Conception of service offers: from strategy to technology and the other way around

The case of Health and Usage Monitoring Systems (HUMS) in missiles stockpile management

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ABSTRACT

This article recounts the trajectory followed in the conception of stockpile management services within MBDA. It particularly emphasises the methods and tools used to restore strategic alignment, in the form of a service-oriented technology roadmap, between a strategic intent to develop stockpile management services and the development of the technological blocs enabling them. To do so it draws on innovation management and strategic management to present a dialogue between strategy and technology. Beyond the technology aspects, it proposes an original service-description framework, adapted from the characteristics-based model, designed at capturing the specificities of the defence sector.

Keywords: Service innovation, Service conception, strategic planning, roadmapping, Health and Usage Monitoring Systems (HUMS), Defence

INTRODUCTION AND RESEARCH METHOD

In product development, the original issue faced in the case-study we are about to recount is all but new. How to match a strategic intent with an uncertain technology development process? In a nutshell, this question is the foundation of technology roadmapping: a very active academic and industrial domain of research (ILEVBARE, 2013).

This article is based on an eighteen months project conducted in collaboration between MBDA France and Ecole Polytechnique (France) from April 2013 to August 2014. It was entitled "Health and Usage Monitoring Systems (HUMS) in missiles stockpile management" and aimed at creating the conditions of the development of HUMS-based stockpile management services towards the company's domestic and export customers. Broadly speaking, stockpile management concerns itself with all activities involved in optimising the maintenance and usage of a missile stockpile, throughout the life of the product from initial design to decommissioning. The Health and Usage Monitoring Systems (HUMS), on the other hand are one of the technical solution enabling stockpile management. It is a generic term applied to:

- The collection of in-service data, mainly through data-loggers *i.e.* data collection devices charged with the recording of environmental (climatic and mechanical) data during the service-life of the missiles ;
- The retrieval and management of this data through a data architecture comprising aspects such as data storage, transfer and security;
- The processing of this data in order to achieve the goals set for the data-loggers and the stockpile management services in general.

When the project started, a number of data-loggers had already been developed and, sometimes, implemented but no stockpile management service had been offered to customers. The research question was, therefore, twofold: firstly "how can the company structure and implement a coherent stockpile management service portfolio" and, secondly "what usage can be done of already implemented data-loggers".

The method followed in this article is primarily a case study extracted from action research.

Within this article, we will present the methods and tools, used during the project in order to answer these questions. Its structure is summarised in Figure 1 aside.

Firstly, we will describe the situation at the beginning of the project. To do so, we will characterise the past exploration trajectory on data-loggers and develop our observation of a dissociation between strategy and technology.

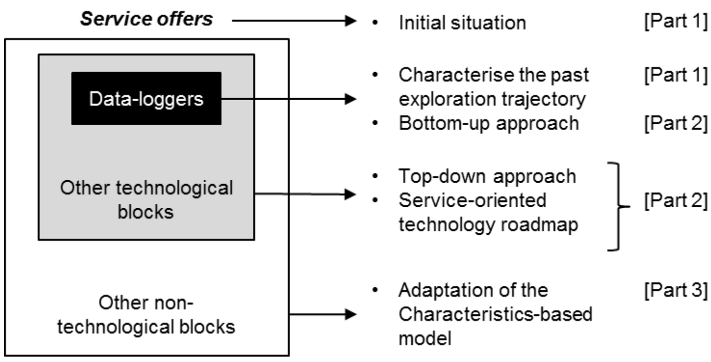

Figure 1: Structure of the article

In our second part, we will present the actual method and tools used to achieve strategic planning and remedy to the initial dissociation. Doing so, we will expand the perimeter of the analysis from data-loggers only to include other technological blocs.

Finally, in our third section we will include other non-technological blocks in order to fully define all the components of the service offers.

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1. INITIAL SITUATION: A DISSOCIATION BETWEEN STRATEGY AND ENABLING TECHNOLOGY

MBDA is a European missiles and missiles-systems developer and manufacturer. Its main operation areas are in France, Germany, Italy and the United-Kingdom. Thanks to an extensive portfolio of field-proven, cutting-edge products, it enjoys a leading position in Europe and a strong basis of export customers. To reach this position, MBDA built on a strong foundation of experts and engineers at the leading-edge of their respective fields. In summary, it is a successful, technology-driven, product-oriented company.
In parallel, as part of its strategic vision for the (then) EADS group dubbed VISION2020, the top management issued, in the end of the 2000's, seven objectives for 2020. Among those, was for the group to become "*the mission critical service partner of [its] customers*" with services amounting to €20Bn. This strategic intent was aligned with the mutations affecting the defence sector: diminishing financial and human resources within the armed forces and growing externalisation. Trends which later remained accurate (MASSON, 2011).
Even though the service potential of stockpile management was identified early on, quite in line with the cultural dominance of the company, development started with a strong technology-driven coloration: the conception of data-loggers.

1.1 A classical, opportunistic, product-development trajectory

The first developments on data-loggers (DL) started as early as 2001. They originated from the miniaturisation of electronics and the company-internal need for better knowledge on actual usage of the missiles in order to improve conception of future products.

To characterise the exploration process, we will draw on Christoph Loch's (LOCH *et al.*, 2006) taxonomy of exploration trajectories (see Fig. 2). The first developments were launched within a European project conducted in association between five companies under MBDA leadership. The 4 years project was named ARCHES (ARchitecture for definition of low-Cost Hums for Equipment and Systems) and structured as follows:

- 1st year: feasibility studies
- 2nd and 3rd years: development of multiple partial prototypes to validate specific aspects such as electronic or software architectures;
- 4th year: full prototype, integration and testing.

