Microsoft

InterWork Alliance
A Global Blockchain Business Council Initiative

Digital MRV Framework

Digital Measurement, Reporting & Verification Framework

Foreword

To stabilize the global climate system the world must drastically reduce carbon dioxide and other greenhouse gas (GHG) emissions. But reductions won't be enough. As a global society we must also remove large amounts of carbon from the atmosphere, to avert the worst social, economic, and environmental impacts of a rapidly changing climate. Failure to achieve carbon removal at scale makes limiting warming to 1.5 degrees Celsius via reductions infeasible.

This provides the impetus for all entities committed to climate action to take what is currently an immature market for negative emissions technologies—or carbon removal—and expand it as quickly as possible.

This priority is a crucial part of Microsoft's carbon negative commitment that we announced in January 2020 and why we started to build our carbon removal program last year. While we believe that projects that help avoid emissions are crucial, we are exclusively focused on those that remove carbon from the atmosphere. The reason is simple: looking ahead 10 years shows we simply can't meet our global climate goals without carbon removal.

This effort requires collaboration among many participants contributing to an ecosystem designed to create high quality carbon removals, based on scientifically verifiable claims in quantities far exceeding what is available today. This will be an "all hands-on deck" effort where it is vital to reduce friction in markets while also establishing standard processes that encourage innovation from a wide variety of contributors.

Microsoft, in collaboration with Aker Carbon Capture, Carbon Asset Solutions, ClimateCHECK, ESMC, Gold Standard, Ørsted, Patch, Puro.earth, SustainCERT and Verra as well as the Nation of Colombia are exploring this Digital Measurement, Reporting and Verification Framework to encourage this acceleration in the removals market.

Executive Summary

Carbon removal is far from mainstream. For more than a decade, the corporate world has met its climate commitments primarily by offsetting carbon dioxide and other greenhouse gas (GHG) emissions by purchasing "credits" from projects that *avoid* or *reduce* emissions, like renewable/efficiency projects, and avoided deforestation. Due to a lack of focus in the past, science-based carbon removals from both natural and technological projects require further development in standards and protocols for making provable claims. Although the development of these standards and protocols are underway in areas like Agriculture, Forestry and Technology based Carbon Capture, progress must be made more quickly.

To scale the removals market so that it produces high quality products from a wide variety of sources and lowers the cost of creating them, there needs to be a Data and Process Standard that defines how to package evidence in verifiable claims from MRV solutions. These claims can then feed into an open ecosystem that can provide independent verification of these claims at a lower cost and a faster time to market.

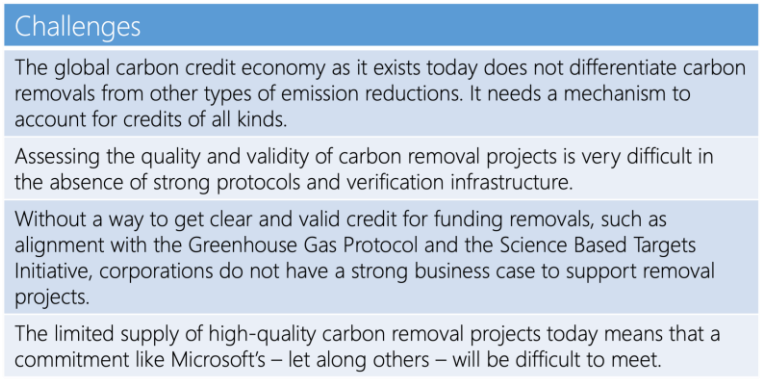


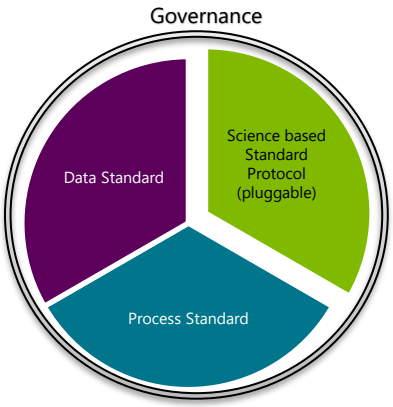
Figure 1- "Microsoft Lessons from an Early Corporate Purchase"
https://query.prod.cms.rt.microsoft.com/cms/api/am/binary/RE4MDlc

