Green x Digital Consortium

Green x Digital Consortium

Technical Specifications for Data Exchange

Version 1.0

4th August 2023

Green x Digital Consortium

Data Visualization Project

Data Format and Exchange SWG

Contents

1. Introduction

1.1. Document status

This document presents an ideal common data format and data platform for the CO2 data that should be shared across the supply chain using digital technology.

It was created by the Data Format and Exchange Sub-Working Group, which operates under the Green Digital Consortium's Visualization Working Group.

The Visualization Working Group seeks to build a mechanism to promote the visualization of CO2 data across the entire supply chain and appropriately reflect emission reduction efforts as data. As shown in Figure 1, two sub-working groups have been created under its auspices: the Methodology Sub-Working Group, which is tasked with investigating calculation methods for the CO2 data that should be shared across the supply chain using digital technology, and the Data Format and Exchange Sub-Working Group, which is tasked with examining a common data format and data platform where that CO2 data is exchanged using digital technology.

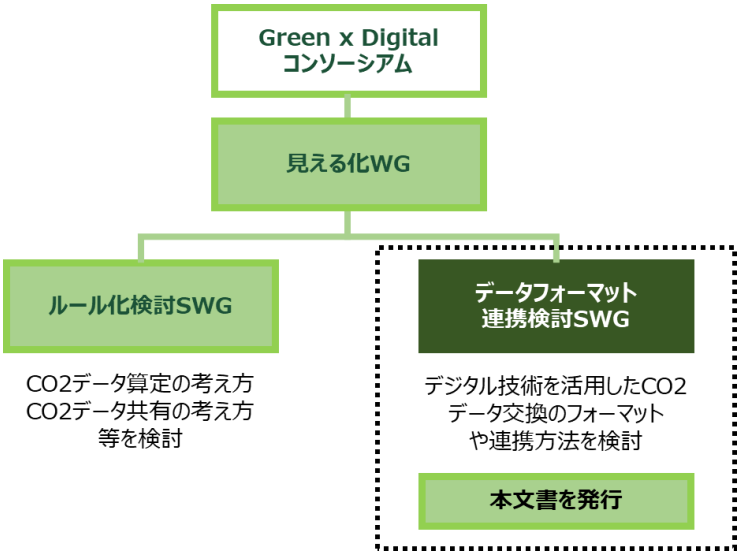

Fig. 1 Data Format and Exchange SWG and the status of this document

The main authors of this document were the leader and subleaders of the Data Format and Exchange SWG based on the results of the SWG's considerations. With cooperation from SWG members, it addresses the following:

(a) Approach to a common data format and detailed specifications
(b) Approach to a data exchange format

Members of the Data Format and Exchange SWG are shown in the following table.

Table 1 Companies comprising the Data Format and Exchange SWG

Leader	Fujitsu
Subleaders	NTT DATA, Nomura Research Institute
SWG members	IHI, Asuene, Amazon Web Services Japan, SBI R3 Japan, NTT DATA, KACOMS, Zero Board, chaintope, Deloitte Tohmatsu

	Consulting, Toshiba, Nagase Sangyo, Nitto Denko Corporation, NEC, Nomura Research Institute, Panasonic Holdings, Hitachi, PwC Consulting, Mitsui, Ricoh

1.2. Background

There is a strong call for to achieve decarbonization throughout supply chains in all industries so as to realize carbon neutrality by 2050. This will require the accurate assessment and reduction of emissions not just by individual companies (Scope 1 and 2) but across the supply chain, including both upstream and downstream emissions (Scope 3).

Particularly for Scope 3 Category 1 (Purchased goods and services) CO2 emissions, the most common calculation method is to multiply procurement value and volume by the particular industry's average carbon intensity, but the inability of this method to reflect supplier efforts to reduce CO2 emissions has led to a growing call to acquire CO2 emissions data from suppliers. This, however, presents two major challenges.

First, the lack of a common methodology for calculating CO2 emissions that assumes the provision of data from suppliers results in disparities in data quality.

Second, while multiple carbon visualization solutions are being developed, there is no common data format or interface, etc., for exchanging data among different solutions, so when different solutions are used within the supply chain, it becomes difficult to gauge emissions across the whole chain.

Consequently, as noted above, the Green x Digital Consortium's Visualization Working Group established the Methodology SWG and the Data Format and Exchange SWG. The Methodology SWG created the "CO2 Visualization Framework," which lays out calculation methods for CO2 data to be shared using digital technology, as well as items to be disclosed when that data is shared. The Data Format and Exchange SWG has considered a common data format and data platform for use when CO2 data is exchanged using digital technology, creating this document.

Further, based on the CO2 Visualization Framework and this document, the Green x Digital Consortium plans to conduct a proof-of-concept experiment from late 2022 into early 2023 to confirm whether emissions data calculated by companies from a wide range of industries using a common method can be exchanged across different solutions so as to gauge supply chain carbon emissions accurately and efficiently. (The PoC experiment[1] will comprise technical verification in relation to data linkage in Phase 1 and practical verification with the participation of user companies in Phase 2, CO2 calculation included.

1.3. Purpose

This document comprises Version 1 of common tech specs for data exchange among different solutions during Phase 2 of our PoC experiment, provided for the reference of solution providers.

After the PoC experiment has been completed, the document will be updated based on the results. Where changes are made to the specs in the frameworks referred to in this document, the document too will be updated as necessary.

1.4. Target

This document targets the CO2 data which the Green x Digital Consortium has concluded should be shared throughout the entire supply chain using digital technology.

[1] PoC experiment press releases: https://www.gxdc.jp/pdf/press_release221209.pdf (Dec. 9, 2022)
https://www.gxdc.jp/pdf/press_release230215.pdf (Feb. 15, 2023)

The Methodology SWG concluded in its CO2 Visualization Framework that Green x Digital Consortium calculation methods would be set out for both product-level and organization-level calculations, taking as their premise of the product-level calculations recommended in the Pathfinder Framework developed by the WBCSD Partnership for Carbon Transparency (PACT)[2], which, like the Scope 3 Standard, are international platforms/frameworks for supply chain CO2 data exchange that have attracted attention in recent years, while also accepting the organization-level calculations that are currently in widespread use.