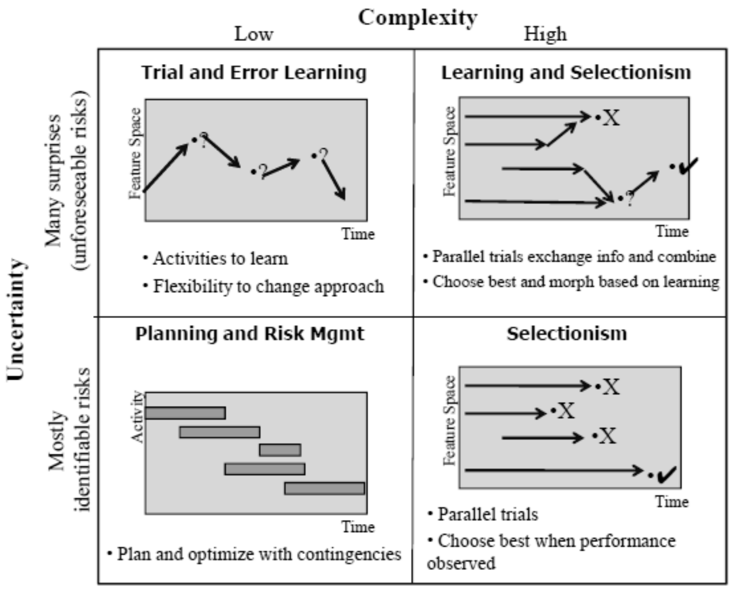

Figure 2: Exploration trajectories (LOCH *et al.*, 2006)

This trajectory is very typical of early exploration and is well described by Bown & Eisenhardt under the term "low cost probes" (BROWN & EISENHARDT, 1997). It follows a clear trial-and-error learning pattern, consistent with the upper-left quadrant in Loch's matrix. Indeed, if complexity was fairly low compared to other electronic-design projects within the company, the lack of clear applications for the data recorded by the data-loggers, introduced a high level of uncertainty. By developing a large number low-cost partial prototypes, the idea was to provide a generic "proof-of-concept", similar in its own scale to Lockheed-Martin's *Skunkworks*. Similarly again, the final prototype was not meant to be scaled-up to full production.

Building on ARCHES developments, the NUMA project, launched for a specific type of missile, aimed at bringing data-logging devices to an industrial standard (including reliability and robustness standards). Due to insufficient technology maturity and (again) lack of clear applications, the project failed and NUMA was never implemented.

In 2009, a third development project (also at a European level and in collaboration) was launched: MINERVE. If it largely benefited from previous ARCHES and NUMA developments, its ambitions were much greater. Indeed, posted objectives included miniaturisation, long-lasting battery life, full scalability, open architecture for later evolutions and interfaces with a global data-handling architecture (communication means, data security …). The complexity ramp-up lead to a shift of the exploration trajectory from "trial and error learning" to "learning and selectionism" (see Fig. 2). In fact, from 2010, the number of parallel missile-specific data-loggers developments increased drastically. All of them followed a very opportunistic logic, rather than a company-wide track. In other words, even though cross-learning and technology combinations happened, every single project was developed in response to specific customer or internal objectives and with missile-specific constraints. Incidentally, it is interesting to note that many of these parallel developments were at least partially outsourced to non-defence-specific companies. By 2013, the result of the exploration process was a vast array of variably accomplished data-loggers, none of them being fully market-ready or usable across the company's product portfolio. In Christoph Loch's terms, there was a lack of "selectionism".

The trajectory described above is available in Annex 1.

1.2 A lack of strategy explained by a lack of consensus

What is very clear in our description of the exploration trajectory, both in the early "trial and error" and later "learning and selectionism" phases, is the lack of coordinated efforts towards a clear goal. In other words, there was a lack of strategy for the implementation of stockpile management services, a corner stone of which data-loggers are. We offer as a hypothesis that this lack of strategy was replaced by punctual (i.e. missile project by missile project and customer by customer) goals and caused the opportunistic and dispersed nature of data-loggers development within MBDA. This hypothesis is to be understood as opposed to data-loggers developments being part of a deliberate emergent strategy in the sense of Henry Mintzberg (1978), where strategic intent is created by the development of the means themselves.

To explain this lack of strategy, we will turn to the rather established fields of strategic planning and (broader) strategic management. Since the 1920s', strategic planning and strategic management have been very active and fast evolving fields of research (ILEVBARE, 2013). Strategic management distinguishes between strategic goal and strategic planning.

As we mentioned earlier, the lack of strategy cannot be explained by the lack of a strategic intent. Indeed, even though very high-level, the objective set by VISION2020 to become "*the mission critical service partner of [EADS] customers*" is clearly a strategic goal. Furthermore, the idea to implement stockpile management services has been present within the company from the very beginning of the exploration process with first internal notes dating back from the mid-2000s'. In a strategic management perspective, if the lack of strategy cannot be imputed to a lack of strategic intent, then it must be borne by a lack of strategic planning. Russel ACKOFF (1970) gives of the latter the following definition: "*Strategic planning is concerned with the formulation of goals and selection of means by which they are to be attained*". Henry MINTZBERG's (1994) definition of strategic planning as "*a formalised procedure to produce an articulated result in form of an integrated system of decisions*" focuses on the "selection of means" part of Ackoff's definition.

To further investigate the cause of such strategic planning deficiency, we take the perspective of roadmapping as it is recognised as a "powerful enabler of the planning process" (EPPLER & PLATTS, 2009) and one of the most widely used. Roadmapping is described as a visual, time-based, analytical, social and collaborative process to drive strategic planning (PHAAL *et al.*, 2009, KAPPEL, 2001). These last two aspect: the social and collaborative nature of roadmapping, is of particular interest in our case study as it gives the last insight as to why strategic intent and technology development were dissociated in the case of stockpile management services within MBDA. Since collaboration between the participants is the primary input in the roadmapping process (KOSTOFF & SCHALLER, 2001), consensus between the participants is of the essence to achieve strategic planning (*ibid.*). In the case of stockpile management, in 2013 such consensus had not occurred. This was mainly due to a lack of collaboration and can be traced back to the organisational structure of the company. As revealed by a large series of interviews within the company, perceptions about possible applications for data-loggers data were disseminated between people from the Customer Support and Services (CSS) Directorate, from the Programs Directorate and from the Technical Directorate. People involved with development of new products and people involved with in service support of "legacy" products also had different perceptions.

1.3 Summary

In this section we showed a disruption between the strategic intent of developing stockpile management services and the actual technology developments (the data-loggers). We explained this disruption by a lack of strategic planning (in the form of roadmapping) and traced its cause to disseminated information and a lack of consensus between the different players involved. The next section shows how we managed to create such consensus in order to create a service-oriented technology roadmap for stockpile management and therefore fill the gap between strategic goals and data-loggers developments.

2. MATCHING STRATEGY AND TECHNOLOGY DEVELOPMENT: THE SERVICE-ORIENTED TECHNOLOGY ROADMAP

2.1 From the customers' needs: a systematic top-down approach

The first step we took in our journey to strategic planning was to adopt a different perspective. So far, the objectives governing the multiple data-loggers developments were all set either (as we mentioned earlier):

- In an opportunistic manner: to answer the demands of a specific customer for a specific product;

- Or in an uncoordinated "emergent" manner (in the terms of Henry Mintzberg (1978)): following what was technologically feasible to create (uncertain) opportunities.

