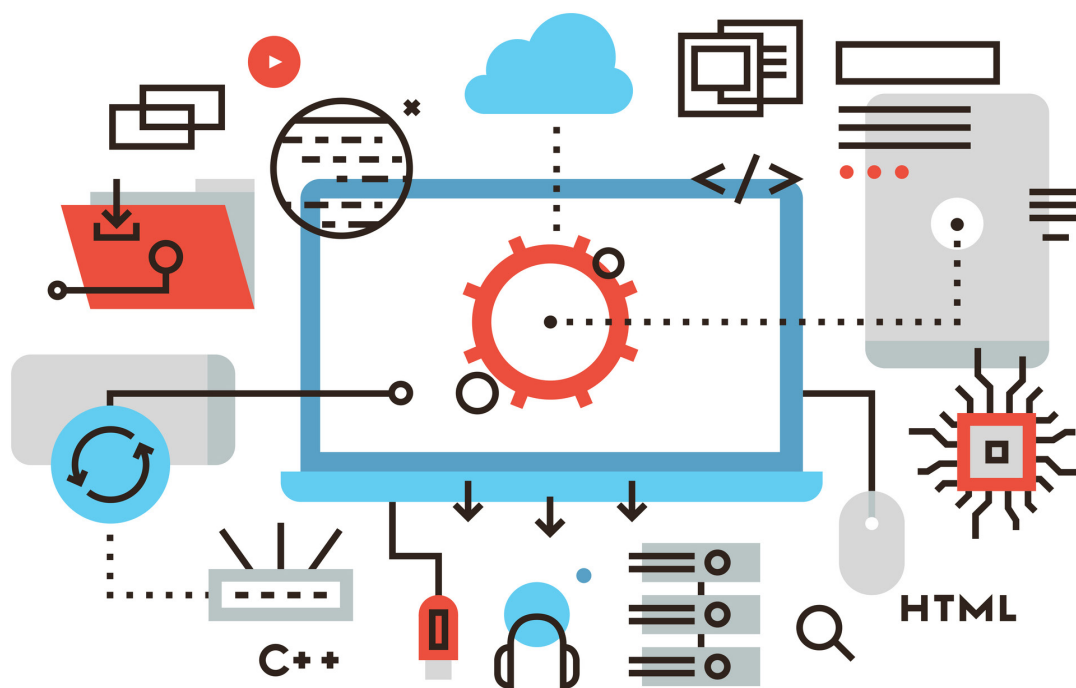# SCIENCE|BUSINESS®

Governing the European Open Science Cloud

October 2017

On 6 September 2017 members of the Science|Business Network's cloud consultation group met to discuss the governance of the EOSC. This report is based partly on those discussions, but is ultimately a product of Science|Business. The views expressed herein do not necessarily reflect those of individual members. Participants in these cloud discussions include representatives of:

Amazon
Association for Computing Machinery – Europe Policy Committee
Association of Commonwealth Universities
Barcelona Supercomputing Centre
CERN
ETH-Zurich
European Space Agency
FigShare
GÉANT
Huawei
Microsoft
Research Data Alliance Europe
University of Eastern Finland
University of Twente

Rapporteur: David Pringle

Introduction

By making today's science more efficient, and tomorrow's revolutionary, the European Open Science Cloud (EOSC) is set to play a pivotal role in ensuring Europe remains competitive in the twentieth-first century. Scheduled to be up and running by 2020, the EOSC should enable the 1.8 million researchers in Europe to get access to research data from any lab or scientific discipline with just a few clicks. It could pave the way for a golden age of European science in which researchers are able to combine data from many different scientific disciplines to generate new insights and breakthroughs.

Making this happen won't be easy. The plan is to interconnect existing and new European data infrastructures run by commercial and publicly-funded providers, adding the software, metadata, data registries and other tools needed to glue things together. Today, the European cloud vision is being incubated by the Commission's research and digital directorates, but the EOSC will ultimately need to be run by a governance structure that has the trust and support of the many different stakeholder groups required to make this vision a reality.

So, how should something as fundamental to Europe's future as the EOSC be governed?

Coordinated by Science|Business, an independent consultation group representing research, industry and policy has been discussing this crucial question. Capturing the output from those discussions, this paper is designed to shape stakeholders' thinking as they consider how to govern Europe's open science cloud.

It first identifies principles that should underpin the governance of the EOSC. These include trust, transparency, accountability, inclusiveness, flexibility, pragmatism, efficiency, a global perspective and a strong focus on the needs of science.