While this document consequently focuses on the recommended calculation data based on product data, it also adds supported attributes for organization data-based calculations, an approach unique to the Green x Digital Consortium.

As the Methodology SWG is charged with considering calculation methods for the CO2 data to be shared throughout the entire supply chain using digital technology, as well as disclosure items when data is shared, these aspects will not be addressed in this document. Please refer to the CO2 Visualization Framework issued by the Methodology SWG.

[2] WBCSD Partnership for Carbon Transparency (PACT)
The World Business Council for Sustainable Development (WBCSD) is a CEO-led community of around 200 sustainable businesses that convenes the Greenhouse Gas Protocol. The Partnership for Carbon Transparency (PACT) works under the auspices of the WBCSD to make value chain emissions more transparent and accelerate decarbonization. It defines the methodological and technical foundations necessary for emissions data exchange and issues these as part of the Pathfinder Framework and the Pathfinder Network. The Green x Digital Consortium participates in the PACT ecosystem as a collaborator. Website: https://www.carbon-transparency.com/

2. Common data format

2.1. Purpose

Accurately gauging CO2 emissions throughout the entire supply chain (particularly Scope 3 emissions) will be vital in achieving supply chain decarbonization on a global basis. In particular, while using primary data from supplier firms is vital in calculating Scope 3 emissions so as to reflect supplier efforts to reduce emissions, the data provided by these suppliers is currently quite diverse according to recipient company use cases and to the CO2 visualization solutions used by the various companies supplying and receiving that data. At the same time, the WBCSD PACT Pathfinder Framework and Pathfinder Network are leading the way internationally in terms of frameworks for supply chain CO2 data exchange, and consideration must be given to interoperability internationally as well as among different types of systems so as to reflect activity across the global span of supply chains.

Consequently, in this document, the Data Format and Exchange SWG set out to provide a common data format contributing to the communication of CO2 data that is within the means of small and medium enterprises in the supply chain and that will enable international data exchange and linkage.

2.2. Policy

One method of creating a common data format would be to analyze data items in existing visualization solutions and set these items as the least common multiples. Another would be to create a common data format to realize the content of the CO2 Visualization Framework produced from Methodology SWG considerations. In addition, the Visualization Working Group is examining data utilization, and yet another approach would be to prepare common data items to realize that data utilization. Looking internationally, WBCSD PACT released v1.0.0 of the technical specifications of the Pathfinder Network[3] on June 16, 2022, laying out common data items for data sharing. Given the above, these guidelines select common data items based on the following perspectives:

- Data items to be based on the content of the CO2 Visualization Framework produced by the Methodology SWG.
- Because supply chains are global in nature, items to be consistent with international activities. Specifically, consider linkage with the Pathfinder Network and related documents (Use Case 001, etc.).
- Consideration also to be given to data utilization by solution users.

The Methodology SWG's CO2 Visualization Framework notes in terms of data exchange units that both product units (kg-CO2e/kg, kg-CO2e/L, etc.) and transaction amount/volume units (kg-CO2e/XX million yen, kg-CO2e/XX kg) can be used for organization-level calculations. However, because the Green x Digital Consortium recommends product-level calculations, we regard product units as preferable as data exchange units in organization-level calculations as well, and consequently common data format in this document addresses only product-level calculations and product-unit declarations in organization-level calculations.

[3] https://www.carbon-transparency.com/media/1qcdbdyn/pathfinder-network_technical-specifications-for-use-case-001.pdf Subsequently, v2.0.0 of the technical specifications were released 21 February, which align to the Pathfinder Framework v2 which was released 25 January. https://wbcsd.github.io/tr/2023/data-exchange-protocol-20230221/

2.3. Common data format details

2.3.1. Global items and unique items

The common data format is divided into global items and items unique to the Green x Digital Consortium.

The global items generally follow the data model defined in Pathfinder Network Technical Specifications for Use Case 001 version 1.0.0 (issued June 16, 2022; below, the Pathfinder Network data model), but also include the Green x Digital Consortium's own specifications in some places (see subsections below for further information).

Items unique to the Green x Digital Consortium comprise those which we have added with a view to data utilization in the CO2 Visualization Framework. We will test their utility during our PoC phase. We are currently collaborating with the PACT initiative to share feedback collected during the PoC phase, and envision the creation of a data model extension for data attributes unique to Green x Digital Consortium's use casesin the context of "Pathfinder Network: Guidance and Criteria Catalog for Pathfinder Data Model Extensions[4]" (issued November 3, 2022).

Please note the following in relation to item details:

- The three requirement levels are "Mandatory," "Optional," and "Recommendation." Mandatory items must be included in the data.
- Because the JSON format is used for data in HTTP payloads, the respective JSON data types are noted.
- For items that allow decimals (fossilGhgEmissions, etc.), we have provisionally specified up to 16 significant digits.
- Refinements made as a result of our inquiries to PACT as well as issues for future consideration have been flagged in notes.
- Those Green x Digital Consortium specifications included in global items are underlined.

2.3.2. Global items

The particulars of the Pathfinder Network data model are as follows. For specification details, please refer to "Pathfinder Network Technical Specifications for Use Case 001 Version 1.0.0" (issued June 16, 2022).

2.3.2.1. id

Requirement level: Mandatory
JSON data type: String

Product Footprint identifier. Used to identify individual data linked across platforms. MUST be a UUID (Universally Unique Identifier) v4 as specified in RFC 4122.

