

UPDATED Project Workplan

DTIF3 Contract Reference: DT 2020 0209

Title/Acronym: **C**reating an **A**rchitecture for **M**anipulating **E**arth
Observation data (CAMEO)

Institute Lead Name: University College Dublin (UCD)

Project Workplan, Deliverables:

GANTT Chart: Timing of Work Packages and their components

	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18
WP0	D0.1	D0.2										D0.3						
WP1								D1.1			D1.2	D1.3.1						D1.3.2
WP2								D2.1		D2.2	D2.3						D2.5.1	D2.2
WP3																		
WP4									D4.1			D4.2						
WP5																		D5.1
WP6			D6.1, D6.2									D6.3						D6.4
WP7					D7.1			D7.2										
	M19	M20	M21	M22	M23	M24	M25	M26	M27	M28	M29	M30	M31	M32	M33	M34	M35	M36
WP0						D0.4												D0.5
WP1									D1.3.3									
WP2	D2.4	D2.3						D2.2						D2.5.2			D2.3	
WP3	D3.1					D3.2												
WP4		D4.3						D4.4										
WP5		D5.3, D5.4			D5.2		D5.3					D5.3		D5.3				
WP6			D6.6.1									D6.6.2				D6.5	D6.6.3	
WP7				D7.3.1		D7.4.1				D7.3.2		D7.4.2	D7.3.3		D7.4.3			D7.5

Table 1. List of work packages

Work package No	Work Package Title	Lead Participant No	Lead Participant Short Name	Person-Months	Start Month	End month
0	Programme Mgmt	1	UCD	54	1	36
1	Data Warehouse	7	Dell Technologies	125	1	27
2	EO Platform	2	Vertice Cloud	321 (-10)*	4	35

3	Data Quality	1	UCD	106 (-5)*	6	30
4	Security	3	EdgeScan	157	4	26
5	Training	1	UCD	67 (-25)*	6	36
6	Innovation Mgmt.	1	UCD	128	1	36
7	EO Demos	4	Icon	239 (-8)*	4	36
			Total months:	1269 (-48)*		

Table 2. Work package descriptions.¹

Work package number	WP0	Start Date				M1		
Work package title	Programme Management							
Participant number	1	2	3	4	5	6	7	
Short name of participant	UCD	VC	ES	Icon	TM	TWM	Dell Technologies	
Person/months	30	4	4	4	4	4	4	

¹ In effort to reduce the RPO budget we have carved out >500K worth of savings for selected work packages. This will mean a reduction in approximately 4 FTE Person Years, total. These reductions are highlighted in parenthesis and with an asterisk for WP PM totals for WPs 2, 3, 5 and 7. Further refinement of the deliverables will be needed, and support will be needed from ESA to leverage training services and collateral for this platform that would have been customised in WP5 in the original submission.

Objectives

- To oversee the effective delivery of project objectives;
- To monitor project progress against project timelines;
- To ensure the timely delivery of Deliverables;
- To continually assess risks and opportunities;
- To ensure the effective interaction and collaboration of the entire consortium in delivering project outcomes

Description of work (where appropriate, broken down into tasks), lead partner and role of participants

- CAMEO project management is provided by a dedicated project manager (PM) based at UCD. The Project Manager will work with the Principal Investigator (PI) and Funded Investigators (FIs), UCD Research and Innovation, Industry Partners, Public Sector agencies, Technology Partners, Enterprise Ireland, and various committees to develop, deliver, and evaluate the research project as set out in DTIF the work-plan. The PM will report to the Lead PI (Prof Michela Bertolotto) at UCD and the Programme Steering Committee, providing leadership in all aspects of financial planning, administration, and management of the project. The main duties and responsibilities of the PM throughout the project are as follows: Organising and coordinating all aspects of the project, ensuring clear and transparent communication with the project team, key external partners, collaborators, and stakeholders
- Managing the project's finances, in the context of set budget lines and funding agency terms and conditions including the forecasting and cash flow management
- Producing financial reports on a monthly basis
- Managing strategic relationships with key stakeholders
- Ensuring all milestones agreed are delivered on time and to the highest standard
- Developing and managing the network of partners (academia, industry, and government/agency, etc.) and act as a single point for queries relating to the programme of work
- Supporting management in the recruitment of personnel, and monitoring and reporting against the recruitment plan
- Together with the PI, and wider leadership team, establish and manage the project oversight and governance committees
- Design and lead workshops or other events related to project inputs, analysis, or delivery
- Develop and manage delivery of the communications plan
- Identifying new collaborative research and innovation opportunities that may develop from within the project and wider consortium
- Acting as a key liaison with the UCD Research and Innovation, assisting in the identification and management of Intellectual Property (IP) arising from the research programme (in collaboration with NovaUCD), and supporting development of new funded initiatives with the Research Partners team
- Assisting with any other related duties assigned by the PI

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Deliverables (brief description and month of delivery)

D0.1 Risk register (M1)

D0.2 Quality-assurance plan (M2)

D0.3 Project management report (M12)

D0.4 Project management report (M24)

D0.5 Final report (M36)

Milestones

MS0.1 Scientific Advisory Board and the Technical Development Committee are complete (M6)

MS0.2 Review with the Scientific Advisory Board (M12)

MS0.3 Review with the Scientific Advisory Board (M24)

MS0.4 Final review with the Scientific Advisory Board (M36)

Work package number	WP1		Start Date			M1		
Work package title	Data Warehouse							
Participant number	1	2	3	4	5	6	7	

Short name of participant	UC D	VC	ES	ICON	TM	TW M	Dell Technologies
Person/months	40	6	4	5	5	12	53

Objectives

- Design and Implementation of Data Warehouse;
- Adjudicate between data storage options server/client/cloud;
- Develop a mechanism for ingesting data into Data Warehouse;
- Facilitate hybrid-cloud infrastructure for data warehouse
- Determine circumstances under which third party data is stored (temporarily/persistently)/discarded; after use;
- Encode data associations through Semantic Tagging;
- Select and adopt data encoding standards (SWE for EO/GeoJSON);
- Select data storage technology attuned to spatial data (eg MongoDB)

Description of work (where appropriate, broken down into tasks), lead partner and role of participants

CAMEO differentiates itself by supporting access to and conflation of a range of disparate EO data sources. CAMEO EO data presents in a variety of formats consisting of data in various temporal and spatial scales and update frequencies. Data will derive from diverse sources including: IoT, sensors, satellites, UAVs, flat files, third party external databases and APIs. Additionally, many of the datasets fulfil the criteria of *big data* and are large, frequently updated and of questionable veracity. The heterogeneous nature of the input data requires a robust solution to allow data integration and fusion to facilitate the timely and efficient manipulation of the data to perform complex queries from a diverse range of expert and non-expert end-users (**WP2**). To meet these requirements, it is proposed to use a data warehouse infrastructure (fig 1.1). WP1 will design and develop the data warehouse (DW) with input from **WP3 (Data Quality)** and **WP4 (Security)**. To achieve the optimal and efficient solution, three tasks have been defined within WP1.