It goes on to outline three different implementation options for the governance structure, each involving different trade-offs between simplicity/efficiency and breadth of representation/involvement. While each of these three models seeks to ensure all the key stakeholders are represented, they explore ways to streamline the governance structure to ensure that the EOSC can move at a pace that is in keeping with advances in data science. Subsequent sections highlight related considerations, such as the need to allow standards to evolve in a bottom-up, iterative manner, rather than via a top-down, rigid approach.

Finally, in the appendix, this paper outlines the governance structure of other bodies seeking to reconcile the fast moving world of technology with the complexities of international politics. For example, the EOSC can draw some lessons from the way in which ICANN has evolved from a body created and controlled by the US government into an international organisation that represents a diverse group of stakeholders. Although ICANN takes the views of different governments into account, it manages to avoid the gridlock that can render some international bodies ineffective. Conversely, the intergovernmental Group on Earth Observations (GEO) has developed a relatively elaborate, but seemingly effective, governance structure that defines clear roles for its member governments, international organisations and the relevant scientific communities.

We welcome comments at info@sciencebusiness.net.

Guiding Principles

Below is a list of principles that should guide the governance of the European Open Science Cloud.

Representative, inclusive and interdisciplinary: The governance structure should reflect the diversity of the scientific community in Europe, encompassing many different disciplines and the so-called long tail of science and citizen science, as well as the major research programmes.

Accountability: The EOSC needs to be accountable to all the key stakeholders, including the European Commission, the Member States, the research infrastructures and the scientific communities. As the EOSC will be a vital organisation to manage science in the EU, it is important that the European institutions have oversight.

Driven by the needs of science: The governance structure should be designed to serve science. While there needs to be a clear authority running the EOSC, it shouldn't interfere in how research is done and it should allow ideas to emerge bottom up. The governance structure should allow for user and data-driven innovation, rather than be technology-driven. At the same time, the EOSC needs to be able to harness new technologies and the new forms of data science they enable. As a clear commitment of resources implies a clear need, those players who make financial and scientific contributions should shape how the EOSC develops.

Pragmatism and proportionality: The development of the governance structure should not be a brake on implementation. The EOSC should start with a minimum viable structure, proportional to its initial mandate, which can then evolve over time.

Flexibility: The governance structure should be flexible and designed to evolve. As a new concept in a fast moving space, the EOSC will be "learning by doing." As it is impossible to foresee all that needs to be done, the EOSC can't be a rigid concept. The legal structure needs to allow for the governance structure to evolve.

Efficient and effective: To enable the EOSC to take decisions at an appropriate speed, there needs to be a clear delineation between operations/execution and oversight/mandate. The governance structure needs to be efficient and able to make decisions quickly enough to keep pace with the evolution of big science and information and communications technologies. A decisive EOSC will enable the rapid adoption of so-called big science – a critical component to maximize European competitiveness.

Action-orientated: The governance structure should be designed to avoid political paralysis – the structure should not allow a single stakeholder to freeze the activities of the EOSC through a veto or another blocking mechanism.

Open for business: As the EOSC will depend in large part on the co-operation of private companies, the governance structure shouldn't prevent participants from being able to make a financial return by supplying products and services that enhance the effectiveness of the cloud and ultimately help to drive economic growth and create jobs.

Strong and streamlined: The ideal governance board would have just 7 to12 members. A board of that size may be politically difficult to adopt in a 28 (or 27) member European Union; but we consider it vital to have a lean and empowered governance structure. The development of the EOSC, and the step change in scientific research it seeks to bring about, should not be blocked by administrative procedures that sacrifice success for political correctness.

Global outlook: To fulfil its mission, the EOSC will need to be able to harness the technological capabilities of North American and East Asian companies. The European cloud should also be compatible with those being developed in the US, Australia, South Africa, Canada and other nations that have a growing interest in open research data

Transparency: There needs to be a clear understanding of what each stakeholder hopes to gain from the EOSC. The interests of each stakeholder need to be transparent, both to engender trust and to ensure the EOSC is fulfilling the needs of all its stakeholders.

Reinforce the FAIR principles: The governance structure needs to be designed to uphold the FAIR principles (Findability, Accessibility, Interoperability, and Reusability) of data stewardship, which are at the core of the EOSC vision. To enable European science to capitalise on big data, the EOSC needs to ensure the FAIR principles are implemented as widely possible.