2.3.2.2. specVersion

Requirement level: Mandatory
JSON data type: String

Version of the data model specifications managed by PACT. A string matching a dotted version pattern, given as the regular expression: ¥d+¥.¥d+¥.¥d+

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[4] Guidance and Criteria Catalog for Pathfinder Data Model Extensions: https://wbcsd.github.io/data-model-extensions/guidance/
Technical Specification for Data Model Extensions: https://wbcsd.github.io/data-model-extensions/spec/
These documents are listed on here: https://www.carbon-transparency.com/our-approach/pathfinder-network

2.3.2.3. version

Requirement level: Mandatory
JSON data type: Number

Product Footprint version. The point immediately after data generation is 0, increasing in increments each time there is an update.

2.3.2.4. created

Requirement level：Mandatory
JSON data type: String

Datetime of data generation on the platform. Datetime string must match ISO 8601 format. (Time zone must be UTC.)

2.3.2.5. updated

Requirement level: Optional
JSON data type: String

Datetime of data updating on the platform. Datetime string must match ISO 8601 format. (Time zone must be UTC.)

2.3.2.6. companyName

Requirement level: Mandatory
JSON data type: String

String indicating the name of the data owner. Used with the aim of supplementing owner identification through companyIds (see below). String of length 1 or greater.

2.3.2.7. companyIds

Requirement level: Mandatory
JSON data type: Array<String>

A non-empty set of URN (Uniform Resource Names), each value of which uniquely identifies the data owner.
[Note]
Company ID that uniquely identifies that company, such as its DUNS Number, ISIN, or ticker code. For the URN, companies can use any namespace registered with IANA such as the OID (Object Identifier) or GLN (Global Location Number) that uniquely identifies the company globally.
Extended specifications are currently being created at PACT to deal with industry-specific identifiers, etc., that are not IANA-registered.

2.3.2.8. productDescription

Requirement level: Mandatory
JSON data type: String

Free-form description of the product plus other information related to it such as production

technology or packaging. Can be left empty.

2.3.2.9. productIds

Requirement level: Mandatory
JSON data type: Array<String>

A non-empty array containing as an element the URN (Uniform Resource Name) which uniquely identifies the data user.

［Note］

For the URN, companies can use any namespace registered with IANA, such as the OID (Object Identifier) or GTIN (Global Trade Item Number) that uniquely identifies the product globally. Extended specifications are currently being created at PACT to deal with industry-specific identifiers and in-house coding systems, etc., that are not IANA-registered.

2.3.2.10. productCategoryCpc

Requirement level: Mandatory
JSON data type: String

UN CPC Code (Central Product Classification Code) version 2.1 that the given product belongs to. Can be left empty.

2.3.2.11. productNameCompany

Requirement level: Mandatory
JSON data type: String

Trade name of the product. Used to supplement product identification through the productIds noted above (e.g. information on production customization). String of length 1 or greater.

2.3.2.12. comment

Requirement level: Mandatory
JSON data type: String

Used for information and instructions related to the calculation of the footprint, or other information which informs the ability to interpret, to audit or to verify the product footprint. Can be left empty.

［Note］

- A future issue for consideration will be whether, if audit and verification methods are to be identified, properties should be defined for ease of interpretation as a system rather than comments being left free-form.

2.3.2.13. pcf

Requirement level: Mandatory
JSON data type: Object

The product carbon footprint identified according to the above-noted properties and related data. Includes the various properties noted below.

2.3.2.13.1. declaredUnit

Requirement level: Mandatory
JSON data type: String

Any of the following values can be set.

- liter:ℓ
- kilogram: kg
- cubic meter: ㎥
- kilowatt hour: kWh
- megajoule: MJ
- ton kilometer: t･km
- square meter: ㎡

［Note］

- When we asked PACT about the inclusion of the product unit as a value, PACT noted that because this might introduce subjectivity, PACT had excluded it with a view to maintaining comparability. Because some Green x Digital Consortium member companies want product unit included, however, we will continue to consult with PACT on this issue.

2.3.2.13.2. unitaryProductAmount

Requirement level: Mandatory
JSON data type: String

The amount of units contained within the product to which the PCF is referring. A decimal number greater than zero.

2.3.2.13.3. fossilGhgEmissions

Requirement level: Mandatory
JSON data type: String

Emissions from the combustion of fossil sources. Must be calculated per declared unit with unit kg of CO2 equivalent per kilogram (kgCO2e/kg). A decimal number equal to or greater than zero. See the Pathfinder Framework for calculation methodology.

2.3.2.13.4. genicEmissions

Requirement level: Optional
JSON data type: Object

Biogenic emissions (see the GHG Protocol FLAG Standard). If defined, at least one of the following three properties MUST be defined.

- landUseEmissions
- landUseChangeEmissions
- otherEmissions

2.3.2.13.4.1. landUseEmissions

Requirement level: Optional
JSON data type: String

Land use emissions (e.g. cultural practice) as a decimal number equal to, greater, or lower than zero.

2.3.2.13.4.2. landUseChangeEmissions

Requirement level: Optional
JSON data type: String

Land use change emissions (e.g. due to deforestation) as a decimal number equal to, greater, or lower than zero. This value must include direct land use change (dLUC) where available, otherwise statistical land use change (sLUC) can be used. Including indirect land use change (iLUC) is optional.

2.3.2.13.4.3. otherEmissions

Requirement level: Optional
JSON data type: String

Other emissions (e.g. biogenic waste treatment) as a decimal number equal to, greater, or lower than zero.

2.3.2.13.5. biogenicCarbonContent

Requirement level: Mandatory
JSON data type: String

Mass of biogenic carbon per given unit of exchange, expressed as a decimal equal to or greater than zero with unit kgCper declared unit.

2.3.2.13.6. reportingPeriodStart

Requirement level: Mandatory
JSON data type: String

Start of the reporting period. Must be a date and time string conforming to ISO 8601 (the time zone must be UTC). For further information, see the CO2 Visualization Framework or the Pathfinder Framework.

2.3.2.13.7. reportingPeriodEnd

Requirement level: Mandatory
JSON data type: String

End of the reporting period. Must be a date and time string conforming to ISO 8601 (the time zone must be UTC). For further information, see the CO2 Visualization Framework or the Pathfinder Framework.

