D2.4 Mapping of EU cloud services, solutions and providers

www.cloudwatchhub.eu|info@cloudwatchhub.eu |@cloudwatchhub

This document elaborates on an innovative concept, “Market Readiness Levels”, as a complementary methodology to “Technology Readiness Levels” as it has been initially introduced in the predecessor document, D2.2. Both concepts, Technology Readiness Levels, and Market Readiness Levels are designed as instruments for project preparation and project review. Initially targeting EC-funded projects (under H2020) it is designed to be used in commercial contexts as well.

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CloudWATCH2 Mission

It is only when the innovation process is inclusive and open that we truly advance technology for humanity – from small businesses to public sector organisations and citizens as the new digital consumers. The use of open source software and open standards are becoming increasingly seen as enablers and levellers for public and private sectors alike, bundling skills to create new services and applications.

CloudWATCH2 takes a pragmatic approach to market uptake and sustainable competitiveness for wider uptake and commercial exploitation. It provides a set of services to help European R&I initiatives capture the value proposition and business case as key to boosting the European economy.

CloudWATCH2 services include:

- A cloud market structure roadmap with transparent pricing to enable R&I projects to chart exploitation paths in ways they had not previously considered, or help them avoid approaches that would not have been successful.
- Mapping the EU cloud ecosystem of products, services and solutions emerging from EU R&I projects. Identifying software champions and best practices in mitigating risks associated with open source projects, and ultimately, enable faster time-to-value and commercialisation.
- Impact meetings for clustering and convergence on common themes and challenges. Re-use of technologies will also be of paramount importance.
- Promoting trusted & secure services through roadshows and deep dive training sessions. Giving R&I initiatives a route to users at major conferences or in local ICT clusters.
- A portfolio of standards for interoperability and security that can facilitate the realisation of an ecosystem of interoperable services for Europe.
- Cloud interoperability testing in an international developer-oriented and hands-on environment. Findings will be transferred into guidance documents and standards.
- Risk management and legal guides to the cloud for private and public organisations to lower barriers and ensure a trusted European cloud market.
- Legal guidelines to the cloud for SMEs containing practical examples of cloud contracts' clauses that need to be assessed before purchasing cloud services.

Disclaimer

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Main Author(s):	Michel Drescher, UOXF & Frank Bennett, iCloud & External expert
Contributing author(s):	-
Reviewer(s):	Nicola Franchetto, ICT Legal Consulting Nicholas Ferguson & Gennaro Fontanarosa, Trust-IT Serivces
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Executive Summary

There is the imperative for Research & Innovation ("R&I") outputs to be useful, usable and used. This deliverable describes how to fulfil that imperative with a new project support method. This method has been validated in a closed environment with 6 existing grant-funded R&I projects.

In April 2016, at the Net Futures conference in Brussels, CloudWATCH2 led a workshop on sustainability and exploitation for projects within the EC cloud clusters[1] as part of its concertation efforts. There was high engagement with the topic, largely driven by the need for expert input to project exploitation and sustainability planning, and better resource sharing within clusters.

By September 2016, CloudWATCH2 responded to this need by developing a new project support method based on combining a well-understood measure of technology maturity, "Technology Readiness Levels" with newly defined "Market Readiness Levels". In October 2016, after an independent expert, Frank Bennett, developed this method based on the needs of CloudWATCH2, the method was refined and successfully trialled with 3 other projects within the cloud computing, software and IoT clusters.

Combining the business model canvas, the output of a business model generation method that has wide acceptance including among projects referenced in this report, with a method to assess market readiness introduced by the independent expert, it was possible to develop the project support method used to assist the trial projects referred to herein.

There is a clear need to increase the sustainability of grant-funded R&I projects, ensuring the outputs of these projects are used by their constituent stakeholders and target customer audiences. In fact, as Pierre Chastanet, acting head of Unit E.2 in DG CNECT, pointed out, it is ever more important to get visibility to EC outputs from projects. The sort of question asked by politicians or MEPs is: After so much investment what came out of it? How have you stimulated new players in this space?[2]

The proposed project support method can be implemented at various stages within the grant lifecycle and is most relevant at the planning stage, in the months preceding annual project reviews to identify corrective actions ahead of time and during the critical phase before the project end with a go-to-market plan.

Against shrinking budgets, the desire to remain competitive through technological excellence and a vision for a European Digital Single Market underpinned by the exploitation of 'home grown' research and innovation, this new project support method focuses on R&I sustainability. This method can be rolled out across EC technology clusters with smart use of existing resources and will open up a new, practical method to sustain the outputs of existing and future R&I projects.

Through further validation of the proposed methodology with further three projects in June 2017, it demonstrated the MTRL framework and methodology to be suitable for publicly funded projects to implement innovation management as required by the European Commission.

[1] https://eucloudclusters.wordpress.com/

[2] Concertation meeting of H2020 Projects from DG CNECT Unit E.2; June 2017, Brussels; Pierre Chastanet: Welcome and a perspective from the EC; http://cloudwatchhub.eu/concertation2017

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1 Introduction

The Digital Single Market represents a fundamentally large opportunity for economic growth, job creation and innovation in technology. In order to unleash the potential of the digital economy, it is important to have a roadmap to guide the market structure as it matures, a clear mapping and clustering of projects within Research & Innovation and a methodology for measuring the technological and commercial impact of these projects.

The Digital Single Market is underpinned by cloud services - infrastructure, platforms, software and advances in telecommunications that facilitate access to digital services – being of high importance to policy makers. With understanding of the market landscape and a practical methodology for realising the benefits of Research & Innovation within a highly competitive market, policies such as those encouraging data portability, transparency, strong data protection controls and predictable market conditions, consumption of cloud services will continue to increase.

The CloudWATCH2 project consortium has prepared guidance from an economic and legal perspective for both the public sector and businesses across Europe, as well as cataloguing advanced R&D projects by cluster in order to provide decision makers with insight into areas yielding the greatest impact. The Cloud Services Catalogue provided by the CloudWATCH2 Project[3] offers a simple way for anyone to search, filter and access information about the R&I projects within the cloud computing research area. By mapping projects to both vertical markets and cloud characteristics, it is possible to broaden understanding of the market landscape. The purpose of mapping cloud services projects is to identify suitable candidates for the Market & Technology Readiness Level Framework, i.e. R&I projects with outputs addressing a specific need in the market with realisable potential and demonstrable traction within the marketplace.