This approach is typical of a "technology push" (ALBRIGHT, 2009 – see Fig. 3) where the "know-how", in other words the technologies and their evolution, defines the "know-what" *i.e.* the architecture and key features enabled by the technologies and the "know-why" *i.e.* the market and applications for such features. Again, due to a lack of coordination, the firm had been unable to fully formalise the "know-what" and "know-why" aspects.

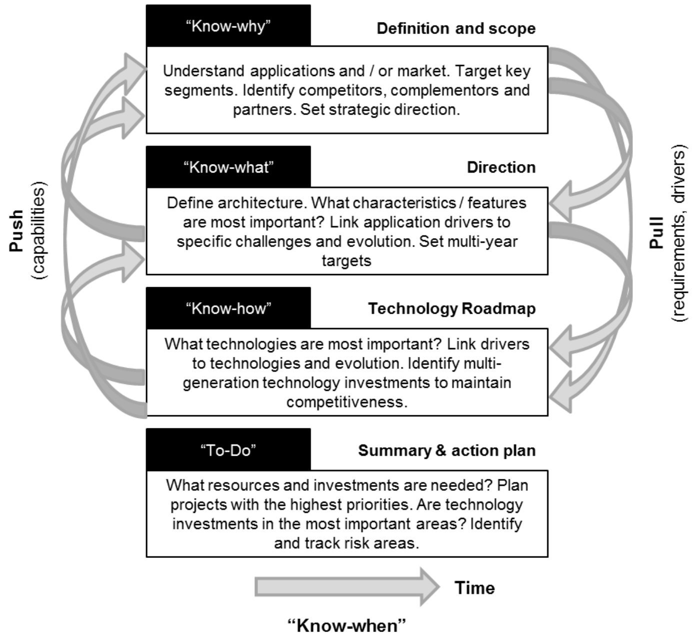

Figure 3: The generic roadmap framework (ALBRIGHT, 2009)

We shifted to a "market pull" approach. By interviewing all of the company's main faces towards the customers (domestic and export country and area managers in the Customer Support and Services Directorate, being 15+ people) we took an inventory of all expressed and most likely expectations of customers with respect to stockpile management. From this set of expectations we extracted six value propositions (or service offers) in order to cover all customers' demands (MALPARTY & NICOLAY, 2014). The distinction between customer's expectation and value proposition is best explained with an example: two distinct expectations were "maintain the military capabilities associated with the missile stockpile for as long as possible" (a strategic expectation) and "differ as long as possible the replacement of the missile stockpile to clear future defence budgets" (an economic expectation). Both of these customers' needs can be addressed by the following value proposition: "Extend stockpile lifespan". It is to be noted that one customer expectation is not necessarily linked to one service offer *i.e.* one value proposition can cover more than one expectation and the other way around. This first step roughly corresponds to the "know-why" layer of Albright's generic framework (*ibid.*).

To define the "Know-what" layer, we adopted a systematic approach. In coordination with experts within the Technical Directory we asked the question "what should we do to deliver our value propositions?" This question was repeated for each value proposition in order to identify "service-components". In our previous example of "extend stockpile lifespan" one of these components was "Verify compliance with limit conditions of use". In turn, each service-component was broken down into "service features" such as "in-use continuous shock measurement". Where service-components correspond to processes performed in order to deliver the value proposition and may mobilise several features, service-features correspond to one particular technology bloc (even though several technologies may be applicable to provide the feature).

Since there was a strong customer demand for stockpile management services, one of the main concerns of the project was to avoid building Heath Robinson machines that would take 10 years to implement. To do so, we engaged in a prioritisation effort. This lead to a categorisation of service-components into:

- Indispensable components: the absence of which renders provision of the service offer impossible. Alone though, indispensable components only make up for a degraded service;
- Necessary components: in complement to indispensable components, these allow to offer the full service; and
- Desirable components: which are not *per se* necessary to provide the service but offer additional benefits such as service improvements, costs and / or risks reductions and so on.

This prioritisation process lead to the matrix presented in Table 1 where each service-component constituting each service offer is classified as "indispensable", "necessary" of "desirable".

Service-components	Stockpile Management service offers					
	Service 1	Service 2	Service 3	Service 4	Service 5	Service 6
Component 1	●	●	●	◍	●	●
Component 2	●		●		●	◍
Component 3			◍		◍	◍
(...)						
Component 7			○		○	○
(...)						
Component 12						◍

Key

● *Indispensable component* ◍ *Necessary component* ○ *Desirable component*

Table 1: Service offers / component prioritisation matrix (source: the authors)

2.2 Reconciliation between strategy and technology: a dual top-down and bottom-up approach

As shown in the first section of this paper, the case study presented here did not start from a blank page. Many technology developments (particularly considering data-loggers) largely predated the beginning of the project. To account for this consideration, we adopted a dual bottom-up and top-down approach to defining the "Know-how" (ALBRIGHT, 2009 – see Fig. 3) layer of our roadmap.

The top-down approach (or market pull in Albright's terms (*ibid*)) presented in the above sub-section and particularly the decomposition of service-components into service-features, led to the realisation that even the perfect data-logging device would be far from enough to actually deliver on any of the value propositions we identified. Other critical features included data management architecture (long-term storage, data-retrieval and traceability, data-security …), data-analysis tools, reporting tools and so forth. For all non-data-loggers technological blocs we followed a traditional top-down approach. For each identified "service-features", experts were commissioned to evaluate technical solutions in terms of availability, readiness, time-to-completion and cost-to-completion. Due to clear objectives materialised by the six "value-propositions" and more applied 12 "service-components", this process proved relatively straightforward.

Concerning the data-loggers-related technologies, in order to benefit from previous work (see Annex 1 on the data-loggers exploration trajectory), we opted for a bottom-up approach. Indeed, adopting the same top-down approach as for non-data-loggers items could have been a source of efforts duplication and inconsistencies between new and legacy technologies. Our approach followed two distinct trajectories.
The first one was focused at a short-to-medium-term horizon. It consisted in an inventory of all technological blocs that had already been developed, were in development or were soon to be developed. Coming back to the exploration trajectory that we recounted in the first section (see Annex 1), this inventory allowed us to move from the "learning" stage and engage in a "selectonism" process (LOCH *et al.*, 2003). This process is roughly described as "choose best and morph based on learning". In effects, due to the variety of applications within stockpile management and the diversity of products on which it is to be performed, this "selectionism" led to a modular approach. Based on previous developments, a median configuration was selected. This configuration includes only readily available technologies to minimize risks in development. It serves as a platform for two other data-logger configurations:

- A minimal configuration: based on the architecture of the median configuration, the minimal configuration sees its functionalities reduced to a bare minimum. This configuration is meant for the most basic applications or for products where strong constraints (volume, weight, electrical consumption, cost …) apply;
- A Maximal configuration: also based on the same architecture, this configuration includes on-going developments and is to be ready in a short-to-medium term.