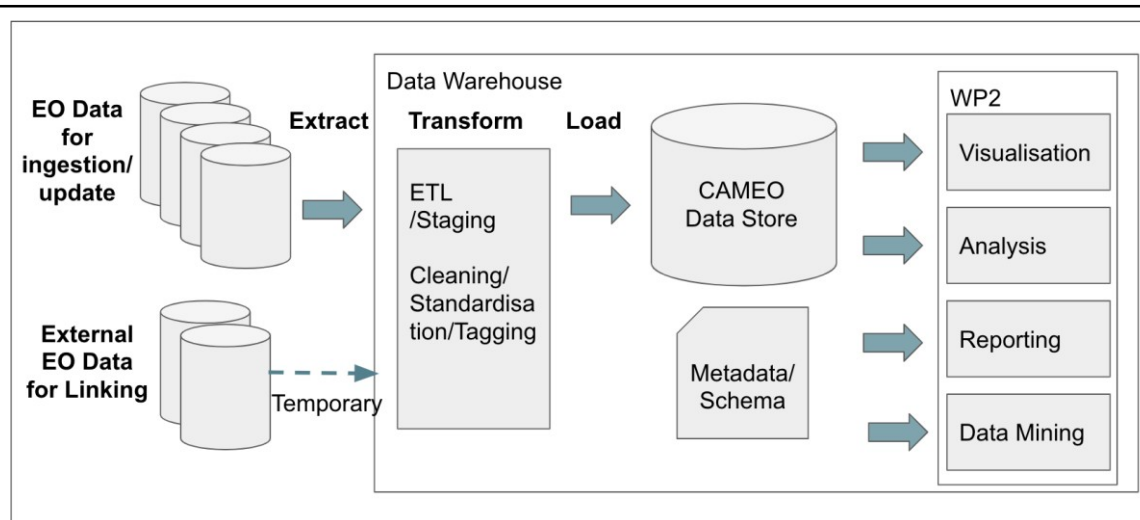


Fig 1.1 CAMEO Data Warehouse Overview

Task 1.1: Requirements & Architecture Design: The requirements identified while preparing this proposal will be refined further in conjunction with the data providers and end-users (WP7) of CAMEO. **Treemetrics** will provide advice around third party data storage, with a special focus on in field data (IoT, GNSS, measurements) and other EO data (e.g. UAV data). **ICON** and **TWM** will provide support and sectoral stakeholder guidance.

The results of this task will feed into the design to ensure it can effectively support the various research and commercial use cases (See **WP2** and **WP7** for examples). Options for the design of the data warehouse architecture will be considered. Drawing on the expertise of the consortium, a review of the State-of-the-Art in data warehouse design will be conducted. For the CAMEO to be expansible, a platform-independent design will be considered. Given the type of data, a NoSQL approach will be utilised. The Kimball methodology² will be commissioned in DW design catering for a range of heterogeneous data that CAMEO will manage. The design must also be cognisant that not all the data available in CAMEO will reside in the DW. In many instances, it may not be practical or indeed possible for all data to be ingested into the DW. For example, several mature data repositories already exist (siloes) within organisations. In such cases, pointers to external datasets will be utilised and decisions on whether to ingest the data temporarily to provide analysis will be determined on a case by case basis. This approach also ensures that the approach is scalable. **T1.1** will produce **D1.1**.

Task 1.2: Data Modelling: The Extract Transform Load (ELT) process will be responsible for ensuring external data is loaded into the DW in a *standardised, efficient* and *usable* manner.

² Kimball, R., & Ross, M. (2011). The data warehouse toolkit: the complete guide to dimensional modeling. John Wiley & Sons.

Standards such as those developed by the Open Geospatial Consortium (OGC)³ will be adhered to and the data/metadata will be INSPIRE-compliant. This task is primarily responsible for designing the logic defining inter data relationships within the DW. This will form a critical component of CAMEO. In particular an appropriate schema for the DW will be defined based on input from **T1.1**. Given the complexity and varying nature of the data, a *flexible* schema is required. A constellation or snowflake schema is appropriate in which multiple FACT tables will be utilized as the metadata for the DW. To aid with the development of the schema, semantic enrichment through tagging of datasets will be considered⁴. This will add meaning and context to the data to make it more usable and searchable which is a novel aspect of CAMEO.

Task 1.3: Metadata Repository: A metadata repository will be developed which compiles information about available data sources. **Task 1.3** will link closely with **Task 1.2** and build upon it. The information stored will include: the data sources available; the data contained in each source, including relevant properties; how each source can be accessed. The repository will be dynamically populated and the software platform will provide functionality to add metadata related to newly added datasources. This repository will form the backbone of an EO data source discovery (locating/searching?) and ranking service. Dell will contribute to the development of the metadata semantic index. Dell has considerable experience in developing knowledge bases for referencing unstructured data, both within the data warehouse and linking to additional external sources. UCD will be integral to the design and development of metadata repository and data model. and will contribute to techniques for semantic enrichment of data into the data warehouse (link to possible NLP and search functionality in **WP2**).

Task 1.4: Implementation & Deployment

The design and implementation adopted within CAMEO will be *agnostic* to underlying platforms or suppliers. Document-driven, NoSQL databases such as Hive, Cassandra, MongoDB and hybrids⁵ will be examined with respect to their utility for the complexity of EO data and the identified requirements. Given the demands associated with complex spatial and temporal queries: size, on-demand availability of resources, large storage capacity and significant compute power, a cloud infrastructure will be utilised for deployment. The benefits of the cloud mean that active management will not be required and scalability will be built in. In conjunction with the platform providers in

³ <https://www.ogc.org/docs/is>

⁴ Ptiček, M., Vrdoljak, B., & Gulić, M. (2019). The potential of semantic paradigm in warehousing of big data. *Automatika*, 60(4), 393-403.

⁵ Ngo, V. M., Le-Khac, N. A., & Kechadi, M. T. (2019). Designing and implementing a data warehouse for agricultural big data. In *International Conference on Big Data* (pp. 1-17). Springer, Cham.

CAMEO, the cloud options available will be considered and the most appropriate one in terms of cost and services will be determined. Dell will lead this work package by offering and customizing its on-premises storage and compute solutions, integrating and enabling cloud-based solutions, and enabling multi-cloud brokerage. Additionally, Dell will leverage its experience in developing vocabularies and ontologies to model the complex relationships between data objects, and how this can be achieved at scale.