Focused: Organisations with too broad a mandate tend to fail because their resources are spread too thin. Particularly in the early days, the EOSC needs to focus exclusively on a well-defined core mandate.

Trusted: The EOSC and its governance structure needs to be trusted by regulators and policymakers. It needs to make open data sharing possible in a way that enables scientists to bypass the new General Data Protection Regulation and national regulations. The EOSC's compliance framework needs to be trusted, so compliant players are trusted to use data in a responsible way and can conduct research that draws on data sets from across Europe.

Implementation models/options

What is the best way to implement a governance structure that reflects the principles set out above? Building on the criteria laid out in the EOSC Declaration, published by the Commission in September 2017, this section explores several different implementation options. It draws on the expertise and experience of members of the consultation group, as well governance structures of other groups straddling technology and politics, notably ICANN.

The examples in the Appendix highlight how the Internet is being governed with a light touch and in a largely effective manner by experts and technologists, rather than politicians. The durability of ICANN, in particular, makes the case for a strong, diverse and largely independent board that can prioritise the development of technological enablers over the geopolitical objectives of individual nation states. Although ICANN was established by the US government, its governance structure has proven receptive to the views of many different global stakeholders, while also being resistant to political meddling. The Appendix in this paper also briefly outlines the governance models of the European Centre of Medium Range Weather Forecasting and the intergovernmental Group on Earth Observations (GEO). Although they are ultimately run by governments, both these bodies have given their operational teams sufficient autonomy to allow them to be effective. The latter is particularly relevant as it encompasses a broad set of scientific disciplines and is conceived as a "system of systems" that addresses some interoperability issues.

Of course, no single model can simply be transplanted into the European Open Science Cloud, which is the first multinational initiative of its kind. The European Commission's EOSC Declaration of July 2017 calls for the EOSC governance framework to be co-designed, stakeholder-driven and composed of three main layers:

1. Institutional, including EU Member States and European Commission
2. Operational, including a governance board and relevant working committees (e.g. thematic and functional)
3. Advisory, including a stakeholder forum.

The Declaration also calls on the governance board to coordinate the efforts of stakeholders endorsing the EOSC Declaration, with a broad mandate to reach practical agreements for the implementation of an EOSC Roadmap by 2020.

It adds that the governance board will have both an advisory role and an implementing role of the decisions by Member States and European Commission concerning the programming, financing and setting-up of a long-term governance and business model for the EOSC. The declaration also proposes that a coordination structure, funded by Horizon 2020, should help the governance board to manage the implementation.

Taking into account this context, there are several different ways in which the EOSC could be governed. This section outlines three different implementation options, which involve various trade-offs between the principles outlined in section 2 of this paper.

Implementation Option 1: Three bodies each with a clear role

One way to implement the three governance layers called for in the declaration would be simply to set up three bodies each with distinct roles:

1. Meeting several times a year, the governance board would allocate funds to expert groups charged with addressing specific issues, oversee an executive team, decide on the rules of engagement, agree a compliance framework and establish the business models that will be required to make the EOSC sustainable. The governance board would take responsibility for ensuring the EOSC can harness the necessary scientific content and ICT infrastructure required to fulfil the promise of the open science cloud. The governance board would take decisions by a simple majority - no member would have a veto.

2. An institutional group representing Member States and the European Commission with a financial and supervisory responsibility. This group would meet once a year to approve the budget and review progress against a set of clearly defined KPIs designed to deliver a return on investment in the EOSC at both a national level and a pan-EU level. The voting procedures should mirror the qualified majority system used by the EU Council of Ministers (to make a decision, 55% of member states, representing at least 65% of the EU population, need to vote in favour). Every two years, this group would appoint half of the members of the governance board.

3. A stakeholders forum representing the research infrastructures, the research communities, public e-Infrastructures, commercial cloud providers and other parties prepared to sign up to the EOSC declaration. This group would meet once a year, review progress and publish advice. Every two years, this group would elect half the members of the governance board.

Analysis: This governance structure would ensure that all the necessary stakeholders have a voice in the running of the EOSC. But there is a danger that a three body structure becomes cumbersome and difficult to coordinate. There is the risk that the three bodies start to compete, rather than co-operate, with each other. If that were the case, the governance board could be distracted from its main role by the need to manage relations between the institutional group and the stakeholders form.