The Digital MRV Framework, defines the terminology, roles, process, generic evidence packaging and attestation that digital MRV solutions follow to make standard claims. The framework can better enable investments in and generation of high quality, well-documented removals at scale. This framework defines variables that enable its application and use for a wide variety of standards, protocols, and technology to be used in combination to create high quality claims, ready for validation and verification. A harmonized, standardized framework agreed to by market participants will enable investors, buyers, and society to ensure the credibility and integrity of outcomes, particularly in a market operating at scale, while maintaining rigor and the necessary documentation and evidence to indisputably track impacts. Additionally, the framework, when implemented, can ensure that double-counting and double-crediting do not occur – to ensure market integrity.

Framework

The Digital MRV Framework provides the high-level, implementation neutral specification for creating a solution that issues standardized claims into an open ecosystem for validation, verification, and crediting. This framework builds off the published "Voluntary Ecological Markets Overview" standard[1] from the InterWork Alliance and will be contributed back to the open standards community enhancing global agreement on terms, definitions, and basic understanding of the process for creating a carbon removal credit.

This framework brings Process, Data, and interchangeable science-based Quality Standards together that can operate under a governance framework to facilitate adjustments, ensure diversity, inclusion and a level playing field.



Although this framework is specifically targeted for Carbon Removals, it can be used for other types of ecological claims like water or nitrogen.

Framework Components

The framework defines components that represent roles, process artifacts and subsystems that work together to package evidence in a claim that can be independently verified following a Process Standard. Each of these components is a placeholder or variable that is replaced with a specific actor, artifact or subsystem allowing the framework to be generic and support a wide and diverse set of implementations.

For example, solutions using the framework for soil carbon sequestration through agricultural practices would have different standards and sources of evidence than a direct air capture program, but each solution would create a standard claim that plugs into a standard process.

[1] https://interwork.org/wp-content/uploads/2021/05/Voluntary_Ecological_Markets_Overview_Revised.pdf

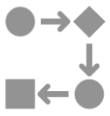
Implementation Network
A shared set of infrastructure where the Data and Process standards are implemented that provides storage, compute, ledgering and other capabilities for all participants.

Ecological Project or Program (EP)
Is the identity and metadata about a program or project that will be conducting the work and providing the evidence for issuing an ecological claim of carbon removal.

Modular Benefit Project (MBP)
An Ecological Project/Program (EP) can have multiple MBPs, where each MBP represents the type of ecological claim being issued. For example, an EP may want to create claims for carbon removal and water, thus having an MBP for each.

Accounting & Certification Standards (Standard Registry):
An organization that creates and certifies science-based standards, i.e., protocols, for measuring environmental impacts and benefits. In this context, these organizations, typically called a Registry, govern a protocol, certify VVBs to verify claims based on the protocol and issue credits off these validated and verified claims.

Quality Standard
Requirements for measuring outcomes, based on approved methodologies or protocols, that results in high quality credits being issued. A Quality Standard can encompass a Standard Protocol as well the certification requirements for a VVB.



Standard Protocol (Methodology)
A science-based standard, often called a methodology, for making a claim like carbon removal. A protocol is specific to the type of activity and can vary based on its location, time, duration, etc. It defines the kind, amount and frequency of evidence collected from required source(s) and formulae for using the evidence to determine the values of the claim. For example, determining the amount of carbon removal as well as other attributes like durability, additionality, co-benefits, etc.

Validation & Verification Body (VVB)
An organization that is certified to validate and verify claims based on a standard, to ensure that the protocols and methodology was followed and that the evidence collected supports the claim.

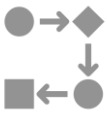
Verification Contract
Is a "Smart Contract" between the Modular Benefit Project, Standard (registry) and the VVB for the claims process. Here the T&Cs of the verification process are agreed to and documents. All artifacts in the claim process are linked to this contract. The MBP may choose to switch standards or VVB and create a new contract for verification.