Vertical Markets	**Cloud Computing Characteristics**
Digital health Energy Engineering & manufacturing Finance & insurance International agencies Local public administrations Media National government agencies Research institutions Smart cities	*Essential characteristics:* On-demand self-service Broad Network access Resource pooling Rapid elasticity Measured service *Common characteristics:* Massive scale Homogeneity Virtualisation Low-cost software Resilient computing Geographic distribution Service orientation Advanced security

Table 1: Mapping criteria for EC H2020 and FP7 projects

This approach serves quick top-down enquiries that originate from a user needs/market segment point of view, and typically answers questions such as “Which projects are providing solutions for the digital health segment, that provide a wide variety of access methods [Broad network access], scale according to needs

[3] http://www.cloudwatchhub.eu/service-offer-catalogue

[Rapid elasticity] and can be deployed at scale [Massive scale]?" This is particularly suitable and helpful for those characterised as *receiving* stakeholders, such as potential investors, funding body programme managers and project officers, and others.

A second approach developed in the project allows clustering of projects and initiatives purely based on similarities of importance and applicability of the cloud computing characteristics across research projects. Drilling into more detail, this records levels of importance of each cloud computing characteristic for each individual research project for which data is available[4]. Advanced statistical analysis, in this case Principal Component Analysis, and other supplemental methods, applied to that data provides insights in a project-oriented manner: By adding an individual project's data to the pool, performing the statistical analysis, and interpreting the resulting clusters allows the positioning of an individual project to identify potential collaboration candidates within its cluster and/or neighbouring clusters. This is known as the bottom-up strategy suitable for exploratory enquiries such as "Are there any other projects with sufficiently similar [cloud computing] priorities that we may collaborate with?" Since this methodology is agnostic to the target domain semantics[5] it can be applied to any segment that needs to be mapped.

However, both methodologies are *static* analysis approaches. Though being relevant and useful in their own right, successful project execution requires acquisition and processing of dynamic information, making decisions, and acting upon them in an appropriate manner – in other words, *innovation management.*

In this context, the CloudWATCH2 project supports EC funded projects in their efforts to implement innovation management: Through contracting the experience of Frank Bennett, an external expert in this matter, and applying it to as many projects as possible, CloudWATCH2 enabled projects to be guided in a way that informed their decision about the relevance, applicability and impact of their outputs, and act accordingly. In other words; is the project on-target to deliver an output ready for commercial exploitation?

Using a concept developed outside the project, CloudWATCH2 took the notion of Market Readiness Level to the entire portfolio of software and cloud-related projects funded through the H2020 programme, and managed by DG CNECT Unit E.2.

This deliverable is a follow-up of its predecessor, D2.2 "Mapping of EU cloud services solutions and technological readiness", published in November 2016. Deliverable D2.2 described the background material, the "Market and Technology Readiness Levels" (MTRL) and how it was applied for the first time in the sector of publicly funded research and innovation projects and provided a succinct description of MTRL. This was made available in April 2017[6] under the auspices of the Cloud Industry Forum as a contributed public article to its knowledge hub for wider exposure.

This deliverable (D2.4) documents the application, impact and relevance of the MRTL methodology for publicly funded projects – in this context projects funded through the EC H2020 programme, as follows:

Section 2 briefly recapitulates the Market and Technology Readiness Levels framework and methodology (MTRL).

Section 3 accounts for applying MTRL to six projects funded through the EC H2020 programme.

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[4] https://tethys.oerc.ox.ac.uk:8443/cluster/OriginalData.xhtml

[5] Advanced statistical analysis such as Principal Component Analysis, Hierarchical clustering using Euclidian distance algorithms, and others operate on a numerical, context-free representation of the target domain semantics. Thus, applicable to any domain, the quality and expressiveness of the outputs therefore depend on the adequacy and accuracy of the numerical representation of the target domain and data collected within. This methodology was used for clustering activities in the project including the online cluster application (see footnote 4). The cluster results were presented at the second Unit E2 Concertation meeting in 2017 co-located at NetFutures 2017.

[6] https://www.cloudindustryforum.org/content/project-product

Section 4 provides conclusions on MTRL, its relevance for funding bodies, and why it had such an impact on the EC funded projects described in section 3.

Section 5 ventures into briefly describing exploitation and commercialisation opportunities for MTRL beyond the lifespan of the CloudWATCH2 project.

2 Market and Technology Readiness Levels (MTRL)

This section provides a summary of the most important elements of the MTRL framework and methodology. We refer to the publication "From Project to Product"[7] for further details, freely available for download.

2.1 The MTRL framework

The MTRL framework comprises all necessary artefacts and tools necessary to execute the MTRL methodology. Some of the elements of the MTRL framework are incorporated from other, publicly available sources, while some were genuinely developed as part of the framework itself, as follows.

2.1.1 Technology Readiness Levels (TRL)

TRL are widely known and used worldwide. From its beginnings as an emerging definition at NASA to capture technical progress in their various space satellite programmes, TRLs are used in many different contexts and sectors with varying definitions – not least the European Commission incorporates TRLs as a fundamental part of its H2020 programme as described in Annex G of the programme's documentation.

MTRL incorporates Technology Readiness Levels using the following definition, which is an amalgamation of earlier versions, and adaptations made in the CloudWATCH2 project:

TRL	Description	Phase
0	**Idea.** Unproven concept, no testing has been performed.	Idea
1	**Basic research.** Principles postulated and observed but no experimental proof available.	
2	**Technology formulation.** Concept and application have been formulated.	
3	**Applied research.** First laboratory tests completed; proof of concept.	
4	**Small scale prototype.** Built in a laboratory environment ("ugly" prototype).	Prototype
5	**Large scale prototype.** Tested in intended environment.	
6	**Prototype system.** Tested in intended environment close to expected performance.	Validation
7	**Demonstration system**. Operating in operational environment at pre-commercial scale.	

[7] https://www.cloudindustryforum.org/content/project-product

8	**First of a kind commercial system.** All technical processes and systems to support commercial activity in ready state.	Production
9	**Full commercial application.** Technology on 'general availability' for all consumers.	

Table 2: Technology Readiness Levels as adapted by the CloudWATCH2 project

Compared to the definition of TRL in the H2020 Annex G[8], this version places technology validation on TRLs 6 and 7 rather than 4 and 5.

The reasoning behind this is two-fold. Firstly, to be clear about the differentiation between Research (TRL 0 – 3), Innovation (TRL 4 – 5) and Validation (TRL 6 – 7), and to align with the H2020 SME Instrument's requirement for technology to be at TRL 6 or better[9]. Secondly, in a competitive industry to recognise the need to deliver proven technology that is tested for its commercial viability. This in turn impacts the time to and cost of executing a go to market strategy.

2.1.2 Market Readiness Levels (MRL)

Market Readiness Levels mirror TRLs in providing scope and orientation for addressing technological problem solving, while at the same time ensuring rigour in bringing ideas and innovation to market for commercial exploitation.