Implementation Option 2: A single governing body

The three bodies outlined in Option 1 amount to a relatively unwieldy governance structure that could make it difficult for the EOSC to move at the pace required.

Instead, the EOSC could be run by a single governance body encompassing the three layers called for by the declaration. Serving a two-year term, this governance board would be a diverse group capable of considering all dimensions of the EOSC. Whereas half the board positions could be appointed by the funding agencies (the Member States and the Commission), the other half would represent the various stakeholders required to enable the EOSC, such as the research infrastructures, the research communities, the commercial cloud providers and the public e-infrastructures.

Meeting several times a year, the board would set the strategic priorities of the EOSC, approve the budget and allocate funds to expert groups charged with addressing specific issues. It would also oversee an executive team, decide on the rules of engagement, agree a compliance framework and establish the EOSC business models. This governance board would take decisions by a simple majority - no member would have a veto. It would take responsibility for ensuring the EOSC has the necessary scientific content and ICT infrastructure required to fulfil its promise.

Each year, this body could submit a progress report to the EU Council of Ministers, involving Ministers from the Member States and participating third countries. This Council could then discuss the progress of the EOSC against a set of clearly-defined KPIs designed to deliver a return on investment at both a national level and a pan-EU level and review its financial position.

Analysis: This streamlined structure would be able to move quickly and ensure that the EOSC can keep pace with the speed of technological change. However, the streamlined structure may mean some stakeholder groups don't feel they are sufficiently included and have a full say in the running of the EOSC. There would also be the danger of a power grab in which a subset of the stakeholders obtains sufficient influence over the governance board to direct the development of the EOSC in a particular direction that compromises other stakeholders' interests.

Implementation Option 3: Two governing bodies

As a compromise solution between Option 1 and Option 2, the EOSC could be run by two bodies - a representative governance board, supplemented by a dedicated body representing the EU institutions.

Meeting several times a year, the governance board would allocate funds to working groups charged with addressing specific issues, oversee an executive team, decide on the rules of engagement, agree a compliance framework and establish the EOSC business models. The governance board would take responsibility for ensuring the EOSC can harness the necessary scientific content and ICT infrastructure required to fulfil the promise of the open science cloud. Each of the main EOSC stakeholder groups – the funding agencies, the research infrastructures, the research communities, the commercial cloud providers and the public e-infrastructures – would appoint three board members.

The term served by each board member would be at the discretion of the stakeholder group they represent. The governance board would take decisions by a simple majority - no member would have a veto.

The board would report on an annual basis to an inter-institutional body representing the European Commission (DGs RTD, CONNECT, BUDG), the European Parliament (the ITRE and BUDG committees) and the Council (presidency trio+ representative of the non EU countries: Budget and Science attaches). This body would meet at least twice a year, with one meeting focused on the budget and the other focused on the progress of the EOSC against the EU's strategic goals using a set of clearly-defined KPIs designed to deliver a return on the investment in the EOSC at both a national level and a pan-EU level. Members of the inter-institutional body would be obliged to report back to their organisations and the EOSC could be discussed at one meeting of the Council of Ministers each year, involving Ministers from the Member States and participating third countries.

Analysis: This two-body compromise solution would balance the need for continuity and transparency with the need to have a fairly streamlined structure. It would ensure that all the main stakeholder groups have a direct involvement in the running of the EOSC, while the creation of a dedicated inter-institutional body would help to increase the political relevance and profile of the EOSC. Such a structure should help to increase the interaction between different types of people, enabling greater cross-fertilisation of ideas and thinking between policy people, scientists and technologists. Data science is even more dependent on the success of this interaction.

Operational structure

The operational structure of the EOSC will need to be capable of tackling many different dimensions at the same time to ensure the open science cloud maintains momentum. Reporting to the governance board, the executive team of the EOSC should delegate specific responsibilities to expert groups, giving them the funds and a timeframe in which to achieve specific objectives. The executive team, which should be led by a director general, should have sufficient financial and human resources to deliver on the EOSC's ambitious objectives.