Deliverables (brief description and month of delivery)

D1.1 Data Warehouse Design Document (M8)

D1.2 Metadata Repository (M11)

D1.3 Implementation of CAMEO Data Warehouse Iterative Releases: Initial (D1.2.1) (M12), Interim (D1.2.2) (M18), Final (D1.2.3) (M27)

Milestones

MS1.1 Refinement of Requirements complete (M3)

MS1.2 Review of SOA DW Designs complete (M6)

MS1.3 Initial Data Schema and Model complete (M8)

MS1.4 DW Technology determined (M10)

Work package number	WP2		Start Date			M4		
Work package title	EO Platform							
Participant number	1	2	3	4	5	6	7	

Short name of participant	UCD	VC	ES	ICO N	TM	TW M	Dell Technologies
Person/months	70 (-10)*	186	4	10	10	10	31

Objectives

- Design and develop an EO Software Platform that both supports & controls access to the EO Data Warehouse;
- Design and Implement easy to use customisable and aggregatable services that support recurrent data /needs adhering to EO data standards;
- Provide a brokerage service by which to locate/rank appropriate data source(s)/providers;
- Provide support for satellite image cropping/trimming through bounding box definition for specific area;
- Develop services for the conflation/fusion of disparate data streams within the spatiotemporal domains;
- Provide services for manipulation of satellite images to clean/cluster features based on pixel clustering and pre-processing;
- Provide data analytics to examine satellite images to clean/cluster features based on pixel clustering utilising pre-processing and machine learning techniques;
- Design and Develop an EO data source discovery service

Description of work (where appropriate, broken down into tasks), lead partner and role of participants

This work package will identify *generic, recurring and much needed* EO data services. The identification of such will *in part* derive from stakeholder engagement with the sectoral areas in WP7. Prioritisation of those services to develop will be based upon perceived sectoral need. The first wave of such services will seek to demonstrate the power deriving from the effective leveraging of EO data and thereafter to encourage the extension and consolidation of their usage.

These services will be constructed as a suite of microservices adopting the emerging de facto industry standard of Microservices Architecture (MSA). In the first instance these will be largely stand alone services however in time process chains together will be developed whereby individual microservices can be aggregated to deliver end-to-end solutions to specific problems.

EO data embraces a myriad of potential data sources and streams including but not limited to: satellite, drone, lidar, ground segment and citizen derived. The CAMEO EO platform will make provision for such diverse and rich datasets through functionality for storage and access; cataloguing

and searching; data processing and analysis; visualization; secure authentication and authorization (dealt with in the security WP4).

Task 2.1: Design & Delivery of CAMEO EO Software Platform

The CAMEO EO software platform will provide the scaffolding within which the overall CAMEO functionality will be delivered. It will involve a number of functionalities:

1. Design and delivery of a *data brokerage service* that will source data from a range of data service providers according to user specified queries including: price, quality, latency and spatio-temporal adjacency.
2. To develop the EO platform to support data warehouse access and provide cloud resources for the CAMEO platform to run on.
3. To integrate both the data quality filter developed within **WP3** and data security provisions from **WP4**;
4. To support on-line access to training resources developed in **WP5** through an off the shelf Virtual Learning Environment.

Task 2.2: Core EO Microservices

Task 2.2 will develop a catalogue of EO microservices will be developed which support:

- Imagery services: for cropping, window query, image enhancement (antialiasing; contrast enhancement), filtering (eg. sharpening/smoothing), pixel clustering, feature extraction, segmentation, affine transformations; preprocessing functionality including orthorectification, projection, data conversion (including image compression); spectral analysis; data export into a variety of different formats (SHP, XMLMetadata, GeoJSON);
- LiDAR services: downsampling, filtering, window query, Digital Terrain Model (DTM) generation, spatio-temporal data integration (e.g. airborne and terrestrial LiDAR datasets, etc.).

Task 2.3 Advanced EO Microservices

A number of advanced services will be developed to supplement the initial CAMEO core microservices. These will include:

- *Intelligent EO data services* eg. image classification, longitudinal change detection, data analytics (application of ML techniques) to facilitate identification and visualisation of data attribute correlations, data attribute spatio-temporal clustering at pixel level using eg Moore I [Ref], Ref, Ref]. UCD involvement in the ESA AIREO project⁶ (AI-Ready Earth Observation Training Datasets) concerned with the design specifications and best practices for AI ready (Machine Learning) training datasets for EO data including generating, structuring, describing and curating training datasets. This experience will enable CAMEO to overcome demonstrable bottlenecks to the application of ML to EO. Version 1.0 of the AIREO specifications and best-practices will be available summer 2021

⁶ <https://eo4society.esa.int/projects/aireo/>

and will frame dataset curation and the effective application of ML to EO data. Dell will contribute to the development of intelligent data query mechanisms using ontologies.

- *Advanced data conflation services*, facilitating spatio-temporal data joins, spatio-temporal integration of different data sources (eg LiDAR and imagery, ground segment, UAV, citizen derived). Dell Technologies will leverage its experience of image processing, IoT data factorisation and sensor fusion, using its knowledge and expertise in ML algorithms, intelligent image processing and semantic lifting.

Task 2.4: Design of Supports for EO Process Chaining

In order to effectively leverage the functionality offered through the CAMEO microservices catalogue (core plus advanced) services a *modular process chaining facility* will be designed to both inform and enable service selection akin to *plug and play* enabling service composition where service interfaces are clean and adhere to interface standards (Restful APIs) facilitating service interoperability and data exchange. UCD will draw upon its experience to deliver orchestration of different services into a usable framework and pipeline. It is anticipated that a multi-agent systems approach will be used to introduce multiple agents collaborating within the process chain.

Task 2.5: User Experience (UX) Design

User adoption and sustained user usage is an imperative for the CAMEO user interface. FAIR data principles (Findable, Accessible, Interoperability and Reusability) and ease of use for non-EO experts will be central to CAMEO. Ease of access and interaction with the data warehouse and associated resources/services will be ensured through *user centred design* and iterative interface releases and usability testing. This task will provide a suite of visualisation options appropriate for particular data view requirements as established through stakeholder engagement in **WP7**. It is intended to accommodate the analytics engine in rapidly supporting data visualisation options. Vertice Cloud has access to extensive UX experience from interface delivery across diverse user sectors and this know-how will be harnessed within this task. **Treemetrics**, **TWM** and **Icon** will assist with usability testing while UCD will contribute to design and development of the icon based UI along with NLP processing for intuitive search.