2.3.2.13.8. geographyCountrySubdivision

Requirement level: Optional
JSON data type: String

Must be defined if the geographical granularity of the carbon footprint is an administrative district (e.g. Tokyo Metropolitan Area) and, in which case, the properties geographyRegionOrSubregion and geographyCountry must be undefined. Use the appropriate ISO 3166-2 code.
［Note］
In Tokyo's case, geographyCountrySubdivision code is JP-13.

2.3.2.13.9. geographyCountry

Requirement level: Optional
JSON data type: String

Must be defined if the geographical granularity of the carbon footprint is country-specific, and, in which case, the properties geographyRegionOrSubregion and geographyCountrySubdivision MUST be undefined. Use the appropriate ISO 3166-1 alpha-2 code (e.g. JP).

2.3.2.13.10. geographyRegionOrSubregion

Requirement level: Optional
JSON data type: String of length 1 or greater

Must be defined if the geographical granularity of the carbon footprint is regional or subregional (e.g. all of Asia) and, in which case, the properties geographyCountrySubdivision and geographyCountry must be undefined. Use the appropriate string from pp 17-18 of "Pathfinder Network Technical specification for Use Case 001[5]."

2.3.2.13.11. primaryDataShare

Requirement level: Mandatory
JSON data type: Number

Share of primary data (percentage) as a decimal between zero and 100.
Green x Digital Consortium specification: In the case of organization-level calculations, set as zero.

2.3.2.13.12. emissionFactorSources

Requirement level: Optional
JSON data type: Array<Objects>

If defined, represent as an array of length 1 or greater with objects including the properties below as elements.

2.3.2.13.12.1. name

Requirement level: Mandatory (if there are emissionFactorSources)
JSON data type: String

[5] https://wbcsd.github.io/data-exchange-protocol/#enumdef-regionorsubregion

Enter the title of the emission factor database as a string of length 1 or greater.

2.3.2.13.12.2. version

Requirement level: Mandatory (if there are emissionFactorSources)
JSON data type：String

Enter the title of the emission factor database as a string of length 1 or greater.

2.3.2.13.13. boundaryProcessesDescription

Requirement level: Optional
JSON data type: String

Can be left empty. Example value: Electricity consumption included as an input in the production phase.

2.3.2.13.14. crossSectoralStandardsUsed

Requirement level: Mandatory
JSON data type: Array<String>

The cross-sectoral standards applied for calculating or allocating GHG emissions. Some or all of the following strings can be entered (cannot be an empty array).

- GHG Protocol Product standard
- ISO Standard 14067
- ISO Standard 14044

Green x Digital Consortium specification:

- Green x Digital Product Framework
- GHG Protocol Scope 3 Standard (For organization-level calculations)
- Green x Digital Scope 3 Framework (For organization-level calculations)

2.3.2.13.15. productOrSectorSpecificRules

Requirement level: Mandatory
JSON data type: Array<Object>

Rules used for calculating or allocating GHG emissions (PCR, etc.). An array with objects with the following properties as its elements. If no product or sector specific rules were followed, this set must be empty.

Green x Digital Consortium specification:
Leave empty in the case of organization-level calculations.

［Note］

- We will consider whether what to enter for otherOperatorName and ruleNames should be defined when Japanese PCRs are applied.

2.3.2.13.15.1. operator

Requirement level: Mandatory
JSON data type: String

Valid values are:

- PEF (EU Product Environmental Footprint)
- EPD International
- Other: A PCR *not* published by the above operators

2.3.2.13.15.2. ruleNames

Requirement level: Mandatory
JSON data type: Array<String>

Array of length 1 or greater with an element comprising a string of length 1 or greater.

2.3.2.13.15.3. otherOperatorName

Requirement level: Optional
JSON data type: String

If the operator was defined as Other, the value here must be the name of the PCR operator.

2.3.2.13.16. allocationRulesDescription

Requirement level: Optional
JSON data type: String
Description of the allocation rules applied.

2.3.3. Green x Digital Consortium items

2.3.3.1. gateToGate

Requirement level: Recommendation
JSON data type: Object

Entered, gate-to-gate emissions can also be provided in addition to cradle-to-gate.

2.3.3.1.1. fossilGhgEmissions

Requirement level: Recommendation
JSON data type: String

Gate-to-gate emissions from fossil fuel combustion (kg-CO2eq/declaredUnit).
The company's own emissions, excluding the upstream portion, provided as a subset of the figure in 2.3.2.13.3. fossilGhgEmissions.

2.3.3.1.2. biogenicCarbonContent

Requirement level: Recommendation
JSON data type: String

Gate-to-gate biogenic carbon content (kgC /declaredUnit).
A company's own emissions, excluding the upstream portion, provided as a subset of the figure in 2.3.2.13.5. biogenicCarbonContent.

2.3.3.1.3. upstreamEmissions

Requirement level: Recommendation
JSON data type: Array<Object>

Gate-to-gate information acquired from companies upstream in the supply chain with which the company has direct transactions, preserved as an array.
When the company is at the top of the supply chain, this array is returned empty.

2.3.3.2. creditAmount 【unique to the Green x Digital Consortium】

Requirement level: Optional
JSON data type: String

Credit amount per declared unit (kg-CO2eq/declaredUnit). Prepend a report on the amount of credit procured and adjusted by the data disclosing party, along with credit use and certificate use information.

2.3.3.3. certificateAmount 【unique to the Green x Digital Consortium】

Requirement level: Recommendation
JSON data type: String

Certificate amount per declared unit (kg-CO2eq/declaredUnit).
Prepend a report on the certificate amount procured and adjusted by the data disclosing party, along with credit use and certificate use information.

2.3.3.4. scope3Category 【unique to the Green x Digital Consortium】

Requirement level: Recommendation
JSON data type: Array<Number>

For organization-level calculations: In addition to Scope 1 and 2, enter Scope 3 calculation categories as an array (e.g. 1, 4, 5).