Adopting the intuitive design of TRLs, Market Readiness Levels are defined in a similar way. For example, while technology on level 9 is (historically) regarded as the final stage of technology, Market Readiness Levels go beyond market entry, and require a product or service to be established and to scale in the market to be at level 9 when the product or service is deemed to achieved *sustainability.*

The individual MRLs are defined as follows:

MRL	Description	Phase
0	**Hunch.** You perceive a need within a market and something ignites.	Ideation
1	**Basic research.** You can now describe the need(s) but have no evidence.	
2	**Needs formulation.** You articulate the need(s) using a customer/user story.	
3	**Needs validation.** You have an initial 'offering'; stakeholders like your slideware.	
4	**Small scale stakeholder campaign.** Run a campaign with stakeholders ("closed" beta – 10 - 25 friendly stakeholders)	Testing
5	**Larger scale early adopter campaign**. Run a campaign with early adopters ("open" beta – 25 – 50 intended customers)	

[8] http://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2016_2017/annexes/h2020-wp1617-annex-g-trl_en.pdf

[9] https://ec.europa.eu/digital-single-market/en/sme-instrument-frequently-asked-questions

6	**Proof of traction.** *Problem/Solution Fit* Early adopters converted to paying customers. Sales pipeline 100 customers.	Traction
7	**Proof of satisfaction.** *Vision/Founder Fit* A happy team and happy customers give evidence to progress.	
8	**Proof of scalability.** *Product/Market Fit* A stable sales pipeline and strong understanding of the market allow revenue projections.	Scaling
9	**Proof of stability.** *Business Model/Market Fit* KPIs surpassed and predictable growth.	

Table 3: Market Readiness Levels. © 2016 Frank Bennett

Comparing MRL and TRL by its numbers, it is obvious that generally, TRL and MRL scores will not coincide: In most scenarios, a market niche (or gap) is identified and its potential researched before scoping a technological solution: MRL scores lead TRL scores up a point in the project where the situation is inversed, however the demonstration that a project is moving toward its commercial objective is when the TRL and MRL move in tandem.

In other cases, it may happen that technological breakthroughs are realised without a clear picture of market applicability or potential – collateral innovation. In such cases, TRL scores lead MRL scores from beginning to end.

2.1.3 The "Four Fits" model

An integral part of the MRL model is the "Four Fits" model that describes discrete stages and milestones in the process of enacting a go to market strategy. Within MTRL, the four fits are assigned to distinct MTLs as described above.

These Four Fits are defined as follows:

Problem/Solution Fit

"Does the problem exist? Can we solve it? Are we 'improving' or 'creating new'?"

First, a project must have clarity of purpose. It must articulate the problem clearly, propose a solution and demonstrate how the viability of a proposed solution will be tested. This stage of development is best characterised by a period of intense research, gathering evidence through interviewing stakeholders affected by the problem and early-stage designs for a solution that addresses a clear set of needs and in some cases that may be vague and lend itself to co-creation.

Vision/Team Fit

"Do we have the right team to solve the problem?"

Second, a project must have an effective team. Strong project leadership depends on clarity of purpose, an understanding of the required skill sets (which should be complementary), the ability to communicate and motivate a team of suitably qualified individuals with a demonstrable track record in leadership. The quality of a project's outputs or service offering is only as good as the team behind it.

Product/Market Fit

" Have we identified our target customer segment(s)?"

Third, a project must move ever closer to matching its service offering, solutions or outputs to best serve the needs of its target customer segment(s) and reward its stakeholders. The TRL/MRL is perfectly aligned to support the reality of converging the development activity with an understanding of how that will address the target market where the market is ripe with innovation and a moving target.

Market/Business Model Fit

"*Do we understand the model for exploitation and sustainability?"*

The TRL/MRL plots the progress and trajectory to market entry. Behind the scenes is work to develop an understanding of the dynamics of go-to-market and the framework to develop that understanding is the business model canvas. This is a well-known method that engages potentially everyone in a project, this is raw thinking time and should be facilitated by a competent person familiar with the process of developing a business model canvas and who brings objectivity to the process. This is not the time for fanciful ideas as it informs the vital activities aligned to the evolution of MRL over time, for example; who do we need as partners and why? The partners needed at the outset of a project when development is in focus typically change as the project assembles its go-to-market plan.

2.1.4 MTRL scores

An MTRL score is defined as the conjoint of a single MRL score, and a single TRL score, and its notation is (x, y) – for clarity and readers convenience the colloquial form is frequently used: (MRLx : TRL y). For example: (MRL 4 : TRL 6).

Regular assessment of a project on the TRL and MRL scales produces a trail of historical progress: A series of MTRL scores achieved in the past, where one MTRL score is the collation of the project's MRL and TRL at a specific point in time.

MTRLs can be used in different ways: Used retrospectively, a trail of MTRL scores can be used as a performance function. Used proactively, MTRL scores project a target goal, as an expression of the project's *potential*, if all conditions are optimally met. Used as a decision-making tool, MTRL scores represent *goals,* often expressed as base and stretch goals.

2.1.5 Business Model Canvas

A business model is an "abstract representation of an organisation, be it conceptual, textual, and/or graphical, of all core interrelated architectural, co-operational, and financial arrangements designed and developed by an organisation presently and in the future, as well as all core products and/or services the organization offers, or will offer, based on these arrangements that are needed to achieve its strategic goals and objectives."[10]

The business model evolves and its first iteration may be skeletal and challenging to build. This is usual and external facilitation of the build breaks through a lack of understanding of the process and reservation to

[10] *Al-Debei, M. M., El-Haddadeh, R., & Avison, D. (2008). "Defining the business model in the new world of digital business." In Proceedings of the Americas Conference on Information Systems (AMCIS) (Vol. 2008, pp. 1-11)*

confess to what is unknown. This is all part of developing a common understanding of the value proposition and what is component (known as building blocks) to it. The canvas when populated is a blueprint for a strategy that has many moving parts (9 building blocks) that have discrete activities, yet is cognisant of their interconnection to delivery of the value.

Key to the success of a business is the value provided by that product or service. Without a realistic value proposition, the business model captured in the BMC will not get into motion. Hence the relationship between the BMC building blocks "Value Propositions" and "Customer Segments" are captured in a breakout document: The "Value Proposition Canvas" (VPC, not shown in this deliverable). Together, the BMC and VPC allow any organisation to validate their business proposal, organisational structure, and allocation of resources. If there is no business canvas[11] at the outset then it is more difficult to develop later when a 'shoehorn' is attempted to reconcile alignment of resources.