As the different dimensions of the EOSC (from interoperability best practices to governance of federations) require different strategies and approaches, the governance board should not try to micro-manage the executive team and the expert groups. Ideally, each of these groups would be run by an experienced programme manager with scientific expertise, rather than a committee. Moreover, these expert groups should draw on the biggest pool of expertise possible, including the private sector and talent and knowledge located outside the EU.
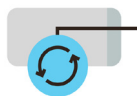
Further considerations

Ensuring the EOSC meets the needs of the scientific community

As the success of the EOSC will depend on scientists using it to share data with each other, the research community needs to be well represented on the governance bodies of the EOSC. However, Europe's scientific community is very diverse, spanning the public sector, academia and the private sector, as well as so-called citizen science conducted informally by individuals. As the many different elements of this community can't be directly represented on the governance board, it will be necessary to select appropriate representatives by identifying the most likely early use cases of the EOSC. When considering prototype use cases, it is crucial to identify representative ones, covering both the major big data projects led by large institutions and the so-called long tail of research involving individual scientists working alone or in small groups. The latter, in particular, will need to be able to access scientific data in an open and straightforward manner. Ideally, the use cases will involve sourcing data from different disciplines, as one of the main goals of the EOSC is to make cross-disciplinary research easier and quicker.

One approach would be to call for proposals for prototype use cases from the scientific communities across Europe and then select representative use cases that could help to shape the EOSC and its governance structure.

Notes on the role of the governance structure

The role of the governance structure will need to evolve with the EOSC and its remit. The EOSC Declaration calls for the governance structure to oversee the following:

- Interfaces with relevant Member State-led initiatives
- FAIR compliance mechanisms
- EOSC access mechanisms
- Interfaces with discipline-based initiatives
- Any other relevant/past project

The EOSC Declaration also calls for the open science cloud to be underpinned by "minimal and rigorous global standards for open research data, as well as standards for EOSC-based services for collaboration through the EOSC." When pursuing this goal, the governance board of the EOSC needs to be pragmatic. It should not attempt to set standards; these should be allowed to develop bottom-up and in an iterative fashion. Although emerging standards could and should be evaluated by experts from both the scientific and technological domains, this process shouldn't lead to the imposition of rigid standards in the traditional sense, which could severely restrict the development of the EOSC.

Although the board should create a compliance framework, to which participants in the EOSC have to adhere, this framework should be sufficiently flexible to allow private companies working within the EOSC framework to develop sustainable business models.

As data interoperability is crucial to the development of the EOSC, the governance board should also proactively encourage research communities to make their data accessible and interoperable via the EOSC. It could, for example, work with the European Commission to introduce appropriate incentives into the funding structure of EU framework programmes. The EOSC also needs to encourage research communities to get together to talk about cross-disciplinary APIs and architectures, create test-beds and begin "learning by doing". To make FAIR data a reality, the EOSC Declaration calls for "a solid stakeholder engagement strategy, on inter-institutional arrangements, well-established frameworks and decision making flows." The first goal should be to facilitate interoperability within related scientific communities, across countries and then across scientific disciplines. Wherever possible, the EOSC should re-use exiting mechanisms, such as the European Interoperability Framework.

The EOSC Declaration notes that standards (technical, semantic, legal and organisational) employed by the EOSC must combine long-term sustainability with optimal freedom of local implementation. The Declaration says they should be jointly defined by the research communities, taking into account existing instruments (e.g. EU Rolling Plan on ICT Standardisation).

The governance structure also needs to ensure the EOSC's roadmap builds on the work of the European Data Infrastructure, which is aiming to deploy the high-bandwidth networks, large scale storage facilities and super-computer capacity necessary to effectively access and process large datasets stored in the cloud.

Appendix: How other political/tech initiatives are governed

This section outlines the governance structures of other international bodies bridging geopolitics and technology, and in some cases, how they have evolved over time. It focuses primarily on the bodies that oversee the development of the Internet, which is probably the best example of a multinational technological framework that serves the needs of both the public and private sectors. Although this section draws heavily on the governance information detailed in the web sites of the bodies featured, it also includes some commentary.

How the Internet is governed

Although the US government played a pivotal role in the development of the Internet, it has largely resisted the temptation to try and control it. The Internet blossomed in the 1990s, thanks to the development of the National Science Foundation Network in the US, the emerging TCP/IP standard and the development of domain names, first under the auspices of the US government and then by the semi-independent Internet Corporation for Assigned Names and Numbers (ICANN). A dedicated community (organised by the World Wide Web Consortium) has also played a key role in setting and enforcing minimal standards, which anyone can use to create standard-compliant tools and services.

In the case of the Internet, the US government got the balance about right between top down intervention and bottom-up evolution – the National Science Foundation provided support without taking control. Despite its fundamental importance to the modern world, the Internet still has no major centralised governance structure; each constituent network sets its own policies. As a myriad of diverse groups are involved in the governance of the Internet, the system is infused with checks and balances, ensuring the system is unlikely to be hijacked by vested interests.