2.3.3.5. distributionLevel 【unique to the Green x Digital Consortium】

Requirement level: Recommendation
JSON data type: String

For organization-level calculations: Physical allocation level (one of the following)

- Organization
- Site
- Building
- Production line

2.3.3.6. distributionIndex 【unique to the Green x Digital Consortium】

Requirement level: Recommendation
JSON data type: String

For organization-level calculations: Physical allocation indicator (one of the following)

- Volume
- Unit
- JPY (production value)

3. Data linkage platform

3.1. Approach

Based on SWG investigations into the ideal data linkage platform, we decided on the following approach to the platform which should be developed by the Green x Digital Consortium.

The first digital linkage platform model that we considered was the centralized database model shown below from the Green x Digital Consortium Visualization Working Group report entitled “Study Preparation Phase/Primary Report for Establishment of Mechanism for Visualization of Supply Chain CO2”.[6] In this model, companies participating in the Consortium share a database and server. The merits of the model are the unified data structure and the centralized control of visibility and tamper resistance, but the maintenance-related cost burden that it would place on the Consortium would need to be considered, as well as the operating scheme.

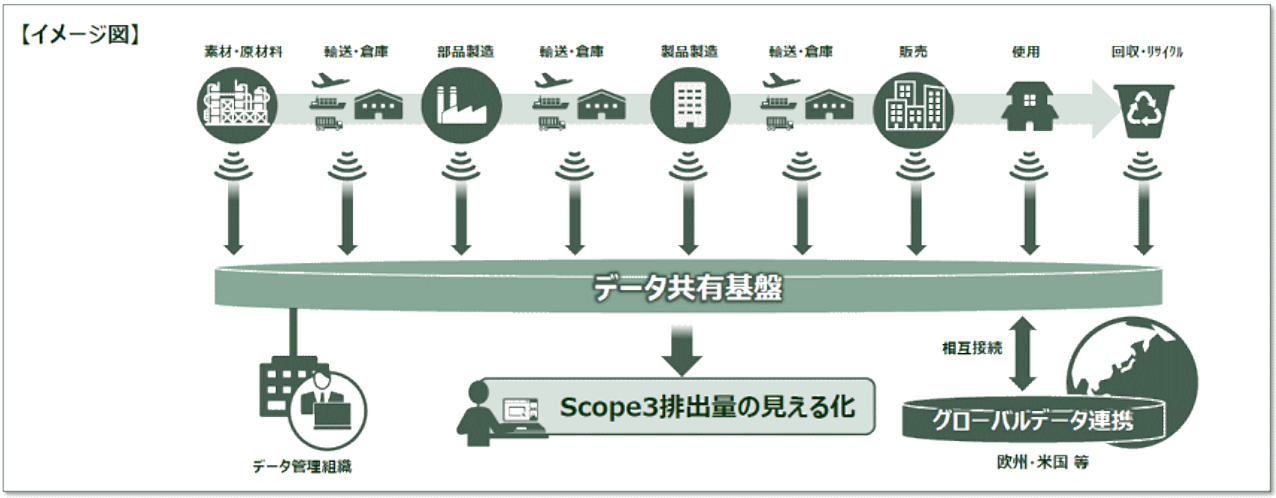

Fig. 2 Data-sharing platform model in primary report

Next, the SWG looked at adopting a non-centralized control model, examples of which are shown below. However, user companies have already adopted various different visualization solutions and have business policies tailored to specific solution vendors, while linking visualization solutions and data linkage solutions would require massive system enhancement on the part of the solution

[6] https://www.gxdc.jp/pdf/achievement_report.pdf

providers. Consequently, this model was not deemed to be the ideal platform for the Green x Digital Consortium to develop.

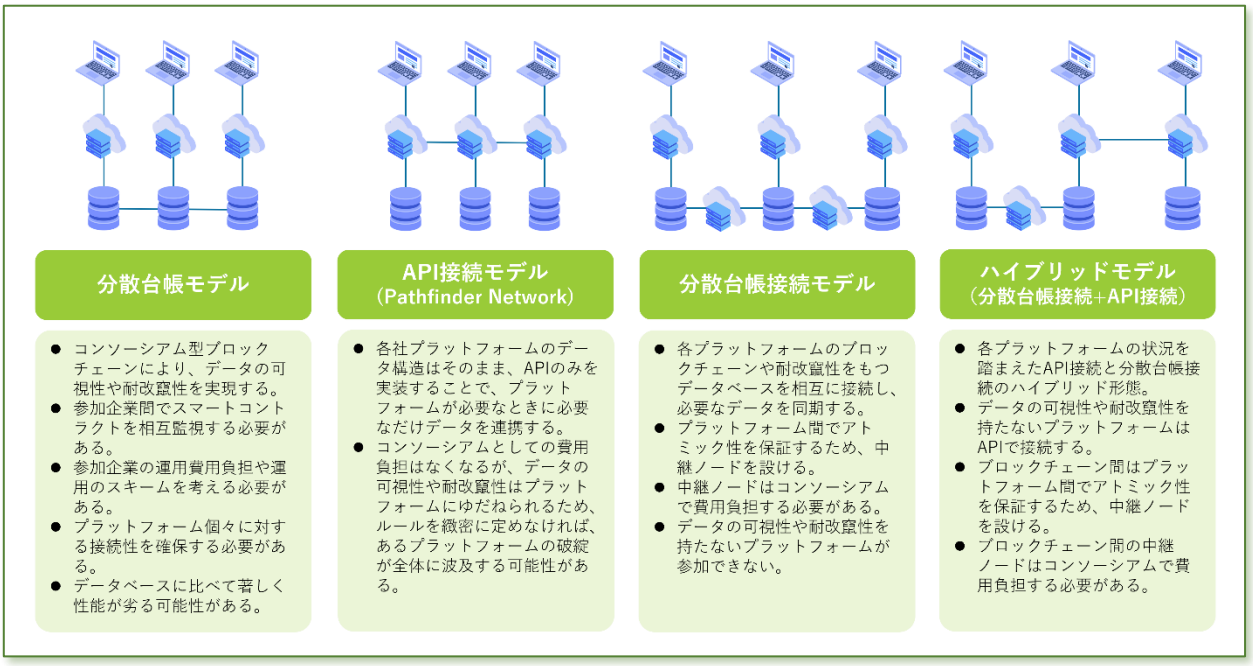

Fig. 3 Image of non-centralized control model

Both models also pose major cost issues for small and medium enterprises in the supply chain, making it difficult to achieve data linkage throughout the entire supply chain. We consequently reached the following conclusions in terms of the ideal platform for the Green x Digital Consortium:

- To develop only a common data format, not a common data platform
- To leave the decision on which data acquisition method is used among the companies making up a supply chain as a B2B decision. (The Pathfinder Network assumes API linkage, and in this document too, specifications in the case of API linkage are noted in the next section. An API connection model will also be used in the PoC experiment, but we will not position this as the only data linkage method.

3.2. Data linkage specifications

This section notes the envisaged pattern in the case of data linkage between visualization solutions (product carbon footprint calculation applications, etc.) and data linkage solutions (platform services offering traceability and tamper resistance when engaging in data linkage) as well as specifications for API linkage.

An API has already been released by PACT as part of the Pathfinder Network for exchanging and sharing product carbon footprint information between different solutions. Given global common needs in relation to GHG emissions, in the case of API linkage, as the first step, we envisage data exchange either through the Pathfinder Network API and, for the Green x Digital Consortium's additional items, the Consortium's own API.

Next step, we envisage data exchange through the Pathfinder Network API for those data elements that are relevant across industries and regions. For those data elements that are Green x Digital unique, we envisage the use of a Pathfinder Network data model extension over which these elements will be shared.

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3.2.1. Envisaged data linkage pattern

There are three possible patterns for data linkage combinations: (1) direct peer-to-peer linkage between visualization solutions; (2) visualization solutions linking to a data linkage solution of some nature; and (3) linkage between data linkage solutions. We also assume two linkage methods, one using an API and the other not.

3.2.1.1. Direct peer-to-peer linkage between visualization solutions

As this format is consistent with PACT assumptions, solution providers can realize data linkage using common specifications by using either the Pathfinder Network API and the Green x Digital Consortium's own API. However, because information on what product is managed on what platform is not supplied by either API, product and solution mapping data needs to be managed external to the solutions (or standardized internally).

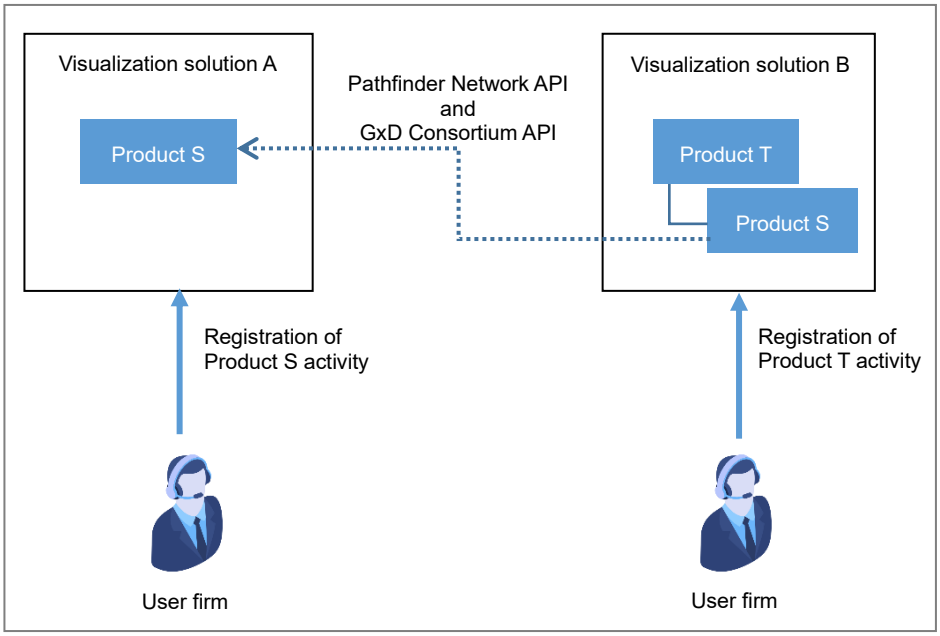

Fig. 4 Direct peer-to-peer linkage of visualization solutions

3.2.1.2. Visualization solutions linking to a data linkage solution of some nature

As noted above, data linkage between visualization solutions requires mapping data external to the solutions. By serving this role, data linkage solutions can reduce the cost of data management for visualization solution linkage (only the connection to the data linkage solution needs to be considered). When the scale of data linkage increases, networks between solutions become more complex and network management costs arise, but these costs can be alleviated through centralized connection management by the data linkage solution. At the same time, where the data linkage solution experiences telecommunications issues for some reason, the whole network can break down, which can greatly boost the asymmetric costs of data linkage solutions.

