and to increase quality of life: independence, autonomy, mobility, communications, care and safety. The system is based on a distributed open platform, enabling other services to be added by third parties, by "plugging" into defined interfaces.</p>
<p>HAH – Hearing at Home http://www.hearing-at-home.eu/ Action Line: IST-2005- 2.6.2 Ambient Assisted Living (AAL) in the Ageing Society; Funded under 6th FWP (Sixth Framework Programme)</p>	<p>2006-2009</p>	<p>HaH focuses on the needs of the hearing-impaired in home environments. Formerly separated devices like personal computer, hi-fi system, TV, digital camera, telephone, fax, intercom and services like internet access, VoIP, Personal Information Management (PIM), pay TV and home automation grow together to be accessible via a TV set connected to a PC or set top box (STB) that implements interfaces to network gateways as well as</p>

Acronym and web site	Period	Description
		to home automation services. The TV becomes the central Home Information and Communication (HIC) platform of the household in the communication society. HaH researched and developed hearing support applications and integrate next generation assistive technologies into such a HIC-platform, connected to radio and TV antennas, a LAN net-work and TV screen, implemented on either PC, Embedded PC, or STB hardware. The HIC-platform will provide the hearing-impaired with easy to fit supportive audio signal processing (SASP) and visual support on the TV screen.
INHOME – An Intelligent Interactive Services Environment for Assisted Living at home http://www.ist-inhome.eu/ Action Line: IST-2005- 2.6.2 Ambient Assisted Living (AAL) in the Ageing Society; Funded under 6 th FWP (Sixth Framework Programme)	2007-2008	The goal of the INHOME project is to provide the means for improving the quality of life of elderly people at home, by developing generic technologies for managing their domestic ambient environment, comprised of white goods, entertainment equipment and home automation systems with the aim to increase their autonomy and safety. Contrary to the practises followed up to now, the INHOME project focuses on the problem of appliances flexible use by discriminating between experienced and inexperienced rather than enabled or disabled users.
NETCARITY – A NETworked multi-sensor system for elderly people: health CARE, safety and security in home environment http://www.netcarity.org Action Line: IST-2005- 2.6.2 Ambient Assisted Living (AAL) in the Ageing Society; Funded under 6 th FWP (Sixth Framework Programme)	2007-2011	NETCARITY proposes a new integrated paradigm for supporting independence and engagement in elderly people living alone at their own home place. The project fosters the development of a 'light' technological infrastructure to be integrated in homes of old people at reduced costs, that both allows the assurance of basic support of everyday activities and health critical situations detection, as well as the social and psychological engagement required to maintain in the elder the emotional well-being enhancing dignity and quality of life. The project will seek to advance ambient intelligence technologies in the integration of micro and nano systems in a networked wireless/wired multi-sensing environment with plug-and-play capabilities and intelligent decision making for an effective detection of critical situations and support of task completion. Efforts will be concentrated in developing low-cost solutions and could rapidly reach the market and facilitate easy adaptation in a wide number of existing homes
OLDES – Older People's e-services at home Action Line: IST-2005- 2.6.2 Ambient Assisted Living (AAL) in the Ageing Society; Funded under 6 th FWP (Sixth Framework Programme – 045282)	2007-2009	The OLDES project will offer new technological solutions to improve the quality of life of older people. OLDES aims at developing a very low cost and easy to use entertainment and health care platform designed to ease the life of older people in their homes. In order to achieve this, new concepts developed in Information Technologies will be integrated and adapted. The platform will be based on a PC corresponding to Negroponte's paradigm of a 100 device, giving the guarantee of an affordable system. OLDES will provide: user entertainment services, through easy-to-access thematic channels and special interest forums supported by animators; and health care facilities based on established Internet and tele-care communication standards.
PERSONA - Perceptive Spaces Promoting Independent Aging Action Line: ST-2005-2.6.2 Ambient Assisted Living (AAL) in the Ageing; Funded under 6 th FWP (Sixth Framework Programme 045459)		PERSONA aims at advancing the paradigm of Ambient Intelligence through the harmonisation of Ambient Assisted Living (AAL) technologies and concepts for the development of sustainable and affordable solutions for the social inclusion and independent living of Senior Citizen, integrated in a common semantic framework. It will develop a scalable open standard technological platform to build a broad range of AAL Services, to demonstrate and test the

Acronym and web site	Period	Description
		concept in real life implementations, assessing their social impact and establishing the initial business strategy for future deployment of the proposed technologies and services.
<p>SENSACTION-AAL - SENsing and ACTION to support mobility in ambient assisted living http://www.eng.unibo.it/PortaleEn/Research/SENSACTION-AAL.htm Action Line: IST-2005- 2.6.2 Ambient Assisted Living (AAL) in the Ageing Society; Funded under 6th FWP (Sixth Framework Programme)</p>	2007 – 2009	SESNSATIOA-AAL aims at advancing the paradigm of Ambient Intelligence through the harmonisation of Ambient Assisted Living (AAL) technologies and concepts for the development of sustainable and affordable solutions for the social inclusion and independent living of Senior Citizen, integrated in a common semantic framework. It will develop a scalable open standard technological platform to build a broad range of AAL Services, to demonstrate and test the concept in real life implementations, assessing their social impact and establishing the initial business strategy for future deployment of the proposed technologies and services.
<p>SHARE-IT - Supported human autonomy for recovery and enhancement of cognitive and motor abilities using information technologies</p> <p>Action Line: IST-2005- 2.6.2 Ambient Assisted Living (AAL) in the Ageing Society; Funded under 6th FWP (Sixth Framework Programme)</p>	2007-2009	The goal of SHARE-it is to develop a scalable, adaptive system of add-ons to sensor and assistive technology so that they can be modularly integrated into an intelligent home environment to enhance the individual's autonomy. The system will be designed to inform and assist the user and his/her caregivers through monitoring and mobility help. Thus, we plan to contribute to the development of the next generation of assistive devices for older persons or people with disabilities so that they can be self-dependent as long as possible. We focus on add-ons to be compatible with existing technologies and to achieve an easier integration into existing systems. We also aim at adaptive systems as transparent and easy to use to the person as possible. Scalability is meant to include or remove devices from the system in a simple, intuitive way. SHARE-it will address important issues in sensor networks, assisted mobility, knowledge engineering and Ambient Intelligence.
<p>SOPRANO Service oriented programmable smart environments for older Europeans</p> <p>Action Line: IST-2005- 2.6.2 Ambient Assisted Living (AAL) in the Ageing Society; Funded under 6th FWP (Sixth Framework Programme)</p>	2007-2010	SOPRANO will design and develop highly innovative, context-aware, smart services with natural and comfortable interfaces for older people at affordable cost, meeting requirements of users, family and care providers and significantly extending the time we can live independently in our homes when older. User friendliness and acceptability is top priority for the project - a zero-slope learning curve is to be achieved and interfaces are to "vanish" into domestic settings. Large-scale viability in real homes will be demonstrated with 600 users to raise public awareness and accelerate AAL exploitation.

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Title: Strategic Intelligence Monitor on Personal Health Systems (SIMPHS): Report on Typology/Segmentation of the PHS Market

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Abstract

This market segmentation reports for Personal Health Systems (PHS) describes the methodological background and illustrates the principles of classification and typology regarding different fragments forming this market. It discusses different aspects of the market for PHS and highlights challenges towards a stringent and clear-cut typology or defining market segmentation. Based on these findings a preliminary hybrid typology and indications and insights are created in order to be used in the continuation of the SIMPHS project. It concludes with an annex containing examples and cases studies.

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