CAMEO will adhere to guidelines of the OGC EO Exploitation Platform DWG⁷. The key activities of such an OGC WG focus on interoperability issues and in particular the identification of standard interfaces and specifications for the core services provided by an EO Platform.

⁷ <https://www.ogc.org/projects/groups/eoexplatform>

Deliverables (brief description and month of delivery)**D2.1** Design of CAMEO EO Software platform Architecture (M8)**D2.2** Design, Implement and Test EO MicroServices catalogue (M10, M18, M26)**D2.3** CAMEO EO Software Platform Iterative Releases (Initial, Interim, Final) (M11, M20, M35)**D2.4** Design and Implement Data Brokerage Service (M19)**D2.5** Design and implement Intelligent Data Analytics Services (D2.5.1 Ver1 M17, D.5.2 Ver2 M32)**Milestones****MS2.1** CAMEO EO Software Platform Release (Initial) (M11)**MS2.2** CAMEO EO Software Platform Release (Initial) (M20)**MS2.3** CAMEO EO Software Platform Release (Initial) (M35)

Work package number	WP3		Start Date			M6		
Work package title	Data Quality Assurance							
Participant number	1	2	3	4	5	6	7	
Short name of participant	UCD	VC	ES	ICO N	TM	TW M	Dell Technologies	
Person/months	65 (-5)*	4	4	3	16	8	6	

Objectives

- Design and formulation of mechanisms for the adjudication of data quality;
- Use of discovery services to identify temporally and geographically adjacent data sources;
- Provision of services for ground truthing data with relevant (location and temporal adjacency) and known high quality data sets;
- Design and implementation of trusted mechanisms to filter '*poor quality*' data and ensure non-admittance to the data warehouse

Description of work (where appropriate, broken down into tasks), lead partner and role of participants

Poor quality data will invariably lead to poor decisions. It is imperative therefore to seek to ensure that the CAMEO data warehouse is only populated with quality data or at the very least data for which the indicative quality of data is known.

Adjudication of data quality and mechanisms for doing so need to be incorporated throughout the entirety of the *big data model* including data collection, data pre-processing, data processing and analytics, and data use. This work package will involve 4 subtasks.

Task 3.1: Design and formulation of mechanisms for the adjudication of data quality;

A series of data quality services will be developed the first tranche of which will focus upon the quality of collected data. In order to assist with such a series of services will be developed by which to identify and source relevant (location and temporal adjacency) data of known high quality which can be used to affirm data quality and support ground truthing. UCD has established experience in data quality research^{8 9 10} examining data quality in terms of data trust. UCD has also established

⁸ John Byabazaire, Gregory O'Hare, Declan Delaney, Data Quality and Trust: A Perception from Shared Data in IoT

In Proc. 2020 IEEE International Conference on Communications Workshops (ICC Workshops), IEEE Press, 2020.

⁹ John Byabazaire, Gregory O'Hare, Declan Delaney, Using Trust as a Measure to Derive Data Quality in Data Shared IoT Deployments, 29th International Conference on Computer Communications and Networks (ICCCN), IEEE, 2020.

¹⁰ John Byabazaire, Gregory O'Hare, Declan Delaney,, Data Quality and Trust: Review of Challenges and Opportunities for Data Sharing in IoT, Electronics 9 (12), 2083, DEc. 2020, MDPI Publishers.

credentials as part of AIREO (AI-Ready Earth Observation Training Datasets) project¹¹ exploring automated quality assessment together with best-practices around dataset documentation in relation to quality - provenance information, and information pertaining to data collection protocols (e.g. including for non-EO derived ground truth/reference data/annotations/labels). A *data quality coefficient* will be determined that will somewhat crudely apportion a measure to data. Quality will be assessed across numerous dimensions including completeness, adjacency (spatial & temporal), lossiness, noise but also other factors including suitability for ML use cases e.g. are the labels/annotations of suitable volume, quality, and class distributions. Subsequent quality service bundles will address quality measures across the big data model stages; pre-processing, conflation, analytics and usage.

Task 3.2: Design and Delivery of discovery services to identify temporally and geographically adjacent data sources;

A data discovery service will be developed to identify *adjacent* data sources which will serve to underpin and inform determination of data quality coefficient(s). Data can be ground truthed through cross comparison of a given data stream with known data of high quality and adjacent within the spatio-temporal domain data. This discovery service will support identification of data sources access a wide range of data categories, IoT enabled devices, third party databases/sets, citizen derived data, satellite imagery and drone data.

Task 3.3: Design and implementation of trusted mechanisms to filter ‘poor quality’ data and ensure non-admittance to the data warehouse;

Implementation of a data quality filter which will act as an admissibility filter through which data will be passed before admission to the CAMEO data warehouse. Data that falls below a particular data quality coefficient (**Task 3.1**) will be prevented for admission. In certain circumstances data maybe admitted but annotated to highlight potential vulnerabilities in particular quality dimensions. This filter will be developed as a microservice which will be accommodated within the CAMEO EO platform (**WP2**).

Deliverables (brief description and month of delivery)

D3.1 Design of Data Quality Adjudication Framework (M19)

D3.2 Design and Implementation of Data Quality Filter (M24)

¹¹ <https://eo4society.esa.int/projects/aireo/>

Milestones**MS3.1** Delivery of Data Quality Filter (M24)

Work package number	WP4		Start Date			M4		
Work package title	Security							
Participant number	1	2	3	4	5	6	7	
Short name of participant	UC D	VC	ES	ICO N	TM	TW M	Dell Technologies	
Person/months	25	3	128	1	0	0	0	

Objectives

- Facilitate building a secure platform by providing security analysis at design phase.
- Integrate early in the SDLC by performing security testing as part of the continuous integration/ delivery process.
- Improve our automated API scanning services and use these improved services as part of our testing methodology for the CAMEO platform.
- Integrate AI and ML techniques to improve the accuracy of our automated scanning and reduce manual effort.
- Provide assurance of the security of the CAMEO platform throughout development and at final release.

Description of work (where appropriate, broken down into tasks), lead partner and role of participants

Task 4.1. Classifying False Positives using Artificial Intelligence and Machine Learning

Edgescan uses manual validation to identify false positives in vulnerability scanning. These false positives are as a result of automated scanners not having enough context, nor sufficiently complex logic to identify true vulnerabilities. Being able to identify false positives using AI and/or Machine Learning would allow Edgescan to reduce the amount of manual work required to perform vulnerability scanning, while still retaining the required level of accuracy. Edgescan and UCD will work collectively on this task.