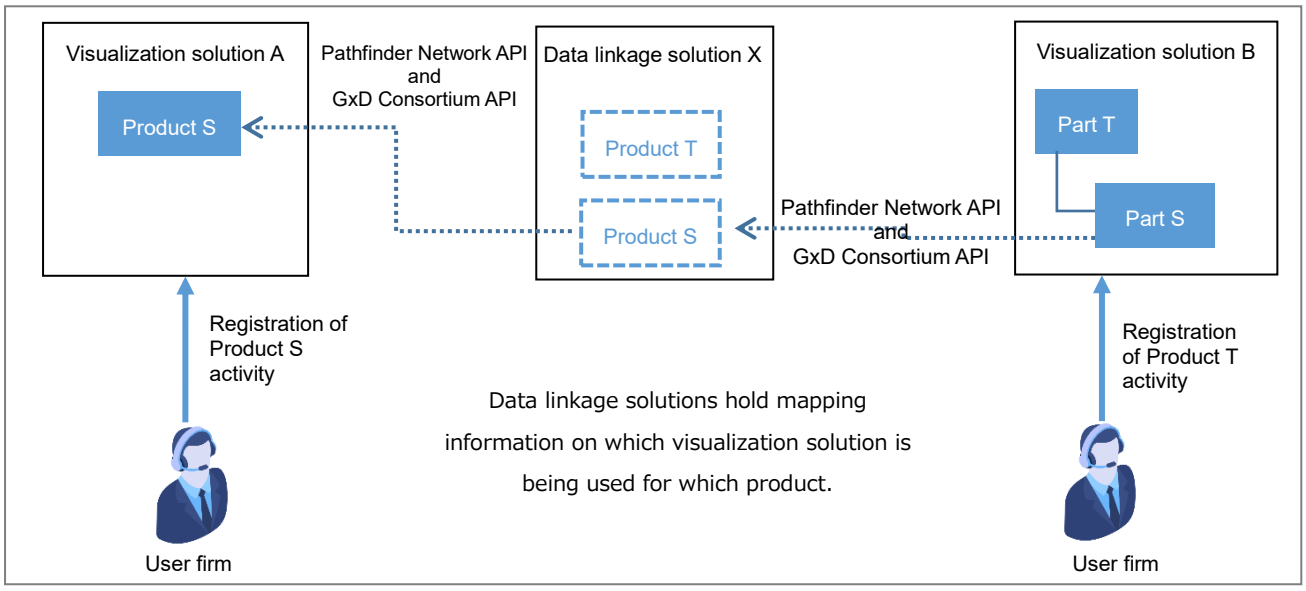

Fig. 5 Visualization solutions linking to a data linkage solution of some nature

3.2.1.3. Linkage between data linkage solutions

As noted above, the network structure can be simplified by using data linkage solutions for data linkage between visualization solutions but data linkage solution costs can also soar. To remove this problem, multiple data linkage solutions can be prepared and interoperated so as to boost tamper resistance and distribute the burden. However, to realize this, further consideration needs to be given to the standardization of methods of synchronizing information among data linkage solutions.

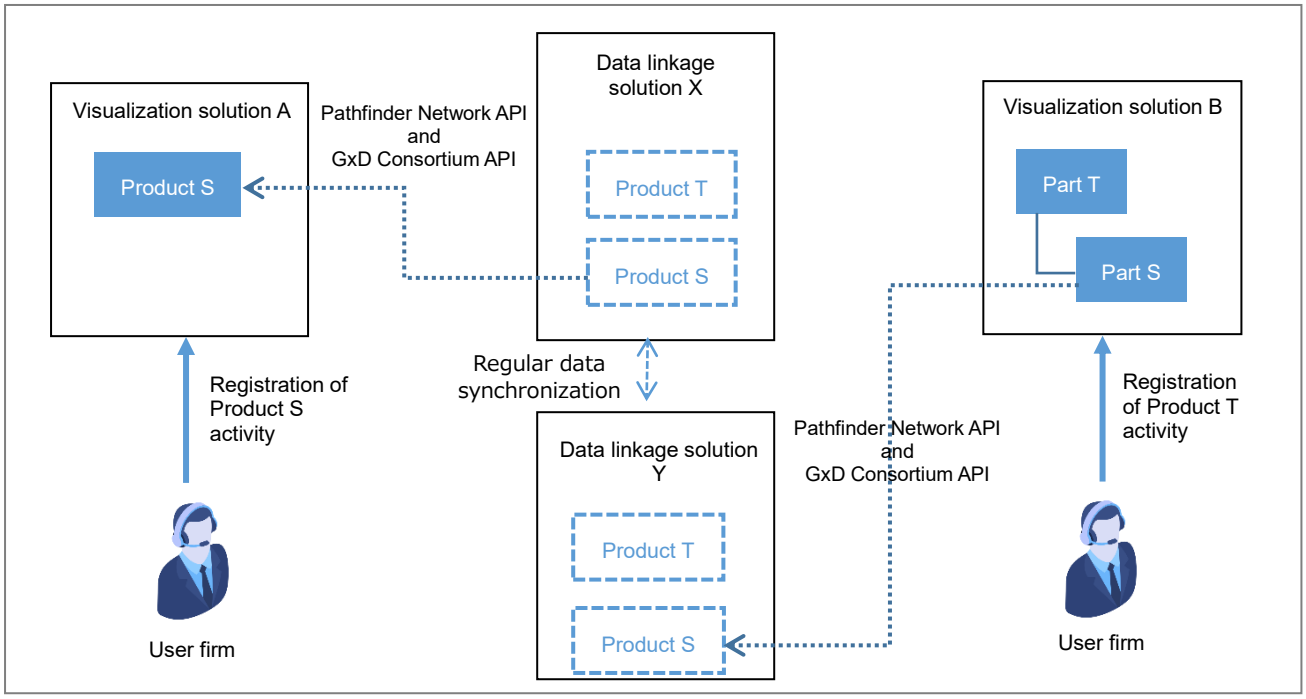

Fig. 6 Linkage between data linkage solutions

3.2.2. Pathfinder Network API

The Pathfinder Network API will be used for API linkage in relation to global items.

For Pathfinder Network API specifications, see Use Case 001 HTTP REST API Version 1.0.0 (p. 30) in “Pathfinder Network Technical specifications for Use Case 001 version 1.0.0” (issued June 16, 2022).

3.2.3. Green x Digital Consortium API

The API unique to the Consoritum referes the PACT API specifications as much as possible to seucure compatibility with the PACT API in the future which only adds a description of the data model unique to the Consortium to the PACT API. Authentication follows the ‘Action Authenticate’ of the Pathfinder Network API. The specifications are as follows.

3.2.3.1. get_list

‘get_list’ refers to ‘Action ListFootpirnts’ in the Pathfinder Network API. The moidifications from the original are following two points, the path change in request syntax and the addition of data models unique to the Green x Digital Consortium to the response parameters.