Ecological Claim
Is made by a Modular Benefit Project, based on the science-based standard using the prescribed methodology and protocols required to generate the necessary evidence for validation of the claim.

Claim Source
Is a registered source of claim data that can be raw source data from a device/sensor or a device/user/application and 3rd party reference data like satellite images or remote sensing. These sources are registered with the Ecological Claim as valid sources of evidence.

Claim Checkpoint
A submission of prescribed evidence data made towards an ecological claim based on a cadence or schedule required by the standard methodology or protocol being followed. An ecological claim is made of a collection of checkpoints.

Span Data Package (SDP)
Contains evidence data from one or more registered sources that is used to create a claim checkpoint. Sources may be 1st party, automated, application/device or reference data. The SDP is immutably stored, and its cryptographic fingerprint is recorded in the claim checkpoint.



Digital MRV Solution
An implementation of this framework that follows a protocol using a combination of technical devices, services, data sources and applications to automate as much of the claim creation process as possible. The solution is integrated with the Implementation Network by creating ecological claims and submitting checkpoints for the MBP implementing it.

Processed Claim
Once an ecological claim is submitted for verification, the verifier (VVB) will lock the Ecological Claim it is verifying and once complete will create a processed claim, retiring the ecological claim, with the verification findings used to justify the creation of a credit based on the claim.

Ecological Benefit Token: Carbon Removal Credit
An issued digital asset, from a processed claim, that represents a quantity in mtCO2e of carbon removal. These credits are issued by an issuing authority and once issued the Processed Claim is finalized. This credit is cryptographically linked to its processed and ecological claim sources for full transparency.

Framework Component Dependencies

Framework components have dependencies or relationships with other components. For example, a Modular Benefit Project (MBP) is dependent on the Standard Protocol chosen in which to base its claims on. The VVB selected must be certified to verify claims for the Standard the MBP is using.

Of note, Carbon Credits and other Ecological Benefit products are used to offset or remove, in this case, carbon to net effective emissions downward. The action of using a credit is commonly referred to as retirement. In this framework, the credit is derived from an ecological claim and its progression through the validation and verification process. As a claim progresses through its lifecycle and moves on to the next stage, it is finalized, which means it is made permanently read-only and linked to is successor.

The framework dependency map:

EP -> MBP
The MBP is a child entity of its parent Ecological Project or Program (EP).

MBP -> Quality Standard
The MBP is bound, or contracted, to follow a standard in which to form and create its ecological claims.

VVB -> Quality Standard
The VVB must be certified to validate claims for the Quality Standard bound to the MBP.

MBP -> Standard Protocol - > Ecological Claim
The Ecological Claim is a child of its parent MBP and is based off the Standard Protocol in the Quality Standard.

MBP -> VVB -> Quality Standard -> Verification Contract
A Verification Contract has signatories representing the MBP, VVB and Quality Standard participating in the claims process.

Claim Source -> Ecological Claim
Sources of evidence collected are registered with the Ecological Claim.

Claim Checkpoint -> Ecological Claim
Claim Checkpoints are children of an Ecological Claim which maintains a collection of checkpoints and sources.

Claim Sources -> Span Data Package
Only registered claim sources are allowed to have their data included in the Span Data Package.

Span Data Package (SDP) -> Claim Checkpoint
The SDP is the input to create a Claim Checkpoint.

Ecological Claim -> VVB
Once completed the Ecological Claim is encumbered or locked by the VVB once the verification process begins.

VVB -> Processed Claim
Once the claim has been processed the Processed Claim is created by the VVB.

Processed Claim -> Ecological Claim
The Ecological Claim is “finalized” once the Processed Claim is created, the two claim states become cryptographically linked.

Processed Claim -> Standard (Registry)
The Standard (Registry) is notified when the Processed Claim is created.