The evolution of the data-loggers exploration trajectory towards selectionism is shown in Annex 2.

The second trajectory followed in our bottom-up approach focused at a long-term horizon. It consisted in a prospective study on future data-loggers technologies in order to prepare for the next generation of stockpile management services. This prospective work was mirrored in a prospective vision, top-down approach, on future stockpile management services.

The final step in creating consensus between strategic objectives and enabling technology was to operate a reconciliation between our top-down and bottom-up approaches. The question this reconciliation aimed at answering was "to what extent do the different data-loggers configurations enable performing the different services?" Due to varying requirements from one type of missiles to the next, our reconciliation question was to be answered on a product segment by product-segment basis. These product segments were constructed from products that had relatively homogenous usage scenarios. We also evaluated different implementation types. Table 2, below, presents the reconciliation result for one product segment.

Technology / implementation	Product Segment 1					
	Service 1	Service 2	Service 3	Service 4	Service 5	Service 6
Implementation type 1						
Minimal configuration	X	X	X	□	X	X
Median configuration	X	X	X	□	X	X
Maximal configuration	X	X	X	□	X	X
Implementation type 2						
Minimal configuration	X	□	□	□	□	□
Median configuration	□	■	□	■	□	■
Maximal configuration	■	■	■	■	■	■

Key

X *Does NOT enable service* □ *Enables DEGRADED service* ■ *Enables FULL service*

Table 2: Top-down / bottom-up reconciliation matrix (source: the authors)

Table 2 reads as follows: "For product segment 1, data-loggers in median configuration and type 2 implementation enable full service 2 provision. In the same implementation type, data-loggers in minimal configuration only allows for degraded service 2. Implementation type 1 does not allow provision of service 2 in any data-logger configuration". To determine whether the implementation type and data-logger configuration enables (full or degraded) service production or not, we based our analysis on the list of service-features developed in the top-down approach. For instance, a configuration / implementation type failing to satisfy an "indispensable" service-feature is marked "X" in the reconciliation matrix.

Such matrix have been a strong vector of mutual understanding between the different parties involved. One of the reason for that is that they can be read in order to answer two different questions:

- "I want to implement Service 1, what type on data-logger / implementation do I need": a rather strategy-oriented question;

- "I have a data-logger / implementation of such type, what service can I achieve? Should I consider another data-logger / implementation type to maximise the possible outcome?": a rather technology-oriented question.

2.3 The service-oriented technology roadmap

To complete the strategic planning process, we engaged in a retro-planning type of structuration of the different technology developments necessary to implement stockpile management services. With respects to the generic roadmap framework (ALBRIGHT, 2009 – see Fig. 3) this would correspond to the "To-do" layer.

A service is primarily a relationship between user and a provider (GADREY, 1991). As such, the same service provided with two different customers, although delivering the same value proposition, may not be performed in the same way. Additionally, within the array of technologies identified in the top-down / bottom-up approach, not all blocs have the same application perimeter:

- Some are entirely generic: once they have been developed once, they can be reused for other products (missile families) and / or other customers without having to engage in any modification (or negligible ones);
- Some are generic to all customers but product-specific: once the technology has been developed for a particular product it can be reused by other customers without additional work;
- Some are generic to all products but customer-specific: a customer having two different types of products wouldn't have to commit twice for the acquisition of the technology in question;
- Finally, some are entirely specific: new developments are to be committed by every customers for every type of product they acquire.

To account for this particularity, we based our planning phase on actual contract prospects. For each contract prospect, we differentiated between the delivery deadline (*e.g.* for data loggers, which must be installed either at initial delivery of the product or after a major overhaul) and service provision deadline (*e.g.* ageing data analysis tools are only needed after a few years of data have been collected). Starting from the different deadlines, we then applied a retro-planning using estimated development times to which we added an uncertainty bracket in order to account for risks. Finally, in order to be able to prioritise the development efforts, we imputed, for each technology, the degree of criticality for the service ("indispensable", "necessary" or "desirable"). An example of this process is shown in Figure 4. Once aggregated we dubbed the result "service-oriented technology roadmap for stockpile management".

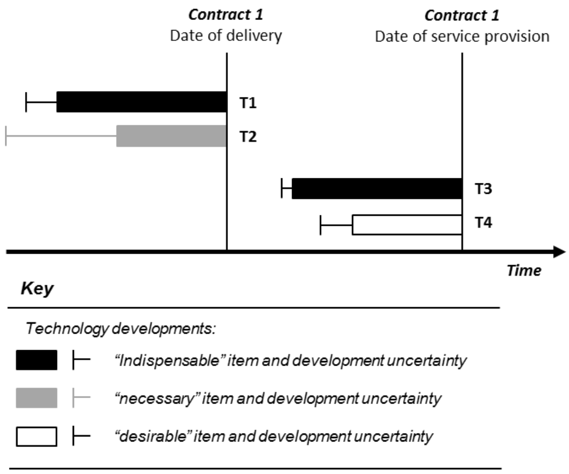

Figure 4: Partial service oriented technology roadmap (source: the authors)

The benefits of this approach to strategic planning can be seen from two different but complementary perspectives. From a market perspective, the contract-based deadlines and the fact that technology developments are thought to answer specific customers' needs leads to coherent technology packages and matching service levels. This also enables customised technology trajectories to answer pressing deadlines and suit evolving needs. From a resources management perspective, the service-oriented technology roadmap allows prioritisation of resources allocation on several criteria:

- Imminence and/or commercial significance of the deadline;
- Expected duration and uncertainty of the development;
- Criticality of the technology for the service.

These two perspectives offer a clear answer to the initial need addressed by our strategic planning process: bridge the gap between strategic intent and technology developments.

In strategic management terms, this representation also allowed the firm to develop "dynamic capabilities". Those are defined as the means by which firms "integrate, build, and reconfigure internal and external competencies to address rapidly changing environments" (TEECE *et al.*, 1997 p.516). Our approach is typical of dynamic capabilities in a "moderately dynamic environment", where industry structure is stable (EISENHARDT & MARTIN, 2000). This seems coherent with the long business-cycles characterizing the defence industry. Indeed, in this case, dynamic capabilities are described as "complicated, detailed, analytic processes that rely extensively on existing knowledge and linear execution to produce predictable outcomes" (*ibid.*). In comparison, dynamic capabilities in "high-velocity" markets with blurred structure, are achieved by "experiential, unstable processes that rely on quickly created new knowledge and iterative execution to produce adaptive, but unpredictable outcomes" (*ibid.*). In slow-moving and high-velocity markets alike, dynamic capabilities are a vector of competitive advantage (TEECE *et al.*, 1997, EISENHARDT & MARTIN, 2000) as it increases performances such as "productivity, quality, time-to-market, customer satisfaction and profitability" (IANSITI & CLARK, 1994).