Task 4.2. Integrating Automated Scanning into CI/CD Pipelines

Continuous Integration and Continuous Delivery (CI/CD) allows software development teams to deliver new features and bug fixes at a very high frequency. Unfortunately such rapid, frequent changes make it difficult to ensure that the resulting code retains the desired level of security. CI/CD pipelines often include automated checks to ensure that the code meets some basic requirements. These can include automated tests to catch potential bugs and regressions, and also static analysis to detect certain vulnerabilities. Integrating Edgescan in the CI/CD pipeline would allow the code to be dynamically tested. This would require overcoming a number of technological challenges, for example:

- Reducing scan times. Most pipelines are expected to complete within 5 or 10 minutes. Staying within such a short time limit requires trading against potential coverage.
- Accessing a running version of the application. Containerisation can help with quickly deploying an instance of the application that can be dynamically tested.
- Minimising false positives. Since this is purely automated, the use of manual validation is not possible. This will possibly draw on the results of **Task 4.1**.

Task 4.3. Improving automated API scanning techniques

Currently API scanning requires some manual effort to cover certain types of vulnerabilities. This project would involve investigating how to automate the discovery of those types of vulnerabilities. Many of these vulnerabilities involve detecting authorisation issues, i.e. where certain resources can be accessed without the required credentials. These are difficult to automate, since they require a knowledge of what content should be available and what should be blocked. Being able to automate detection of these vulnerabilities would reduce the amount of manual effort required in scanning APIs. This project has some synergy with **Task 4.2**, as the ability to get good coverage on APIs automatically gives extra value to adding Edgescan to the build pipeline.

Task 4.4. Traditional Security Provision of CAMEO Architecture

Edgescan will provide traditional security services for CAMEO. This will include the following:

- Architecture review. Edgescan will provide advice on any security issues that should be considered at the design stage.

- Secure coding support. Edgescan will provide support to development teams on how to keep their code secure.
- Vulnerability management. Edgescan will onboard any developed applications into the platform. This will mean the applications will be scanned periodically for vulnerabilities using the standard Edgescan scanning methodology.
- Penetration testing. Edgescan will perform penetration testing on any developed applications. The reporting will be delivered through the Edgescan platform. The volume of pentesting will be based on the agreed scope.

Deliverables (brief description and month of delivery)

D4.1 Platform Architecture Security Report (M9)

D4.2 Initial Platform Security Report (M12)

D4.3 Interim Platform Security Report (M20)

D4.4 Final Platform Security Report (M26)

Milestones

MS4.1 CI/CD Pipeline Integration Proof of Concept (M11)

MS4.2 Automated API Scanning Techniques Implemented (M24)

MS4.3 Automatic False Positive Detection Deployment (M36)

Work package number	WP5		Start Date			M6		
Work package title	Training							
Participant number	1	2	3	4	5	6	7	
Short name of participant	UCD	VC	ES	Icon	TM	TW M	Dell Technologies	

Person/months	55 (-25)*	0	0	6	6	0	0
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Objectives:

- Compilation of needs of SME and public sector for EO-related key questions that EO could solve;
- Design of a set of generic short EO Data Services courses not currently served by existing courses;;
- Delivery of online/in person EO data services workshops Copernicus, Sentinel 2, Landsat;
- Delivery of customised training as identified;
- Provision of training in EO data standards, IT, data science, Machine Learning where appropriate
- Stratification of curriculum content for different learner groups: entry, intermediate, experienced;
- Integration of course material and learning objectives into UCD's Learning Management System (Brightspace);
- Establishment of an associated qualification/certificate

Description of work (where appropriate, broken down into tasks), lead partner and role of participants

This work package will be comprised of a number of tasks:

Task 5.1: Scope Setting and Stakeholder Engagement

The activity will involve a development activity with SMEs and organisations (e.g. IFA (Irish Farmers Association)) who are not necessarily using EO data currently but are operating in the key areas of Marine, Climate and Agriculture. This task will advocate for the usage of EO data in informing their activity and decision making. This will be achieved through a series of workshops and dedicated breakout rooms focusing on the needs of both SME industry and public organisations regarding the exploitation of EO data and barriers to using existing platforms and tools, with one to one meetings where necessary. Upskilling requirements will be identified where SMEs and public bodies could exploit EO data to create a significant marketable advantage but have, as yet, not been able to develop the tools to exploit these opportunities.

A gap analysis on available training resources will be performed against these needs. Subsequently, relevant UCD expertise will be identified, as will existing relevant pre-existing

courses within UCD (e.g. Advance courses in Soil) and elsewhere. Initial contact will be made for partnering with those providers (e.g. ESA, Copernicus Academy, others).

Task 5.2: Generic Training Activity:

The generic needs that are not currently served by existing courses nor provided by other partners will be developed into training course requirements. These requirements will be reviewed with industry and public sector as appropriate.

These course requirements will be developed into a course outline that will again be reviewed by key stakeholders. Finally these courses will be developed and trialled. Feedback from the courses will be incorporated and updated versions of the courses will be developed. Courses will be marketed where appropriate. The generic activity will be supplemented by the delivery of online/in person EO data services workshops using freely available data such as Copernicus, Sentinel 2, Landsat.

SAR and InSAR would be one such example and courses on such would be delivered by UCD experts. SAR is identified as a generic course as it is a significant gap in current available training nationally. There is limited national expertise and it is the most challenging data-types to use, yet of potentially most benefit to Ireland due to cloud-penetration of radar. There is low uptake and use among Irish SMEs and the public sector. Other existing UCD courses that may be modified to support a generic training programme include Remote Sensing and GIS.

Task 5.3: Customised Training Activity

Task 5.3 will develop and deliver bespoke training resources addressing specific a selection of critical stakeholder needs derived from **Task 7.1**. Content will be based on specific areas of interest to a smaller number of stakeholders. This will require undertaking limited R&D to develop content, tools and/or understanding to ensure the customised training delivers the required skills.

Task 5.4: Ancillary Training Activity

In the implementation of the SME and stakeholder needs, it is likely that other training needs [not directly EO] will be identified. These are expected to be in areas such as EO data standards, IT, data science, Machine Learning. These needs will be discussed with the stakeholders and a selection of critical needs will be targeted to develop courses in these areas.

Task 5.5: Integration within Learning Management System (LMS)/Virtual Learning Environment (VLE):

All curriculum offerings will have to be managed appropriately and delivered, there is a significant task in the delivery logistics for this course portfolio. The courses will be streamed by curriculum content for different learner groups: entry, intermediate, experienced. Subsequently, the course material and learning objectives will be integrated within UCD's Learning Management System (Brightspace) and an associated qualification/certificate established .