Standard (Registry) -> Carbon Removal Credit
The Standard (Registry) conducts a final quality check on the Processed Claim and then Issues a Carbon Removal Credit and finalizing the Processed Claim.

Carbon Removal Credit -> Processed Claim
The Carbon Removal Credit is cryptographically linked to the finalized Processed Claim

Artifact Details

Verification Contract

The Verification Contract is a "Smart Contract" between the MBP (Ecological Project), Standard Registry and VVB for the creation, verification, and issuance of credits for claims made under the contract. Every artifact created in this process is linked back to the Verification Contract.

The details like the Quality Standard and Version are all agreed to by the signatories of the contract. An MBP may choose to switch standards or VVB, which would require a new Verification Contract to be executed and the old contract archived.

Span Data Package

A span data package is a file package (.zip, etc.) that contains data from multiple registered sources that is to be stored as evidence for a claim. It is up to the digital MRV solution as to the actual data format(s) so long as it is agreed to and understood by the parties involved in the verification process.

Claim sources are registered with the Ecological Claim and provided an Id, this Id is used to validate and verify that the data contained within the SDP is from the registered source.

Example claim sources that can be registered:

- IoT Sensors
- Reference Data (Satellite, Remote Sensing, etc.)
- In-person application/device/human

Each SDP will have an evidence header file that lists the sources and their files contained in the package:

- Source ID and Signature
- Data from Source

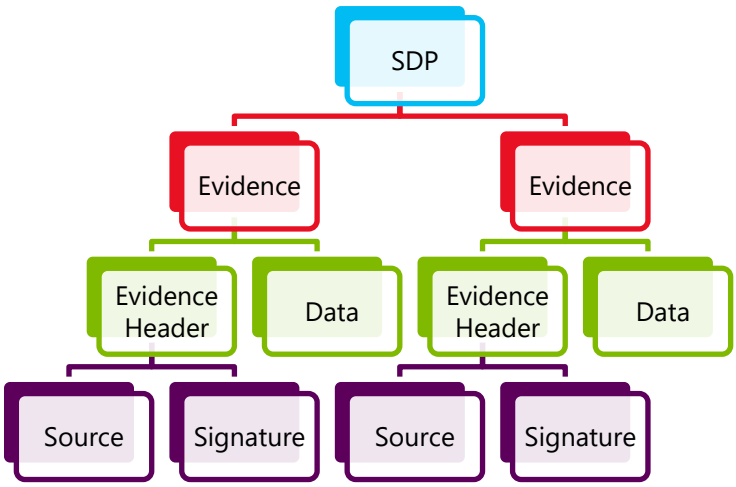


Figure 2 - Source Data Package

Claim Checkpoint

Once the digital MRV solution creates an SDP, it will need to submit it to the Ecological Claim as a Claim Checkpoint. A Network Implementation can expose a Claims API where the SDP can be submitted as a checkpoint that will securely store the SDP and create a cryptographic fingerprint for the SDP that becomes a receipt embedded in the checkpoint.

This process is outlined in the Ecological Claims portion of this document.

Ecological Claim

The Ecological Claim is the standard foundation for Digital MRV solutions to create and submit a claim on the implementation network. It has metadata about the claim and collections of children like sources, checkpoints, and co-benefits.

The Ecological Claim, once all the prescribed checkpoints are received, is then encumbered, or locked by the VVB upon notification of finalization of the claim. This prevents an Ecological Claim from being processed by more than one VVB.