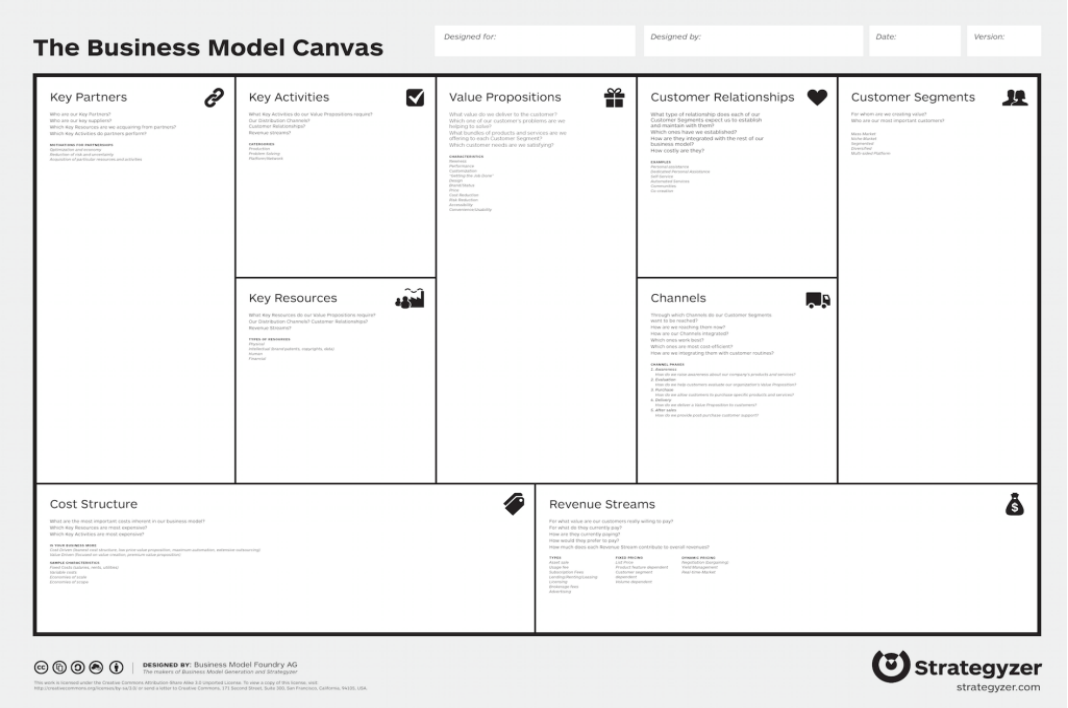

Figure 1: The Business Model Canvas as defined by Strategyzer

2.1.6 Minimum viable product (MVP)

There are several definitions of a minimum viable product; by far the most succinct and clear definition is given by Techopedia as follows[12]:

> *"A minimum viable product (MVP) is a development technique in which a new product or website is developed with sufficient features to satisfy early adopters. The final, complete set of features is only designed and developed after considering feedback from the product's initial users."*

This definition emphasises two important changes of paradigms:

[11] https://strategyzer.com/canvas/business-model-canvas

[12] https://www.techopedia.com/definition/27809/minimum-viable-product-mvp

- An MVP is not a product, but a technique, a process, a methodology playing its part in a larger strategy of business conduct.
- MVP stresses the importance of customer/consumer influence and feedback that shape the final set of features

Therefore, MTRL incorporates MVP as a means to reach TRL 9 much earlier than usual. At the same time, this increases pressure on achieving corresponding market readiness.

2.1.7 Technology Adoption Lifecycle

The mechanics of technology adoption play a crucial role in the success or failure of establishing a product or service in the market. The most influential contribution to understanding the technology adoption lifecycle is provided by Geoffrey A. Moore in his book "Crossing the Chasm"[13] where he describes the success criteria of how to cross the chasm from early adopters (technology enthusiasts and visionaries) leading the wave, to pragmatists and late adopters.

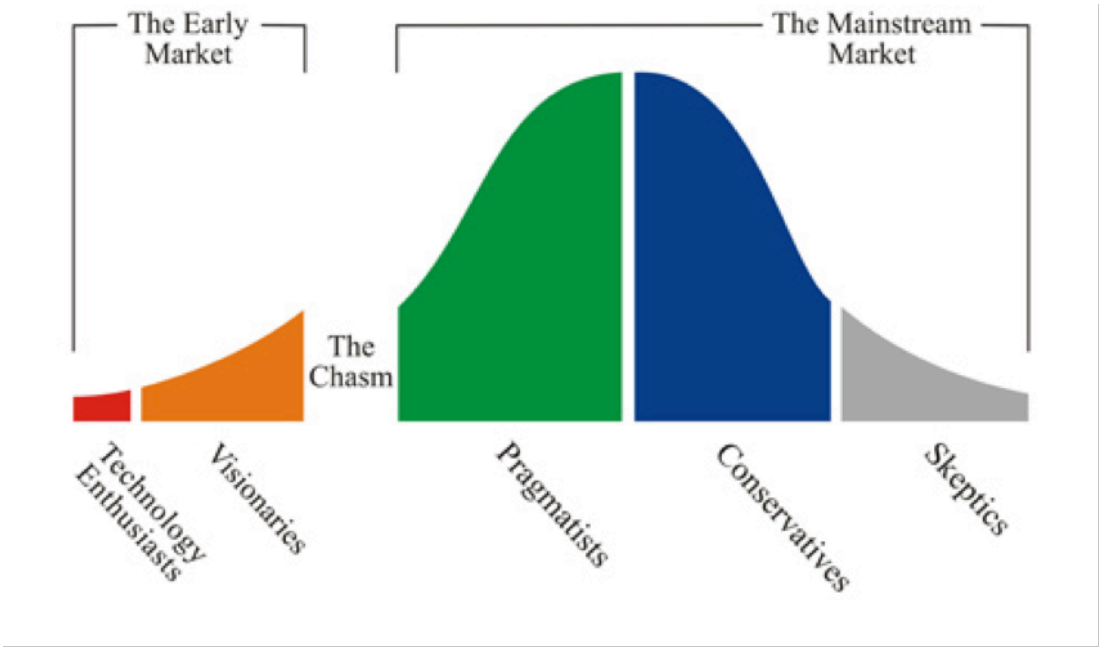

Figure 2: The chasm in technology adoption between early adopters and the mainstream

The tight link and integration between MVP and the technology adoption lifecycle has led to the lean start-up movement, and MTRL firmly places itself in it.

2.2 MTRL methodology

Knowing the elements of the framework is only one part of successfully applying MTRL in a strategic gameplay. The BMC and its 9 elements (see diagram above) are the components to the actions that are recorded by MTRL. What the MTRL does is to provide a meaningful and easy to understand interpretation of the BMC – what is our progress toward the project's goal?

Among those projects that have been participants in using MTRL, it has provided clarity in terms of their current MTRL position and what is a realistic and achievable MTRL goal for their project.