2.4 Summary

In our first section, we identified a gap between a strategic intent and technology developments that we attributed to a lack of consensus. The second section showed the method we adopted to bridge this gap though a strategic planning process. To structure this process we used Albright's (2009) generic roadmap framework. In this framework we first adopted a top-down, "market-pull", approach. For the "know-why" layer we relied on the knowledge of the firm's faces to the different customers. This allowed us to identify six value propositions associated to stockpile management. To address the "know-what" layer we adopted, in coordination with various experts within the company, a systematic approach in decomposing each value proposition into generic "service components" and "service features" that we then prioritised. The result was a "Service offers / component prioritisation matrix" (see Tab. 1). For the "know-how" layer we shifted to a dual top-down and bottom-up approach in order to take into account prior developments. Upon reconciliation of the two approaches we obtained the "Top-down / bottom-up reconciliation matrix" (see Tab. 2). Finally, for the "to-do" layer, we developed the "service-oriented technology roadmap": a contract-oriented, customer's-needs-answering retro-planning (see Fig. 4). This whole process allowed us to effectively build consensus between the different parties involved and create a dynamic capability within the firm.

In the next section we will tackle a new critical area towards actual service implementation: all of the non-technology-related components of a service offer.

3. TOWARDS SERVICE IMPLEMENTATION

Up until this point we only approached the notion of service from two angles: the objects enabling the service (materialised by our technology roadmap) and the function these objects are to achieve *i.e.* the value proposition (our six service offers). The question we are about to tackle here is whether or not a service can wholly be defined by the sum of the technological objects enabling its production; and, if not, what other aspects are to be taken into consideration.

3.1 A service is not a product

The term of service has received a large number of different definitions. Hereafter, we present a small selection of them.

"An elementary service is the result of the servuction system, in other words, the result of an interaction between physical support, personnel and customer" (EIGLIER & LANGEARD, 1975)

"A service is any act or performance that one party can offer to another that is essentially intangible and does not result in ownership of anything. Its production may or may not be tied to a physical product" (KOTLER, 1987)

"A service is an act (or a succession of acts) of duration and localisation defined, achieved thanks to human and/or material means, implemented for the benefits of an individual or collective customer, according to processes, codified procedures and behaviours" (DUMOULIN & FLIPO, 1991)

To describe services as "functions aiming, for providers in relationship with customers, at delivering a value proposition by mobilising material objects, information and individuals' knowledge" (DJELLAL & GALLOUJ, 2005) seems to summarise the different elements present in the various definitions above. One of the most common element within service definitions is the relational nature of services: services are acts of simultaneous production and consumption between a provider and a customer, where both participate to the production process (co-production). In service-related literature, this characteristic is called "inseparability" (BALIN & GIARD, 2006) and is one of the four most cited service-characteristics together referred as "IHIP": "intangibility", "heterogeneity", "inseparability" and "perishability". Those convey the following notions (*ibid.*):

- Intangibility covers a wide range of specific notions according to different authors: "immateriality", "inaccessibility to the senses", "absence of ownership", "existence in time only" (whereas goods exist in both time and space) and so on;
- Heterogeneity is often used as a synonym of variability, it covers: the "inability to standardise the service output", "variability in service performance" and "variability in service quality";
- Inseparability, as we said, encompasses "simultaneity of consumption and production" and "co-production";
- Perishability is defined either in a marketing perspective where "services can't be saved, stored for reuse at a later date, resold or returned" or in a capacity management perspective where "unused service capacity cannot be stored for future use".

IHIP suggests that services possess intrinsic characteristics that distinguish them from products. For instance, if services are heterogeneous, they cannot be specified beforehand and repeatedly produced accordingly with minimal variation in results, as a product could be. In our perspective, IHIP proves that there is more to describing services than only the material artefacts (the technological blocs) enabling them. The set of definitions provided above supports this assessment and gives clues as to what else is to be taken into consideration with elements such as "processes", "procedures", "behaviours" (DUMOULIN & FLIPO, 1991), "information", "individuals' knowledge" (DJELLAL & GALLOUJ, 2005), …
In the next sub-section we will present the "characteristics-based model" (GALLOUJ & WEINSTEIN, 1997; GALLOUJ & TOIVONEN, 2011/2) which aims at capturing such elements in a generic model.

3.2 A generic service description model: the characteristics-based model

The work of Faïz Gallouj & Olivier Weinstein (1997), later complemented in collaboration with Marja Toivonen (GALLOUJ & TOIVONEN, 2011/2) draws from a product-oriented model from the 1960's (LANCASTER, 1966) later developed by Paulo Saviotti and John Metcalfe (1984). In this model, a product (in the authors' perspective, a material object) is defined as a set of technical and service characteristics:

- Service characteristics, formally noted [Y], are seen from the customer's perspective. They are the final characteristics of the product, *e.g.*, for a car: it's performances, comfort, safety features and so on (*ibid.*);
- Internal characteristics, [X], are seen from the manufacturer's perspective and relate to the set of means (*e.g.* types of engine, suspensions, transmission, …) used to achieve the final characteristics [Y];
- Process characteristics, [Z], again from the manufacturer's perspective, are all the methods by which the internal characteristics [X] are produced. They include raw material, energy, manufacturing processes and so on.

In their 1997 paper, F. Gallouj and O. Weinstein discuss a transposition of this model to describe services. The general form of their model is presented in Figure 5.

Two vectors are directly transposed from the original model: [Y] and [X]. The vector [Y] corresponds to the final characteristics of the service. In other words, they represent the value proposition. The technical characteristics [X] represent all material objects and technical artefacts used to or on which the service is to be produced. They include "tangible technical characteristics" such as machines, information technologies…; as well as "intangible technical characteristics" like mathematical models, legal and financial expertise and so on.

The process characteristics [Z] do not appear in the model. The authors justify this choice in that, for services, process and technical characteristics might be indiscernible as "the processes in all their tangible and intangible forms are […] (partial) replacements for internal technical specifications" (*ibid.*). In the 1997 model, process characteristics are therefore included in the technical characteristics vector [X].