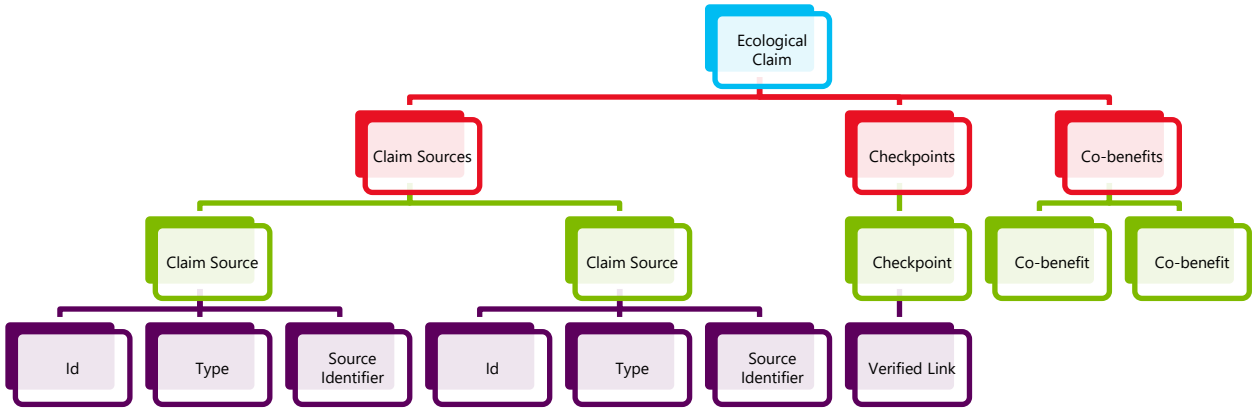


Figure 3 - Ecological Claim

Processed Claim

The processed claim is created by the VVB to record its findings during the validation and verification process. Once the processed claim is completed, the VVB finalizes the Ecological Claim.

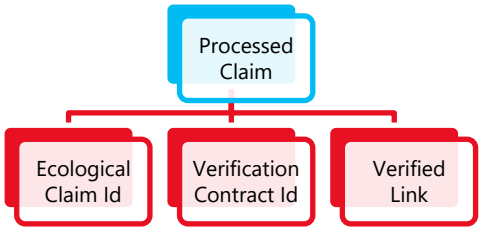


Figure 4 - Processed Claim

Ecological Benefit Token: Carbon Removal Credit

The IWA VEM Overview generically describes a tokenized value representing an ecological benefit token. There are two types of standard carbon credits in the IWA specification:

- Core Carbon Principles token (CCP) – can represent either a reduction or a removal of carbon and is a fungible with other CCP tokens.
- Carbon Removal Unit token (CRU) – is for removals only and is non-fungible with other tokens of any type.

These two types of tokens largely share the same schema and are used to test market hypothesis from various participants about concentration of liquidity. Which is not covered in this framework.

The credit that is issued by the Standard Registry upon final verification of a Processed Claim, finalizes that Processed Claim. This creates a chain of linage from the issued credit to its Processed Claim and to the source Ecological Claim.

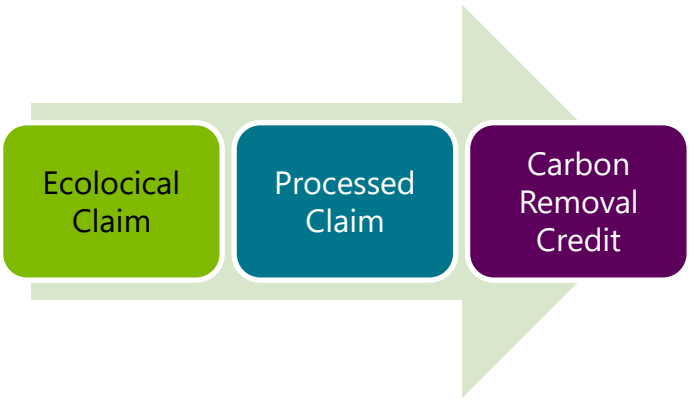


Figure 5 - Carbon Removal Credit Generation

Framework Process Flow

Components in the framework work together following a process that generates artifacts documenting and attesting each step along the way. Participants in this process are actors fulfilling a role in the process contributing data, verification and attestation that is cryptographically and immutably recorded by the network implementation.