[13] https://www.harpercollins.com/9780062292988/crossing-the-chasm-3rd-edition

2.2.1 Project MTRL assessments

The assessment procedure and surrounding activities are described in detail in Deliverable D2.2 “Mapping of EU cloud services solutions and technological readiness”

The primary purpose of an MTRL assessment is to establish a current position, a point of reference, for the project. Similar to but far from being as formalised as organisational audits, MTRL project assessments formulate an MTRL score and provide evidence and account for a specific score. Part of the assessment service intake is a brief self-assessment resulting in a MTRL score that is then compared to the score reasoned by the assessors and explained during the assessment delivery meeting.

The second purpose of the assessment is to provide value towards the projects in assessing its *potential* within a given timeframe. For some projects, this meant a projection of their potential within the remaining 6 months of their project duration. For others, this meant projecting a possible progression through 6-month intervals until their respective final month. Although both constitute a future projection and potential, evidence from all assessed projects highlight:

- when applied in the late phase of a project the projected potential answers the question; “What can we realistically achieve in the remaining time?”
- when applied to fledgling projects, MTRL sets aspirations and goals, determining what *needs* to be done.

All projects take out of the assessment guidance for decisions and actions to help achieve the future MTRL score assigned to the project.

In that sense, MTRL assessments are very similar to annual project reviews conducted by independent external reviewers conducted on behalf of the EC represented by the project officer.

2.2.2 External advisory and consulting

Much of the success of MTRL lies in the orchestration and coordination of its components (i.e. the elements of the toolbox). While some strategies and “proven practices” (in differentiation to best practices) are available and heavily promoted in the business world (for example, the lean start-up movement), they predominantly tend to cement a linear approach on how to bring an innovation to the market.

While a linear approach is easier to teach and to learn, experience outside and within MTRL assessments indicate a non-linear methodology, at the very least an iterative way, provides better results.

This area of MTRL is in its early stage of definition; however, conversations with interested early adopters indicate that a long-term engagement with an external advisor – or mentor – offers significant value in implementing MTRL and guiding a project to achieve its ultimate goal.

2.2.3 Professional services

As MTRL evolves and matures, new components will be added to the MTRL toolbox as required and appropriate.

Correspondingly, professional services learned in the use of the MTRL methodology will offer projects a complete and holistic support package during their lifetime.

3 High-level summary of results

With a catalogue of cloud services provided by CloudWATCH2, it is possible to scale out the use of the Market and Technology Readiness Level Framework (MTRL) to accelerate progress across the entire portfolio of projects managed by DC CNECT Unit E.2 and even beyond.

Between September 2016 and September 2017, the CloudWATCH2 project carried out six MTRL assessments addressing specific areas within the catalogue, as follows:

- CloudTeams (Software Engineering & Development)
- WAZIUP (Big Data and IoT)
- MUSA (Muti-cloud application security)
- CLARUS (Cloud Security)
- COLA (Cloud orchestration)
- EUBrazil BigSEA (Smart Cities)

To elicit candidate projects for an assessment of their technology and market readiness, we reached out to the existing and established network of projects maintained by CW2 Task 2.1 through the concertation meetings and mailing list. With permission of the projects we describe high-level results achieved using MTRL methodology.

3.1 CloudTeams

CloudTeams[14] is a crowdsourcing platform that connects software developers with software testers. This project addresses two main problems in the European software market: finding matching users to validate software features early in the development cycle and reducing the overall cost of testing. This is a 2-year project finishing around February 2017. CloudTeams was scored at (MRL 4 : TRL 4) due to the fact that it had not launched its beta yet. We anticipate a rapid increase in both technology and market readiness upon launch, with an MTRL potential of (MRL 6-7 : TRL 6-7) due to their strong planning and ability to execute.

Two of CloudTeams' project leaders joined the workshop to discuss key recommendations to elaborate on new commercial stakeholder groups which we identified, a demand generation model we provided that would drive signups through their website, specific advice on licensing models to create revenue streams supporting the project's sustainability objectives, refining their value proposition to include in-house developers within a large organisation as well as external software development providers, and a go-to-market strategy that targeted such potential users.

CloudTeams has demonstrated exemplary progress and collaboration, and with the right support in connecting a community of software development projects to a sufficiently diverse and engaged community of testers, it is likely that CloudTeams may progress quickly through several Technology & Market Readiness levels over the coming months with their launch.

Since the assessment in November 2016, the CloudTeams project successfully launched its collaborative platform at cloudteams.eu in early Q2 2017.

At the time of writing, it is hosting 50+ projects in more than 20 categories. With that in mind, CloudTeams is currently estimated to score at (MRL 6.5 : TRL 8).

[14] https://www.cloudteams.eu/projects/

3.2 MUSA: Multi-Cloud Secure Applications

MUSA[15] is an ambitious project to develop solutions for what is arguably the hottest area of tech development today, information security. MUSA is developing a framework for businesses deploying distributed applications over heterogeneous cloud resources. There are known risks, and this is an area attracting massive investment in response to those risks, on November 1st 2016 the UK announced a £1.9Bn investment to support its National Cyber Security Strategy 2016-21 to combat cybercrime.

The EU General Data Protection Regulation (Regulation 2016/679, 'GDPR') comes into force on 25th May 2018 and every business and organisation will need to comply, or face substantial financial penalty. It is recognised that the rapid adoption of cloud services has not always been accompanied by rigorous evaluation of the assurance of those services and their compliance with GDPR. This directly feeds the process of evaluation of risk that is required of good governance.

Prior to our meeting at CloudWATCH2 workshop, MUSA had a project review with their project officer that resulted in decisions that were aligned with the recommendations reached by the independent team reviewing the MUSA project and presented at the workshop.

The recommendations were arrived at after reviewing the information provided by MUSA in a pre-workshop RFI, evaluation of the information on MUSA website and reviewing sources of information of others that have a similar technological focus to solving security in the way that MUSA describe (see above). The search revealed some interesting differences in the approaches taken to describe the problem/solution and the language used in those descriptions that were included in the recommendations to MUSA.

The main benefits to the project as relayed during the workshop are:

1. Independent confirmation of the decisions reached during the official project review, e.g. focusing the exploitation efforts on only part of the tools in the MUSA framework.
2. Guidance on how to build on the experience of business model generation and put that in the focus of TRL/MRL to have point in time assessment and develop a trajectory for the reassessment of the TRL/MRL leading up to product release.
3. It is hard work to keep on top of website refresh and an independent assessment brings to the attention what the eye does not see when you are the owner of the website.

No hard follow actions were agreed with the project. The project will end in December 2017, and is now set on a new course following its last project review.