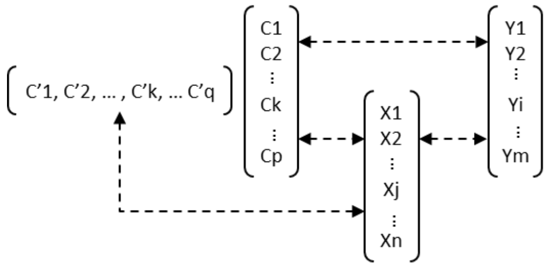

Figure 5: Initial characteristics-based model (GALLOUJ & WEINSTEIN, 1997)

The authors' main addition to the original model is the "Competences" vector, noted [C]. Such competences may contribute to the final characteristics of the service [Y] in two manners: with or without technological mediation. In other words, competences may comprise the ability to use and combine technological characteristics and / or directly contribute to [Y]. A particular case of the general form of the model, involves only the vectors [C] and [Y]. It is dubbed "pure, intangible service" (one example given is "remedial massage, when the masseur uses only his hands"). Additionally (and maybe more importantly), the authors introduced a second competence characteristics called [C']. It stands for the competences of the user and is meant to account for the co-production (*inseparable*) nature of services. By doing so, the authors recognise that customers are actively involved in the service production and that their characteristics are also to be take into consideration. Another particular system, {[C'], [X], [Y]} is also noteworthy. It corresponds to self-service situation.

This recognition of the customers' role in service production is at the core of the later development of the service characteristics-based model (GALLOUJ & TOIVONEN, 2011/2), which saw a dissociation between service provider and customer (see Figure 6). Apart from this dissociation and the duplication of all vectors on both sides (which, in our opinion, is a huge step forward), the improved model introduces a number of new items.

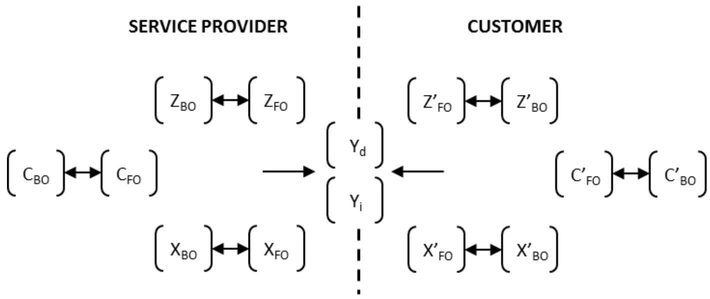

Figure 6: Improved characteristics-based model (GALLOUJ & TOIVONEN, 2011/2)

The first one is the comeback of the process characteristics [Z]. The vector, however, has a more limited meaning than in the original model (SAVIOTTI & METCALFE, 1984). It encompasses the process themselves (the "genuine acts"), from all stages (like in the original model: "design, marketing, production" although, in service production, the lines between them are often blurred) but leaves out the technical means such as raw materials or energy. The rationale is that they are, arguably, not as critical in service production; when necessary however, raw materials, energy and so on can be included in the [X] vector. The [Z] vector is duplicated on the customer's side (under [Z']). This shows full integration of the customer in the service production.

The second improvement is the distinction made, for each of the [X], [C], [Z] vectors and their equivalents on the customer's side, between front-office (subscript FO) and back-office (subscript BO). This refinement allows the authors to define in greater details the different elements composing a service. For instance, on the provider's side, a distinction is made between the "prototypes of the service (blueprints, flowcharts)" listed in [X_{BO}], and "concrete results (reports, contracts, software etc.)" listed in [X_{FO}].

Lastly, let us highlight the modifications brought to the description of the value proposition (the final characteristics or [Y]) in the improved model. The position of the vector, between the two participating entities, seems particularly appropriate as it shows that both parties conjugate in achieving a common set of objectives. Formally, the authors split the concept of final characteristics into the "direct (immediate) utilities" noted [Y_d], and "indirect (long-term) utilities" noted [Y_i]. This notion is best explained with an example. When going to a general practitioner for a particular illness, the result of the service, strictly speaking, is a diagnosis of the illness and a prescription for curative drugs. This, on one hand, represents the direct utility of the service to which contribute the vectors [C], [X], [Z] and their mirrors on the customer's side. On the other hand, the indirect utility would be the actual improvement of the patient's health. Interestingly enough, [Y_i] is why the patient used the service in the first place and [Y_d] is only the mean of fulfilling his or her needs.

3.3 An adaptation of the characteristics-based model to the defence industry and application to the case study

Largely based on the work presented in the previous sub-section, we will here introduce our own version of the service characteristics-based model designed to fit with our case study's specificities and, more generally, the specificities of the defence sector. Our version of the model is shown in Figure 7.

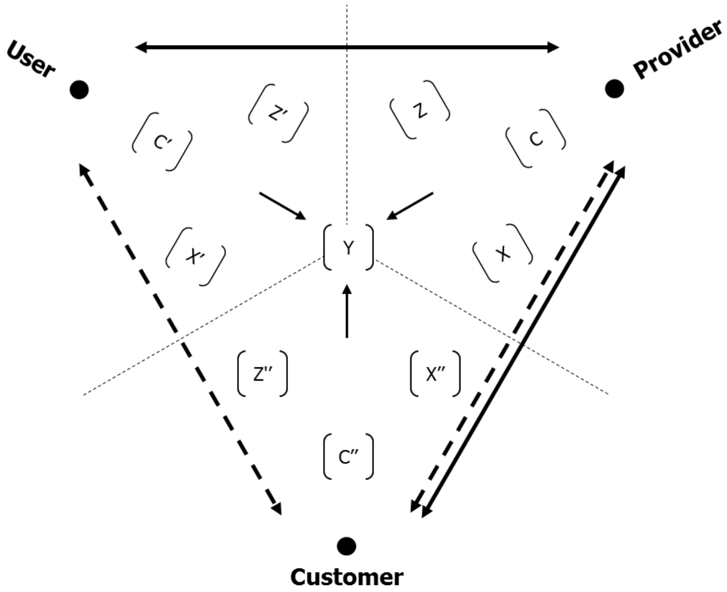

Figure 7: Defence-oriented service characteristics-based model (source: the authors)

The main elements of the improved characteristics-based model (GALLOUJ & TOIVONEN, 2011/2) are transferred *in extenso* to our defence-oriented version; with the [Y], [X], [C] and [Z] vectors having the same definition and modalities of application. In our model however, the distinction between front-office (FO) and back-office (BO) no longer appears for [X], [C] and [Z]. Formally justifying this choice would require more than a few paragraphs. Instead we will limit ourselves to saying that this simplification is based on the premise that interrelations in the defence sector are so strong that FO / BO lines of interactions are very blurred and therefore, arguably, less significant to the service description. One of the possible explanations supporting this premise is the earlier involvement in service definition of actors outside the provider than in other sectors, with co-creation extending to the design and implement phases rather than being limited to the production phase. Although this is not specific to the defence sector, it has a particular prevalence there. Additionally, with the tripartite configuration that we adopted (we will go into further details about that in the following paragraph), to distinguish front-office and back-office would introduce an entire new level of complexity that could be detrimental to the clarity of the service description. Indeed, with two different lines of interaction for each actor, one would assume multiple front-office (and possibly multiple back-office) characteristics. The value as well as the possible ways to reinstate the FO / BO distinction is currently under evaluation by the authors.