Process:

1. An Ecological Project creates a Modular Benefit Project
2. The Modular Benefit Project selects a Standard Protocol to "bind" to that establishes the Protocol and Methodology it will follow to create Ecological Claims.
3. A Verification Contract is executed between the participating parties, MBP, Standard Registry and VVB.
4. A Digital MRV solution is selected and deployed to collect evidence and build SDPs in accordance with the protocol prescribed.
5. The Digital MRV creates an Ecological Claim to begin the evidence collection and checkpointing process.
6. The Digital MRV collects the evidence from 1st party and reference sources as prescribed by the protocol and builds a Span Data Package.
7. The Digital MRV submits a checkpoint using the SDP built to the implementation, based on the cadence for checkpoints prescribed by the protocol.
8. After the last checkpoint, the claim is "finalized", and notification is sent to the VVB according to the Verification Contract.

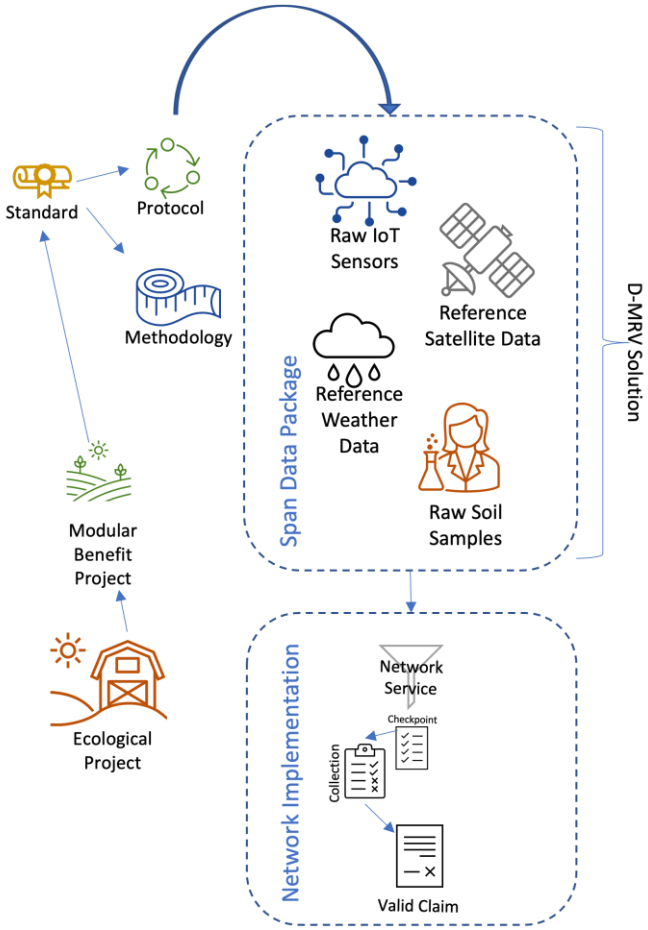


Figure 6 - Framework Process

Protocol to Digital MRV Mapping

A Digital MRV solution needs to follow a Standard Protocol for its implementation, and it would be optimal for protocol developers to be aware of this framework and able to prescribe evidence collection methods and checkpoint cadence for the building of Ecological Claims.

For example, protocol developers can prescribe:

- A data source: a device, an application or reference data that can provide evidence to support the claim.
    - Specify the data source identity parameters required for the source to be registered to submit valid evidence. Can include device identifiers, application certificate, user identifiers, geolocation and time stamps, reference data URL with data hash, etc.

    - The data format of the evidence a registered source should submit, including if the data should be digitally signed. This can include the data type, i.e., file extensions, meta-data, etc.
    - Specify the cadence which evidence should be included in a Span Data Package for submission as a checkpoint.
- Establish a cadence for claim checkpoints for building the Ecological Claim over time. These can be event-based checkpoints, i.e., agricultural event between crop rotations, or time based, i.e., every day/week/month.

Moving Forward

Continued collaboration is required to both improve and continuously refine this framework so that it can help establish a common understanding of the Process and Data standards needed to support interchangeable Quality Standards. This modular approach to standardization along with a foundation based on common terms and shared data descriptions should aid in the development of new Quality Standards for carbon removals in the future.

We hope that by donating this framework to the InterWork Alliance and interested parties, it will continue to evolve and improve into many implementations across a diverse set of innovative carbon removal projects.