To maximise the impact of the training offered, some will be developed and delivered in partnership with the Space Industry Skillnet. Some structures and training content being developed as part of the HCI initiative in Digital Agriculture at UCD will be adapted to meet the needs identified among this SME community and relevant public sector bodies.

Deliverables (brief description and month of delivery)

D5.1 Curriculum design and content building for EO data Service short courses (M18)

D5.2 Integration of EO short courses into online learning management system (M23)

D5.3 Delivery of EO short courses (in-person & online) (M20, M25, M30, M32)

D5.4 Certification/accreditation of EO courses within UCD (M20)

Milestones

MS5.1 Training gap analysis report (M8)

MS5.2 User trials of EO generic short course (M12)

MS5.3 Customised training needs report (M10)

MS5.4 Ancillary training needs report (M15)

MS5.5 Training Report (M30)

Work package number	WP6		Start Date			M1		
Work package title	Innovation Management (Dissemination, Communication, Exploitation and Commercialisation)							
Participant number	1	2	3	4	5	6	7	
Short name of participant	UC D	VC	ES	Icon	TM	TW M	Dell Technologies	
Person/months	35	4	0	22	42	19	6	

Objectives

- To capture the project results and promote through dissemination;
- To evaluate and maximize CAMEO innovation impact via IP protection and communication with stakeholders;
- To analyse commercialization potential and business models before taking first steps to go to market

Description of work (where appropriate, broken down into tasks), lead partner and role of participants

To achieve the WP6 objectives and the overall Disruptive Innovation aim of CAMEO, WP6 will encompass the following activities:

Task 6.1: Knowledge Management: IP Protection and Dissemination – This activity will allow for exploitation of the results according to the appropriate channel. The aim is to capitalize on the innovations. This will be achieved by effective exposure of CAMEO capabilities to the EO community specifically and to accrue public interest in EO technologies in general.

Task 6.2: Stakeholder Communication: The partners will engage with the various consortium stakeholders aiming at attracting further investment in project outputs, growing the EO community in Ireland (both research and enterprise), and making the country an international attractor for EO innovation and business growth.

Task 6.3: Commercialisation and go-to-market Strategy: This activity is concerned with the preparation of the exploitation plan based on market analysis and evaluation of business models, in particular for the consortium SMEs. The consortium SMEs will engage with the lead partner throughout this WP to share their commercialisation experiences and assist in developing the best strategy for commercialisations at the end of the project. Examples of eventual commercial vehicles include: IP licensing, IP assignments, start-ups and spin-offs, joint ventures, and direct commercial use of IP developed in-house.

Deliverables

D6.1 IP Register (M3) - A consortium register of foreground IP including brief description, market opportunity, owner and type; this will be a *live* document for the duration of the project.

D6.2 CAMEO Centre Webpage creation and maintenance (M3)

D6.3 Dissemination and Communication Plan (M12) - A plan for dissemination and communication to the various stakeholders with brief description of channels and owners; this will be a live document throughout the duration of the project.

D6.4 Dissemination and Communication Register (M18) - Register of all dissemination and communication activities undertaken by the partners; this will be a live document throughout the duration of the project.

D6.5 Exploitation Plan (M34) - The Exploitation Plan will detail actions towards technology transfer for UCD and go-to-market plans for commercial partners.

D6.6 Sectoral dissemination use-case report - Showcasing CAMEO sectoral demonstrators (produced in WP7) (D6.6.1 Agriculture M21, D6.6.2 Marine M30, D6.6.3 Climate M35)

Milestones

MS6.1 Marketing collateral (M4)

MS6.2 Stakeholder analysis (M6)

MS6.3 Business-model analysis & GTM strategy (M30)

Work package number	WP7		Start Date			M4		
Work package title	EO Demonstrators							
Participant number	1	2	3	4	5	6	7	
Short name of participant	UC D	VC	ES	Icon	TM	TW M	Dell Technologies	
Person/months	61 (-8)*	9	0	52	60	57	0	

Objectives

- To engage with each sector to identify recurrent/generic sector specific service needs
 - Compile current offerings using EO info
 - Survey for new cases
 - Devise method for Service Discovery
- To develop demonstrators in three distinct sectors namely: Climate, Marine and Agriculture/Bioeconomy
 - To demonstrate CAMEO infrastructural support and capacity across distinct problems handling heterogeneity of scale, need, and sectoral maturity
 - To characterise and document the disruptive potential of CAMEO in terms of revenue/upscaling of capacity/client base, efficiency, costs, competitiveness:
 - A new approach to new market penetration arises from the use of an innovative Customer Service Discover (CSD)
 - Bridging the gap between current service offerings and existing and potential users.
 - Adding national datasets for all target jurisdictions to augment the service offerings.
 - Development of new methods of external validation of EO data.

Description of work (where appropriate, broken down into tasks), lead partner and role of participants

WP7 will comprise a number of discrete tasks.

Task 7.1: Establishment of Sector Specific Needs:

Lead partner Icon, participants TechWorks Marine, Treemetrics

Close collaboration with Enterprise Ireland's National Space Coordination Group, in particular the Earth Observation Working Group which will be established in 2021. These entities will provide the consortium partners (in particular the application SMEs) with a direct link to government agencies and organisations within Ireland to establish direct user needs and demand for the services being developed in this work package. The application SMEs will also engage directly with their current customer base in Europe and elsewhere to demonstrate the increased scale of the services provided.

Task 7.2: Formulation of the Use Case Process Chain

While use cases will inevitably differ this task will formalise a sequence of generic process steps that will underlie most use cases in the first instance. The exposing and making explicit of this process chain will help as a frame of reference for **Task 7.3** the generation of sector specific use cases. It will also help to make formal the mapping between this process and the CAMEO microservice catalogue and indeed facilitate service/functionality gaps. To deliver need to reduce friction and impedance at 6 discrete stages:

1. *Finding best images and/or data for a given location within a prescribed time window.* It is distinctly possible that certain sites will have no or limited. At a given site sampled from late 2019-2020 in Co Tipperary never had an optical image available.
2. *Processing the geospatial data so it can be used in a GIS and for quantitative interpretation.* Critical issue is making the data suitable for time series analysis. Time series analysis will be presented as vector based representations of the stack statics analysed. This will leverage the power of cloud based storage and analysis provided within CAMEO.
3. *Selecting part of geospatial data required for the county/farm/field of interest.* Note step 2 probably has to happen first to have stable and reproducible processing over a larger area than the region of Interest (RoI).
4. *Consultative Service Delivery (CSD) will also provide a pathway to selection of method/model to take geospatial data and create qualitative or quantitative information of value for the use case.* This is the key roadblock for generalizable tools unless step 2 is done correctly. Also difficult to find unique predictors for agriculture (as anything else)
5. *Package the information as knowledge for the sectoral end user.* Find a way to make it worth paying for.
6. *Define the delivery pathway to ensure the right knowledge at the right time and in the correct format.*

Task 7.3: Generation of use cases (climate, marine, agriculture):

Work package lead Icon together with Treemetrics and TechWorks Marine will work with other research and industry partners within the consortium, in driving the sector specific use cases in this WP, and the research partners will contribute to the data analytics/ML design and implementation aspects of the demonstrators.