Similarly, the introduction of a third involved party renders difficult to explicitly show the distinction between direct and indirect final characteristics ([Y_d] versus [Y_i]). Integrating such distinction into the model and creating a deeper understanding of the balance mechanisms by which the three parties agree on the desired direct and indirect final characteristics of a prospective service is a current stream of research conducted by the authors.

As plainly visible in Fig. 7, the key feature of our defence-oriented model is the distinction made between the customer(s) and the user(s) of the service. We define these two parties as follows:

- The user(s) of the service: the entity(ies) to whose needs the service's value proposition is primarily designed to answer. The entity(ies), together with the provider of the service, is also the main co-producer of the service.
- The customer(s) of the service: the entity(ies) commissioning, evaluating and managing (*i.e.* depository of decision-making power) the service. The entity(ies) eventually participates in the service production but is not the main operator.

Within the service-related literature, the terms "customer" and "user" are very often used as synonyms. Even though the distinction between the two terms can be relevant to other sectors, it is particularly appropriate in the defence sector (at least in western countries) due to the clear separation between the armed forces (navies, air forces and land forces) and the procurement agencies (*e.g.* DGA (*Direction Generale de l'Armement*) in France, or DE&S (Defence Equipement & Support) in the UK). The role of the armed forces, broadly speaking, is to accomplish the mission given to them by the political power (*i.e.* a combination of executive and legislative powers, their respective weigh varying between countries) as part of their operational contract. Product and services acquired by the armed forces are meant to enable or a least facilitate the accomplishment of the operational contract. As such, with respect to our previous definitions, the armed forces are most usually the users of the services. They are very rarely the customers of the service however as this role usually falls within the responsibility of the procurement agencies, which are described as nodal points of the defence procurement process (JOANA, 2008; HOEFFLER, 2008). This central position is explained by the duality of the missions carried out by the procurement agencies. On one side, towards the armed forces, the procurement agencies have a role of prospective technology watch and fundamental research, in order to stir future acquisition of capacities that are coherent with the evolutions on the field of battle. This role is complemented by a mission, carried on behalf of the armed forces, to specify ongoing acquisitions in order to ensure the best possible fit of the product with the constraints of their operational contract. On the other side, towards the industry, their attributions are there again twofold. Firstly, the procurement agencies have an overarching role of piloting the Defence Industrial Base (DIB or DITB). In this sense they are responsible for the continuity of competences over time within this DIB and allocate major procurement programs accordingly (under budgetary, coherence of acquired capacities and public market regulations constraints). Secondly, procurement agencies manage, together with the industry, major acquisition programs throughout their development, testing, validation and acceptation process. In the very linear defence procurement process, the procurement agencies have a nodal position between the users and providers, materialised in our model by dotted arrows (see Fig. 7), which leaves very few contacts between the users and providers (*ibid.*).

The plain arrows between the customer(s) and provider and between the provider and the user(s) represent a new type of interaction to be established when developing services. As demonstrated in sub-section 3.1, services are of a relational nature: they are co-produced by the user and the provider. Our plain arrows aim at capturing this particularity.

As a summary, our version of the characteristics-based model offer a coherent system of three interrelated actors (user(s), provider and customer(s)), converging on a single value proposition [Y]. To do so, each actor mobilises:

- A set material and immaterial technical characteristics [X], [X'] and [X'']; and
- The competences necessary to operate such technical characteristics as well as competences directly contributing to the value proposition, together noted [C], [C'] and [C''].

To structure the complex interactions between them, as well as their own internal interactions, each actor relies on a set of procedures [Z], [Z'] and [Z''].

⁂

CONCLUSION AND MANAGERIAL IMPLICATIONS

This article followed a trajectory from the particular to the more general. The first section was strongly based on the data extracted from our case study on the development of missiles stockpile management services. We used a classical innovation-management framework (LOCH *et al.*, 2006) to characterise the exploration trajectory of data-loggers within the company. Combined with a strategic management perspective, this allowed us to construct a diagnosis as to why, after 10 years of development efforts, stockpile management services were not implemented. This diagnosis involved a lack of strategic planning, which origins were traced back to dispersed perceptions on the nature of stockpile management services and insufficient coordination between the different parties involved in developing such services.

From a managerial perspective, this diagnosis lead to the realisation that previous data-loggers developments were based on very opportunistic goals, rather than a company-wide trajectory.

Our second section presented the method used, during an 18 months project, to provide strategic planning in order to link the strategic intent of developing services and the technology supporting this intent. Still strongly anchored in the case study, the section shows a first movement towards a more general application as the tools used during the strategic planning process are not stockpile-management specific.

To structure the process of roadmapping, we founded our work on Albright's (2009) "generic roadmap framework". We first adopted a top-down, market-pull approach. It is to be noted that this approach was not traditional within the strongly product-oriented company. By conducting a series of interviews, we identified 6 value propositions associated with stockpile management. This corresponds to Albright's "know-why" layer. To address the "know-how" layer, we conducted a systematic decomposition of the six value propositions into 12 generic "service-components", which were later prioritised. The "know-how" layer was approached in a continuing top-down trajectory for non-data-loggers technical blocs and from a bottom-up trajectory for the data-loggers themselves. The latter allowed us to avoid efforts duplication and inconsistencies between the future data-loggers and the legacy ones. After reconciliation of the two approaches we were able to compile a product-segment-based matrix. The main benefit of this matrix was to combine strategic and technological orientations. Finally, we were able to compile a technology roadmap. In the retro-planning type and based on forecasted contracts opportunities, this roadmap allowed the company to develop a dynamic capability (TEECE *et al.*, 1997, EISENHARDT & MARTIN, 2000).

This strategic planning process had three main virtues. Firstly, it compiled information that was previously disseminated throughout the organisation. Secondly, it provided a common set of references and a common language to coordinate the actions of very diverse participants. Thirdly, it provided a powerful communication tool to promote stockpile management services across the different layers of the organisation and towards potential customers.