3.3 WAZIUP: Open IoT and Big Data platform, from Africans for Africans

Undeniably, IoT and Cloud are complementary paradigms and can improve each other's performance and use when combined appropriately. The WAZIUP[16] project combines both with the third ingredient unequivocally needed in this context: BigData. IoT devices, certainly when deployed on a large scale, can produce BigData which needs to be handled accordingly.

Characterised using *the four Vs* "Velocity", "Volume", "Veracity" and "Variability", any combination of these characteristics requires an appropriate IT infrastructure to handle the data. Cloud-based infrastructures are the right choice of means.

[15] http://www.tut.fi/musa-project/
[16] http://www.waziup.eu/

WAZIUP aims to develop and provide a cloud platform (a PaaS solution) offering SMEs an environment to develop BigData and IoT solutions. The project's intention is to engage African SMEs to develop solutions for the African market, particularly rural environments. WAZIUP started in February 2016 and will end in January 2019.

WAZIUP integrates a number of key components that already exist in production with supporting communities (TRL 9), but binds itself to a relatively young and new platform that still needs to find and demonstrate its own sustainability. Regardless, the platform itself does exist as a current lab prototype and awaits its use and deployment "in the field".

WAZIUP partners include PAs and NGOs from African countries, who form the direct liaison to the target sector, the SMEs developing and producing the solutions, and the villages in rural Africa who would consume these solutions. A plethora of use cases (user stories) exists, and WAZIUP selected five key use cases for trailblazing and validation.

In November 2016, we scored WAZIUP at (MRL 3 : TRL 4). Although one might consider it a low scoring, it reflects the projects' spot on state according to its own plan.

Without going into details of the recommendations, WAZIUP has an unusually diverse set of (potential) stakeholders that may group into clusters with quite different potential business models and agendas. It is important for WAZIUP to develop the stakeholder personas and produce material tailored to each of these groups. Likewise, different stakeholder groups acting as product/service providers, may provide different services and thus need to develop different service catalogues - by trailblazing through publishing blueprint service catalogues with the effect of faster uptake and traction in the market.

A number of specific recommendations were made related to connection and networking for synergy of hardware development and software development. On the commercial front, a number of high potential funding stakeholders were recommended. Incorporating recommendations from the CloudWATCH2 year 1 review, we followed up with the WAZIUP project to see where support with the Common Exploitation Booster[17] may be needed. However, at that point in time, the Common Exploitation Booster project was not able to accept any more applications until further notice.

Since the assessment in November 2016, WAZIUP clearly improved on the value propositions the developed platform will provide to those who use it. In close collaboration with its local project partners, WAZIUP improved on understanding the needs of its direct customers (African start-ups), as well as its indirect customers (i.e. the customers of its direct customers). Combined with sharpening its philanthropist approach reflected in the overall business model (of the project not intending to generate direct revenue for its European consortium partners, but to emphasise developing and kick-starting a viable and sustainable business model for African companies) WAZIUP has developed a solid understanding of the various elements of the MTRL framework (particularly the Four Fits model).

Following the MVP technique, WAZIUP has already deployed five environmental prototypes (in Ghana, Senegal, and Togo) within 1 year of the project's inception. In parallel, WAZIUP has selected 11 African start-ups it will work with on bringing their solutions to the market. WAZIUP has partnered with FIGLOBAL, and has received numerous prestigious awards, for example a travel award supporting its participation in the World Economic Forum in Davos, Switzerland.

Based on the exceptional progress, we estimate WAZIUP to have progressed from (MRL 3 : TRL 4) to (MRL : 4 : TRL 5) in little more than 6 months' time.

[17] http://exploitation.meta-group.com/Pagine/About-Us.aspx

3.4 CLARUS

The CLARUS[18] project develops "a framework for user centred privacy and security in the cloud". CloudWATCH2 assessed the CLARUS project in June 2017.

Central to this framework are two delivery models; the CLARUS proxy (a SaaS model) and the CLARUS on premise model (primarily a product, not a service) that will provide the value of the framework to the customer with minimal intrusion to the existing infrastructure.

Without going too much into the technical details of the project, the CLARUS project predominantly targets the health care sector with its project outcomes. While this is clearly a growing market, large corporations have laid significant claims on market shares, so competition on successful market entry and sustaining revenue are expected to be fierce.

The CLARUS project self-assessed its maturity as (MRL 5, TRL 6) whereas the CloudWATCH2 project assigned a score of (MRL 4, TRL 6). This discrepancy highlights a common misconception in project assessment. While there are many good reasons to include demand side representatives (i.e. customers) in the composition of a project consortium the MTRL methodology argues that these cannot be considered intended customers in the sense of Market Readiness Level 5. Instead, MTRL considers those demand side representatives as friendly stakeholders – important actors, who Geoffrey Moore classify as Early Adopters (having propensity for risk) of technology in his book "Crossing The Chasm" (see above). Yet, they are intrinsically biased since they are paid to perform a certain task. Would the same entities act the same way had they not received remuneration for their efforts? This question remains to be answered for each project assessment, and is in all likelihood impossible to answer. Therefore, to err on the safe side, MTRL considers demand side representatives as stakeholders, not intended customers.

Specific recommendations to the CLARUS project were less of technical nature, since the consortium has a very clear picture of the remaining tasks to do. Instead, recommendations emphasise strategic gameplay, and to discuss important questions regarding the positioning of the CLARUS products and services as niche or general purpose, and how to address competition, IPR and licensing questions in a market that shows similarities to the gold rush in America in the 18th century.

3.5 COLA

The COLA[19] project develops a toolkit, MiCADO, that aims to solve the cross-domain problem of satisfying dynamic demand side consumption with elasticity on the supply side. CloudWATCH2 assessed the COLA project in June 2017.

This problem is well-known in the electricity market, where the entirety of consumers extends a relatively stable base demand driven by long-running electricity consumption needs (e.g. industry), regular oscillating needs (private consumers in day-and-night consuming rhythm), as well as almost entirely unpredictable demand spikes influenced by external factors such as weather. The supply side response in this example is limited in its dynamicity due to power plants requiring significant lead-in times for their respective start-up and shut-down phases, and volatility of e.g. renewable energy sources (particularly PV and wind energy).

The same holds true for the IaaS cloud computing market, while intrinsically designed to be elastic is increasingly operating on the same economic grounds as the electricity market. While elasticity is desirable, on the supply side it is challenging to predict completely elastic/random usage patterns and that typically

[18] http://www.clarussecure.eu/
[19] http://project-cola.eu/

results in overprovisioning with its associated costs being passed on to the consumer. It is small wonder that on-demand resources cost about 4 times as much as regularly provisioned and reserved resources. Although at a much smaller scale, while demand side IaaS-based cloud computing has the same characteristics of sustained base load and unpredictable/erratic peak load, supply side is also facing lead-in times for provisioning and decommissioning the underpinning hardware – and a peculiarity of IaaS service delivery and consumption: To a large extent, IaaS resources are still *manually* provisioned through a GUI, with automation based on a few well understood machine-level metrics such as high CPU load triggering provisioning, booting and integration of another VM into a cluster of worker VMs.