The application SMEs respectively will develop demonstrators for forestry in the Agriculture/Bioeconomy area, marine in the Renewable Energy sector, and the determination of land use, habitat monitoring subsidy scheme management & change monitoring in agriculture and Green Deal related activities. Each application will be developed as a prototype for testing and validation during the MVP generation phase of the project. These demonstrators will be tested by a subset of stakeholders. Input and feedback from these trials will be used to optimise and further develop the applications. This will be an iterative process. Prototype applications will be deployed at the relevant milestones of the project.

Three specific sectoral demonstrators will be developed:

Climate: Climate is fundamental to many sectoral areas. The CAMEO climate EO demonstrator will address a number of areas including: longitudinal analysis of weather patterns to support investigation of climate change and the impacts of such; symbiotic relationships between for example land usage and climate and increasing demand for localised hyper-localised near-casting weather services to support agricultural interventions like crop spraying and harvesting. Weather attributes have been shown to correlate strongly with many environmental attributes by way of example precipitation impacts on bathing water quality through rain runoff containing animal effluent in the summer months. This demonstrator will seek to evidence and support such dependencies in a number of use cases. **Icon** will lead this demonstrator and has the capability to produce processing algorithms of all major image types, optical and non-optical. We have over 25 years experience in land use determination using EO data. We have been working with cloud-penetrating Radar, an essential dataset for working in Northern Europe data, since 2008.

Agriculture: A variety of Agtech services are envisaged including large area maps relating to regulation and governance (R&G), change detection maps - serving R&G such as farm habitat maps and farmers such as grass cover maps, small area quantity and quality maps - field maps of for example amount and attributes of standing crop; integration with recommender systems - and with other data to make recommendations for management, Integration with data systems - archival data for model development and historical record.

Treemetrics shall combine their extensive expertise in satellite data processing and offshore in-situ data collection and analysis to provide an integrated data solution for the forestry sector. With the growing interest in carbon sequestration, reliable estimates on carbon sequestered in forest areas is required by the forest industry and the national regulators. The use case shall focus on exploring operational applications of satellite and field data for forest change detection and carbon estimation. Additionally, Treemetrics proposes to use UAV, Terrestrial LidAR and field data to calibrate and validate the carbon estimations. This will allow improved monitoring of carbon in forest areas.

Marine : TechWorks Marine (TWM) shall combine their extensive expertise in satellite data processing and offshore in-situ data collection and analysis to provide an integrated data solution for the Marine Renewable Energy (MRE) sector. With the growing interest in offshore wind energy, reliable estimates on available wind energy and sea-surface/significant wave heights are a necessity throughout the planning and operational phases of MRE development. The use case shall focus on exploring operational applications of satellite data in the MRE sector, i.e. wind and sea/wave height monitoring. Additionally, TechWorks Marine propose evaluating and validating data from the latest altimetry mission launched in November 2020, Sentinel-6. Sentinel-6 uses radar altimetry with SAR capabilities which can measure the sea-surface height with greater precision thus achieving a spatial resolution of 300m compared to previous missions that covered several kilometres of the ocean surface. By performing validation activities on the latest Sentinel-6 mission and the high-resolution Sentinel-1 OCN products, **TWM** shall provide products vital to marine infrastructure design, marine insurance, climate change models and offshore MRE development. We will also demonstrate the value of utilising and combining satellite and in-situ data in support of both research and operational renewable energy applications.

Task 7.4 Further use case development (climate, marine, agriculture):

Other opportunities to develop use cases will be explored during the second half of the project term. These will build upon platform development and research performed by the SMEs and research partners, and will expand the platform portfolio beyond the specific use cases described here.

Task 7.5: Commercialisation:

As part of the commercialisation plan, TechWorks Marine and Treemetrics will participate in multiple export development missions overseas through Enterprise Ireland. Opportunities for service development and optimisation provided through funding calls by ESA, EUMETSAT and national funding agencies will also be examined and exploited to build up the capacity and extend the reach of the platform. This will be linked closely to **(WP6)** Innovation Management work package led by **UCD**.

This will be augmented by direct B2G activities by the SME partners.

Engagement:

- Service Discovery will be used to achieve customer buy-in. It is unlikely that there will be any producer-based requirements outside of the forestry sector. For annual crop, habitat monitoring and marine monitoring it is likely that the customer will be an official body or NGO; the growth potential is in reaching new agencies that have not used EO information and extending the service offerings to existing agencies, both in the extension to existing services and the roll out of new use cases. Early research in this approach has already yielded small scale commercial results.
- Initial polling outside Ireland has produced a positive response from relevant agencies in other EU Member States. It is important to stress that this CSD concept is designed to work in international contexts, and initial consultations have already included non-Irish potential consumers.
- The commercial opportunity here is not with farmers but with large food producers that need information in relation to current farming activity and potential yields/problems. Equally, on the input side the potential is with service and product suppliers to the farming community - for example, fertiliser suppliers.

Disruptive potential:

Disruption will be achieved through the seeking out of customers through deep dive engagement in needs analysis. The focus of this approach is on the customer and the customer's problems, not on the provision of the EO information. It is very likely that EO information will be bundled with other datasets like the National Datasets proposed in this application and also other inputs. For example, in a pilot on fodder availability EO information was combined with both Meteorological data and a route optimisation capability to deliver a comprehensive solution that none of the data inputs provide in isolation.

Deliverables (brief description and month of delivery)

D7.1 Report on State of the Art for DIAS and other existing platforms (M5);

D7.2 Report identifying recurrent/generic sector specific service needs and Gap Analysis (M8);

D7.3 Development of sectoral demonstrators (D7.3.1 Agriculture M22, D7.3.2 Marine M28, D7.3.3 Climate M31);

D7.4 Development of demonstrator case study documentation (D7.4.1 Agriculture M24, D7.4.2 Marine M30, D7.4.3 Climate M33);

D7.5 Final release of sectoral demonstrators (D7.5.1 Agriculture M36, D7.5.2 Marine M36, D7.5.3 Climate M36)

Milestones

MS7.1 Identification of Generic and Sector Specific Service Needs (M8)

MS7.2 Development and Showcasing of Agriculture Sector Demonstrator (M24)

MS7.3 Development and Showcasing of Marine Sector Demonstrator (M28)

MS7.4 Development and Showcasing of Climate Sector Demonstrator (M33)

Resources assigned to work packages should be in line with their objectives and deliverables. You are advised to include a distinct work package on 'management' and a distinct work package on 'commercialisation (dissemination and exploitation)' and communication activities.