Our third and final section took a step back from our stockpile management case study and established that services in general cannot be described only by the sum of the technological blocs enabling their production. We then presented a generic model aimed at capturing the specificities of service production: the characteristics-based model (GALLOUJ & WEINSTEIN, 1997; GALLOUJ & TOIVONEN, 2011/2). Finally, we proposed an adaptation of this generic model to fit the specificities of the defence sector. This lead to adopt a tripartite configuration where the provider, the user(s) and the customer(s) of the service converge in a coherent system of technical, competence and process-characteristics to co-produce a shared value proposition.

Again, from a managerial perspective, this step paved the way towards a ramp-up in the implementation of stockpile management services with the creation of a dedicated project team. The expansion of the service description scope outside of the traditional product-oriented perimeter, puts emphasis on what is yet to be done. The version of the characteristics-based model that we presented has a rather general perspective. As such, in the same way that we developed specific tools to implement Albright's framework, it is to be complemented by actual service conception tools. Such tools constitute a current stream of research for the authors.

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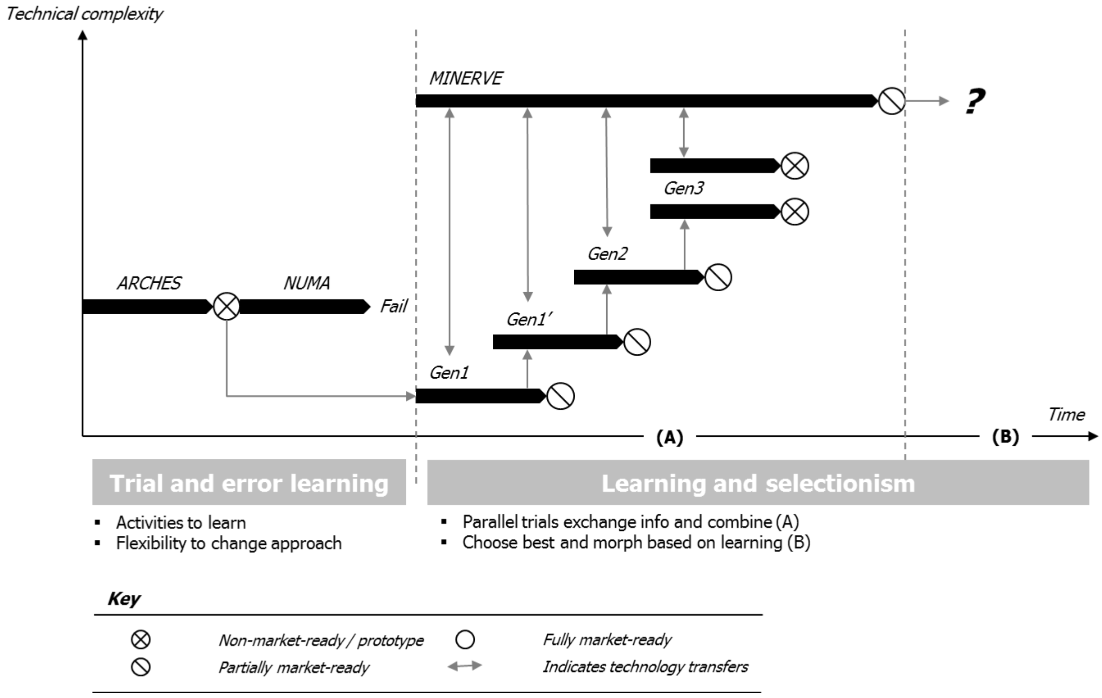
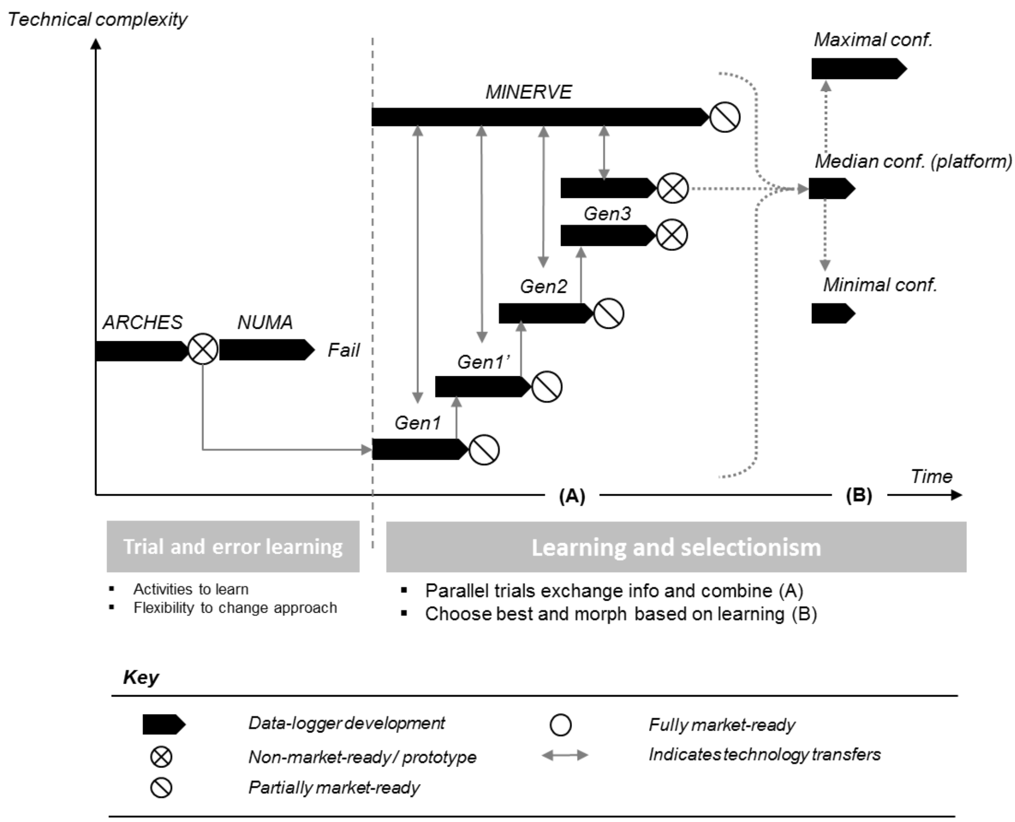
ANNEX

Annex 1 - Data-loggers exploration trajectory within MBDA: 2001-2013



Source: the authors

Annex 2 – Selectionism in the data-loggers exploration trajectory



Source: the authors