However, true application-level orchestration requires a deeper understanding of application (high) performance and associated metrics: A high CPU-load is not always an indicator of a deteriorating application performance; therefore, a different set of metrics and automated actions need to be developed to allow automated IaaS provisioning according to application-level and user-defined Quality of Service metrics. The COLA project's MiCADO framework allows exactly that.

The COLA project self-assessed a score of (MRL: 1 : TRL 4), whereas we assessed the project with a score of (MRL 1 : TRL 3.5). This is a common situation for 30 month long projects: Pure research projects often start at TRL 2 or even lower, while Research and Innovation Projects often start at TRL 3 and at times at TRL 4. In contrast, the H2020 SME Instrument requires technology at TRL 6 or higher for applications to be eligible for SME Instrument phase 2 projects: This simply reflects the different stages and aspirations of projects and their financial sponsors.

The project clearly addresses perceived market needs pains, and can describe them, however not yet in satisfactorily mature user stories and scenarios. There is no discrepancy between external and internal perception and assessment of the current state of affairs, which is encouraging for future project progress.

At the time of the assessment, the project had almost 2 entire years of activities ahead of it. With the IaaS market rapidly maturing towards a utility market, the COLA project is currently still ahead of the curve with the market applying itself to COLA for the toolkit it is developing. Yet, the dynamicity of the market requires COLA to implement effective innovation management and be alert to competitive threat. COLA needs to stay very attentive, observant, and agile in its ability of incorporating new developments and disbanding obsolete components.

The potential of the project is highly promising: With about 24 months still to work on the platform, COLA certainly has the potential to enter the market within that timeframe: We assessed the potential of the MiCADO framework at the score (MRL 5.5 : TRL 8).

3.6 EUBRA BigSEA

The EUBrazil BigSEA[20] project is a research and innovation project funded under the EU-BRA joint funding of the European Commission and the Brazilian Government. CloudWATCH2 assessed the EUBRA BigSEA project in June 2017.

The BigSEA project set out to integrate no less than 11 components into meaningful sets of services and toolkits for its customers. The most prominent use case is the city of Sao Paulo wanting to improve its traffic management and forecast system to provide local and international tourists with better traffic announcements and recommendations for sightseeing, increasing the overall tourism experience in Sao Paulo and its suburbs.

[20] http://www.eubra-bigsea.eu/

The BigSEA project self-assessed with a score at (MRL 4, TRL 5), which is identical to our assessment. The project is well aware of its challenge of needing to integrate a large number of components on heavily varying levels of maturity: While some components can be safely assumed to have reached TRL 8, or even knocking on the door of TRL 9, many other components sit around TRL 4 or 5 at the time of the MTRL assessment. Even though some components reside on the low complexity end of the spectrum, some components still require significant amounts of effort to elevate them to a level of maturity that would allow integration with other components with reasonable effort.

Despite these challenges the project has interesting outcomes with potential – however the communication and value proposition arguments were hidden gems under an overload of technical and very detailed project and component documentation: The information was there, but needed to be carved out by the readers themselves. This is perhaps an overcompensating response to earlier project reviews and criticisms of a lack of documentation.

Given the relatively advanced maturity of the project with about 6 months until completion (at the time of the assessment) the suggestions for the project emphasised improving the description and scope of the various services and added values the project has on offer, and to reduce the overall technical terminology and focus of its web presence.

4 Conclusions

4.1 Project MTRL assessments

Using a concept developed outside the project, CloudWATCH2 has taken the notion of Market Readiness Level to the entire portfolio of software and cloud-related projects funded through the H2020 programme, managed by DG CNECT Unit E.2.

While the concept of Technology Readiness Levels (TRL) is widely known among project partners (organisations) and members (personnel), Market Readiness Levels (MRL) are entirely new. Yet, participants in the public workshop at the CloudForward 2016 conference, and pursuant closed doors assessment of the projects CloudTeams, MUSA and WAZIUP grasped the idea intuitively, immediately developing an understanding of both the framework and the methodology, as well as the consequential need for action within the scope of their respective projects.

Likewise, CLARUS, COLA and EUBRA BigSEA immediately understood the benefit of the MTRL framework and methodology. Taking EUBRA BigSEA as a representative example of the latter three projects, the impact of the assessment using the MTRL methodology – assess, engage, act – speaks for itself: Comparing the project's website at the time of assessment with how the project presents itself a mere 2 months later, the difference is a stark as night and day: Clear, crisp separation of project outputs into intuitive categories, and succinct yet to the point focussed definition of services, collateral research outputs and challenges provide an easily digestible definition and explanation of the project while not hiding its challenging complexity.

4.2 When does applying MTRL yield the best results?

The answer to that question depends on how you use it.

MTRL can be used as a quality checklist for project pitches and proposals[21]. The structure of EC H2020 proposal templates is the result of a long development and improvement process and thus reflects the Commission's (and the proposal reviewers') need to understand the context, anticipated value and impact, and credibility of the execution plan of the project. The quality of the information conveyed in the project proposals directly resonates with the Four Fits model (see section 2.1.3 for more information). Used that way, MTRL can be used to assess the project's *applicability*, *capacity* and *tenacity* (ACT) of delivering the desired results.

MTRL can be used as a specific tool to formulate a go to market strategy. Used in the later phases of the project, MTRL incorporates tried and true marketing and exploitation methodologies. Substantiated through assessments for the CloudTeams and CLARUS projects, it provides a clear and focused action plan for the remaining time until the project ends, and support for the project in executing the last push towards completion. In that sense, this use case can be argued as "just" another project planning application (see below), yet it is sufficiently distinct in our mind to warrant separate explanation.

MTRL can be used as a project planning tool. In that case, periodic (re-)assessments combined with goal-setting future MTRL scores for the next phase of a project, the mere nature of the planned trajectory from current to future score provides scope and focus on the project priorities for the time ahead.

4.3 Why projects should use MTRL: Strategic gameplay and innovation management

The CloudWATCH2 project has provided EC funded projects with a number of methodologies on how they map on to the landscape of software services and cloud computing. While the first employs categorisation of projects offering straight-forward answers to questions of the "if this then that" category (i.e. categorisation along vertical markets, and cloud computing characteristics) the second methodology allows projects to seek answers in a more exploratory way: Statistical analysis provides a way to interpret qualified similarity of projects as a multi-dimensional clustering space with an answer that depends on the viewpoint of the observer: Answers to questions such as "Given the following scoring of importance, are there other projects are sufficiently similar to me, and how close are my next neighbours?".