Table 3. List of Deliverables

Deliverable (number)	Deliverable name	Work package number	Short name of lead participant	Type	Delivery date
D0.1	Risk register	0	UCD	OTHER	M1
D0.2	Quality-assurance plan	0	UCD	R	M2
D0.3	Project management report	0	UCD	R	M12

D0.4	Project management report	0	UCD	R	M24
D0.5	Final report	0	UCD	R	M36
D1.1	Data Warehouse Design Document	1	Dell	DEM	M8
D1.2	Metadata Repository	1	Dell	OTHE R	M11
D1.3	Implementation of CAMEO Data Warehouse Iterative Releases: Initial (D1.2.1), Interim (D1.2.2), Final (D1.2.3)	1	Dell	DEM	M12, M18, M27
D2.1	Design of CAMEO EO Software platform Architecture	2	VC	DEM	M8
D2.2	Design, Implement and Test EO MicroServices catalogue	2	VC	DEM	M10, M18, M26
D2.3	CAMEO EO Software Platform Iterative Releases (Initial, Interim, Final)	2	VC	DEM	M11, M20, M35
D2.4	Design and Implement Data Brokerage Service	2	VC	DEM	M19
D2.5	Design and implement Intelligent Data Analytics Services	2	VC	DEM	M17, M32
D3.1	Design of Data Quality Adjudication Framework	3	UCD	DEM	M19
D3.2	Design and Implementation of Data Quality Filter	3	UCD	DEM	M24

D4.1	Platform Architecture Security Report	4	ES	R	M9
D4.2	Initial Platform Security Report	4	ES	R	M12
D4.3	Interim Platform Security Report	4	ES	R	M20
D4.4	Final Platform Security Report	4	ES	R	M26
D5.1	Curriculum design and content building for EO data Service short courses	5	UCD	DEM	M18
D5.2	Integration of EO short courses into online learning management system	5	UCD	DEM	M23
D5.3	Delivery of EO short courses (in-person & online)	5	UCD	OTHE R	M20, M25, M30, M32
D5.4	Certification/accreditation of EO courses within UCD	5	UCD	OTHE R	M20
D6.1	IP Register	6	UCD	DEC	M3
D6.2	CAMEO Centre Webpage creation and maintenance	6	UCD	DEC	M3
D6.3	Dissemination and Communication Plan	6	UCD	DEM	M12
D6.4	Dissemination and Communication Register	6	UCD	DEC	M18
D6.5	Exploitation Plan	6	UCD	DEC	M34

D6.6	Sectoral dissemination use-case report - D6.6.1 Agriculture, D6.6.2 Marine, D6.6.3 Climate	6	UCD	R	M21, M30, M35
D7.1	Report on State of the Art for DIAS and other existing platforms	7	Icon	R	M5
D7.2	Report identifying recurrent/generic sector specific service needs and Gap Analysis	7	Icon	R	M8
D7.3	Development of sectoral demonstrators - D7.3.1 Agriculture, D7.3.2 Marine, D7.3.3 Climate	7	Icon	DEM	M22, M28, M31
D7.4	Development of demonstrator case study documentation - D7.4.1 Agriculture, D7.4.2 Marine, D7.4.3 Climate	7	Icon	R	M24, M30, M33
D7.5	Final release of sectoral demonstrators - D7.5.1 Agriculture, D7.5.2 Marine, D7.5.3 Climate	7	Icon	DEM	M36

Deliverable numbers in order of delivery dates. Please use the numbering convention <WP number>.<number of deliverable within that WP>. For example, deliverable 4.2 would be the second deliverable from work package 4.

Delivery date: Measured in months from the project start date (month 1)

Type: use one of the following codes:

R: Document, report (excluding project periodic or final report)

DEM: Demonstrator, pilot, prototype, plan designs

DEC: Websites, patents filing, press & media actions, videos, etc.

OTHER: Software, technical diagram, etc

Table 4. List of Milestones

Milestone number	Milestone name	Related work package(s)	Due date	Means of verification
MS0.1	Scientific Advisory Board and the Technical Development Committee are complete	0	M6	Meeting minutes
MS0.2	Review with the Scientific Advisory Board	0	M12	Report
MS0.3	Review with the Scientific Advisory Board	0	M24	Report
MS0.4	Final review with the Scientific Advisory Board	0	M36	Report
MS1.1	Refinement of Requirements complete	1	M3	Report
MS1.2	Review of SOA DW Designs complete	1	M6	Report
MS1.3	Initial Data Schema and Model complete	1	M8	Schema Document & Software
MS1.4	DW Technology determined	1	M10	Report
MS2.1	CAMEO EO Software Platform Release (Initial)	2	M11	Platform release
MS2.2	CAMEO EO Software Platform Release (Initial)	2	M20	Platform release

MS2.3	CAMEO EO Software Platform Release (Initial)	2	M35	Platform release
MS3.1	Delivery of Data Quality Filter	3	M24	Software
MS4.1	CI/CD Pipeline Integration Proof of Concept	4	M11	Software
MS4.2	Automated API Scanning Techniques Implemented	4	M24	Software
MS4.3	Automatic False Positive Detection Deployment	4	M36	Software
MS5.1	Training gap analysis report	5	M8	Report
MS5.2	User trials of EO generic short course	5	M12	Training Course Delivery and Participant Feedback
MS5.3	Customised training needs report	5	M10	Report
MS5.4	Ancillary training needs report	5	M15	Report
MS5.5	Training Impact Report	5	M30	Report
MS6.1	Marketing collateral	6	M4	Report
MS6.2	Stakeholder analysis	6	M6	Report
MS6.3	Business-model analysis & GTM strategy	6	M30	Report
MS7.1	Identification of Generic and Sector Specific Service Needs	7	M8	User Requirements Specification

MS7.2	Development and Showcasing of Agriculture Sector Demonstrator	7	M24	Software & Documentation
MS7.3	Development and Showcasing of Marine Sector Demonstrator	7	M28	Software & Documentation
MS7.4	Development and Showcasing of Climate Sector Demonstrator	7	M33	Software & Documentation

Estimated date: measured in months from the project start date (month 1)

Means of verification: show how you will confirm that the milestone has been attained. Refer to indicators if appropriate. For example: a laboratory prototype that is 'up and running'; software released and validated by a user group; field survey complete and data quality validated.