Lists product footprints with optional filtering by property “created” or “updated.” Host systems should implement an access management system and only return the product footprints for which the data owner granted access to the requesting data recipient.

3.2.3.1.1. Request syntax

GET Subpath/JEITA/0/footprints?Filter HTTP/1.1
Host: Hostname
authorization: Bearer BearerToken

3.2.3.1.2. Request parameters

Subpath: If a host system uses a relative subpath, then the requesting data recipient must prepend this subpath.

Hostname: The requesting data recipient must use the domain name of the host system.

BearerToken: The requesting data recipient must use as a BearerToken the value of property access_token of a response body from action Authenticate.

Filter: Filter is an optional request parameter. If defined, it must conform to the $filter syntax as defined by the ODatav4 specification. A $filter must only reference property created or property updated. The filter must specify filter operation ge.

3.2.3.1.3. Response syntax

HTTP/1.1 HttpStatusCode OK
content-type: application/json
content-length: ContentLength
Body

3.2.3.1.4. Response parameters

HttpStatusCode:
If the host system accepts the access token, the HttpStatusCode MUST be 200. If the host

system responds with an error response, the HttpStatusCode MUST match the HTTP Status Code of the respective error response code. If the host system does not return the list of ProductFootprints, it MUST return an error HTTP Status Code (4xx, 5xx).

ContentLength:
The length of the body. See RFC 2616.

Body:
If the host system accepts the access token, the body must be a JSON object with property data with value the list of ProductFootprints. The list must be encoded as a JSON array. If the list is empty, the host system must return an empty JSON array.

Additionally,
a) if the request parameter Filter is defined against property updated, then only ProductFootprints with property updated defined and with a value equal to or greater than the timestamp given by the filter should be included in the Body;
or
b) if the filter is against property created, then only ProductFootprints with a creation time equal to or greater than the timestamp given by the filter should be included in the Body.
Example value of Filter: $filter=updated ge 2020-03-01T00:00:00Z

If the host system does not accept the access token, the body must be an error response with code AccessDenied.
If the host system does not accept the access token because it expired, the body should be an error response with code TokenExpired.
In all other cases, for instance in case of a malformed value of the header authorization, the body should be an error response with code BadRequest.

3.2.3.1.5. Example

Request
GET **example**/0/footprints$filter=updated ge2022-12-14T06:00:00+09:00 HTTP/1.1
host: **a.example.com**
authorization: Bearer **PIYOpiyoPIYOpiyoPIYOpiyo**

Response
HTTP/1.1 200 OK
content-type: application/json
content-length: **300**

```
{"data":[{
        "id":"497f6eca-6276-4993-bfeb-53cbbbba6f08”
        "specVersion":"1.0.0",
        "version":0,
        ...,
        "pcf":{
                "declaredUnit":"kilogram",
                "unitaryProductAmount":0.00204,
                "fossilGhgEmissions":"8.6",
                ...,
                "gateTogate":{
                ...
```

```
                    },
                    ...
                }
        }]}
```

3.2.3.2. get_pcf

'get_list' refers to 'Action ListFootpirnts' in the Pathfinder Network API. The moidifications from the original are following two points, the path change in request syntax and the addition of data models unique to the Green x Digital Consortium to the response parameters.

Get product footprint. Host systems should implement an access management system and only return the product footprints for which the data owner granted access to the requesting data recipient.

3.2.3.2.1. Request syntax

GET Subpath/JEITA/0/footprints?Filter HTTP/1.1
Host: Hostname
authorization: Bearer BearerToken

3.2.3.2.2. Request parameters

Subpath: If a host system uses a relative subpath, then the requesting data recipient must prepend this subpath.

Hostname: The requesting data recipient must use the domain name of the host system.

BearerToken: The requesting data recipient must use as a BearerToken the value of property access_token of a response body from action Authenticate.

PfId: The requesting data recipient must use as PfId the id of a product footprint it intends to retrieve.

3.2.3.2.3. Response syntax

HTTP/1.1 HttpStatusCode OK
content-type: application/json
content-length: ContentLength
Body

3.2.3.2.4. Response parameters

HttpStatusCode:
If the host system accepts the access token, the HttpStatusCode must be 200. If the host system responds with an error response, the HttpStatusCode must match the HTTP Status Code of the respective error response code. If the host system does not return a ProductFootprint, the host system must return an error HTTP Status Code (4xx, 5xx).

ContentLength:
Length of the body. See RFC 2616.

Body:

If the host system accepts the access token and allows the requesting data recipient to access the ProductFootprint, the body must be a JSON object with property data. The value of property data must be the product footprint with footprint identifier PfId. If there were changes to the ProductFootprint with identifier PfId, the host system should return the latest ProductFootprint identified with identifier PfId and the maximum value of property version.

> Note: If a host system implements the life cycle rules, then the “latest” version of a ProductFootprint is the one with the maximum value of the version given a fixed PfId.

If the host system does not accept the access token, the body must be an error response with code AccessDenied.
If the host system does not accept the access token because it expired, the body should be an error response with code TokenExpired.
The host system may return an error response with code NoSuchFootprint.

In all other cases, for instance in case of a malformed value of the header authorization, the body should be an error response with code BadRequest.

3.2.3.2.5. Example

Request

GET **example**/0/footprints/497f6eca-6276-4993-bfeb-53cbbbba6f08 HTTP/1.1
host: **a.example.com**
authorization: Bearer **PIYOpiyoPIYOpiyoPIYOpiyo**

Response

HTTP/1.1 200 OK
content-type: application/json
content-length: **300**

```
{"data":{
        "id":“497f6eca-6276-4993-bfeb-53cbbbba6f08",
        "specVersion":"1.0.0",
        "version":0,
        ...,
        "pcf":{
                "declaredUnit":"kilogram",
                "unitaryProductAmount":0.00204,
                "fossilGhgEmissions":"8.6",
                ...,
                "gateTogate":{
                        ...
                },
                ...
        }
}}
```