Yet, both methodologies are *static* analysis approaches. Though being relevant and useful in their own right, both methodologies merely provide **orientation** in an otherwise static landscape. But, successful project execution requires acquisition and processing of dynamic and often volatile information, making decisions, and acting upon them in an appropriate manner. To anticipate market participants' activities and future positions, one needs to **observe** *direction* and *velocity* of their movements.

Together, orientation and observation allow formulating options and alternatives for the execution strategy of a project, to **decide** on what the next steps will be, determining the project's direction and speed of its own actions. By **acting** on these decisions the project executes its strategy towards reaching its goal. This is known as the *strategy cycle*[22], which describes the mechanics, influencing factors and underpinning motivations of how to reach a set goal:

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[21] This use case for MTRL has already been described in the predecessor deliverable D2.2. While we did not yet encounter an opportunity to explicitly apply MTRL as a project proposal quality tool, we remain convinced that this will notable improve project proposal quality.

[22] https://medium.com/wardleymaps/on-being-lost-2ef5f05eb1ec

1. The mechanics are known as the OODA loop of John Boyd[23]
2. The influencing factors of this strategy cycle are Sun Tzu's "five constant factors"[24], translated and interpreted as: *Purpose* (Moral Law), *Landscape* (Earth), *Climate* (Heaven), *Doctrine* (Method & Discipline), and *Leadership* (Commander).
3. The underpinning motivations that drive the strategy cycle are defined as *the why of purpose*, and the *why of movement*.

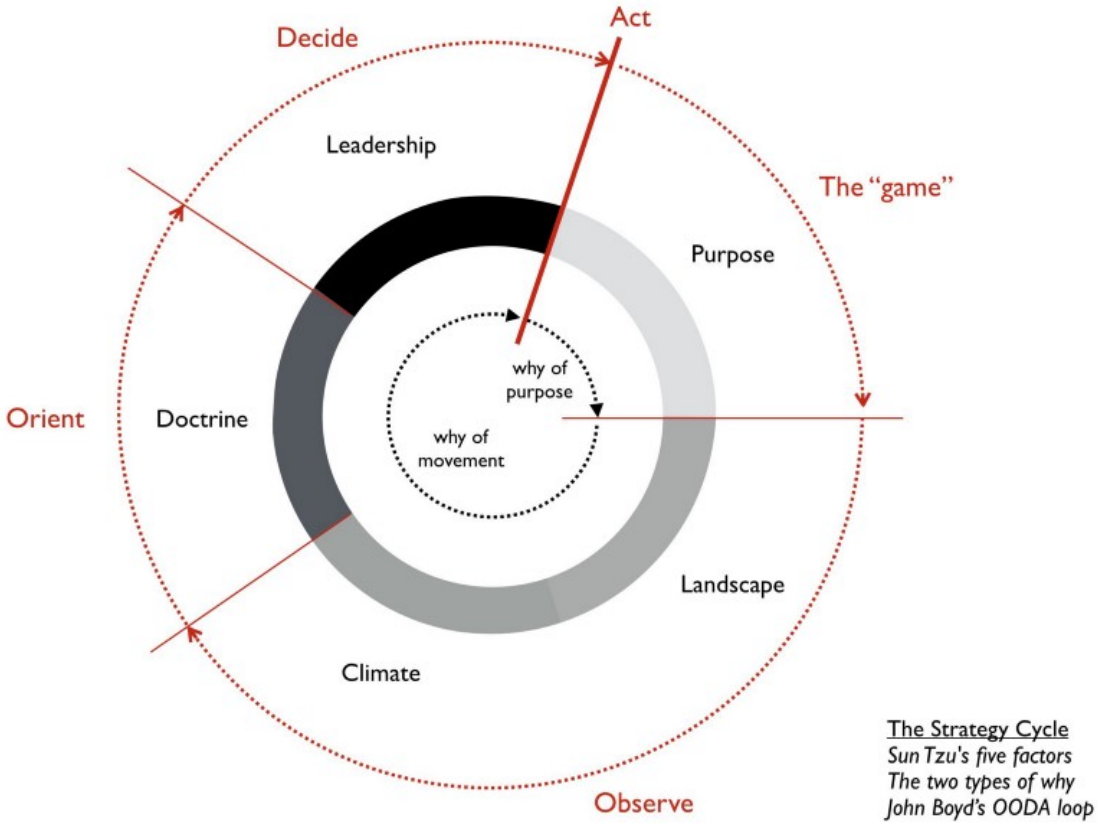

Figure 3: The strategy cycle according to S. Wardley.

The European Commission has started to implement a gradual transition from static and linear project execution to dynamic and iterative project leadership by emphasising the need for projects to put innovation management in place[25]:

> *"Innovation management is a process which requires an understanding of both market and technical problems, with a goal of successfully implementing appropriate creative ideas. A new or improved product, service or process is its typical output. It also allows a consortium to respond to an external or internal opportunity."*

In other words, innovation management is the application of strategic gameplay to EC funded projects.

[23] https://en.wikipedia.org/wiki/OODA_loop
[24] https://suntzusaid.com/book/1
[25] http://ec.europa.eu/research/participants/data/ref/h2020/grants_manual/pse/h2020-evaluation-faq_en.pdf

With the co-joining of Technology Readiness Levels with Market Readiness Levels, the MTRL framework and methodology provides projects with the tools and processes to set, monitor and ultimately deliver against a project's outcomes.

By adopting MTRL, projects implement innovation management as required by the European Commission.

4.4 Why startups should use MTRL: Helping them to get the full picture

We believe that the approach described in this document is of value not only for EC-funded projects but also **startups** in general. This will be trialled at the CloudWATCH2 final event with two MTRL workshops targeting both startups and projects. Whether the startup is developing a step innovation, a field product or service, or something with the potential of disrupting entire markets, experiences tells time and again that just developing it is not enough: On the road to the market, technological innovation albeit being important and at times a show stopper and is only one half of the entire story. The session will focus on helping startups realise the importance of MRL and preparing the startup for being successful in the market.

5 Log Table

DOCUMENT ITERATIONS		
V0.1	First project-internal draft	Frank Bennett, iCloud; Michel Drescher, UOXF
V0.2	Authors internal review	Frank Bennett, iCloud
V0.3	Draft sent to reviewers	Michel Drescher, UOXF; Nicola Franchetto, ICTL; Nicholas Ferguson, Gennaro Fontanarosa, Trust-IT
V0.4	PMB review	CloudWATCH2 PMB
vFinal		Michel Drescher, UOXF