Almost all Internet technological standards are developed and set by the Internet Society (ISOC) and the units operating under the auspices of ISOC: the Internet Architecture Board (IAB), the Internet Engineering Steering Group (IESG), the Internet Engineering Task Force (IETF), the Internet Research Steering Group (IRSG), the Internet Research Task Force (IRTF), and the RFC Editor. Although these units are responsible to ISOC, the ISOC allows them a large degree of independence in their technical work.

But from a political perspective, the most important of the many groups that oversee the Internet is ICANN. Incorporated as a California non-profit, ICANN effectively determines the boundaries of the official Internet by controlling the use of domain names. The US government gave ICANN, a multi-stakeholder body, responsibility for the domain name system in 1998. In its formative years, the US government maintained limited control over the organisation, but is now relinquishing that control.

The Internet Governance Forum (IGF), another multi-stakeholder group, is supposed to help protect ICANN's independence, but some commentators believe ICANN is drifting closer to United Nations oversight. Some governments, such as those in Russia, China and Saudi Arabia, have advocated consolidating Internet governance under the International Telecommunications Union, a UN organization.

Some commentators fear that a takeover by the UN could undermine ICANN's multi-stakeholder model, which is designed in such a way that no one sector dominates. The ICANN board is somewhat reflective of the broad Internet community. In fact, its the governance model is designed to ensure that other stakeholders remain on an equal footing with governments, which don't get to make the final decisions.

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Although the Governmental Advisory Committee (the GAC), made up of representatives of national governments, provides advice to ICANN on public policy aspects of the domain name system, ICANN isn't obliged to follow that advice. However, GAC's web site notes that "where the ICANN Board proposes actions inconsistent with GAC advice it must give reasons for doing so and attempt to reach a mutually acceptable solution."

How ICANN is run

The following is an abridged version of the text on the ICANN web site:

ICANN's Board has 16 voting members ("Directors") and five non-voting liaisons ("Liaisons"). The Nominating Committee, Supporting Organizations and the At-Large Community (as these terms are used in ICANN's Bylaws) seek to ensure that the Board is composed of members who in the aggregate display diversity in geography, culture, skills, experience and perspective. No official of a national government or a multinational entity established by treaty or other agreement between national governments may serve as a Director. Only the President may be both an ICANN employee, or management, and a Board Member.

Besides providing technical operations of vital DNS resources, ICANN also defines policies for how the "names and numbers" of the Internet should run. The work moves forward in a style ICANN describes as the "bottom-up, consensus-driven, multi-stakeholder model:"

Bottom up. Rather than the Board of Directors solely declaring what topics ICANN will address, members of sub-groups in ICANN can raise issues at the grassroots level. Then, if the issue is worth addressing and falls within ICANN's remit, it can rise through various Advisory Committees and Supporting Organizations until eventually policy recommendations are passed to the Board for a vote.

Consensus-driven. Almost anyone can join most of ICANN's volunteer working groups. ICANN notes that "hearing all points of view, searching for mutual interests, and working toward consensus take time, but the process resists capture by any single interest."

Multi-stakeholder model. ICANN claims to treat the public sector, the private sector, and technical experts as peers. In the ICANN community, there are registries, registrars, Internet Service Providers (ISPs), intellectual property advocates, commercial and business interests, non-commercial and non-profit interests, representation from more than 100 governments, and a global array of individual Internet users.

Funding: ICANN is funded mainly from domain name and IP address registries and registrars. Its budget includes funds for a number of staff, headed by a President/CEO and including an Ombudsman.

The World Wide Web Consortium

The following is an abridged version of the text on the W3C web site:

The World Wide Web Consortium (W3C) creates technical standards and guidelines to ensure that the web remains open, accessible, and interoperable for everyone around the globe. W3C standards HTML5 and CSS are the foundational technologies upon which all web sites are built. W3C is jointly run by the MIT Computer Science and Artificial Intelligence Laboratory (MIT CSAIL) in the United States, the European Research Consortium for Informatics and Mathematics (ERCIM) headquartered in France, Keio University in Japan and Beihang University in China.

Organisational Structure: W3C does not have a typical organizational structure, nor is it incorporated. W3C is administered via a joint agreement among the "Host Institutions": MIT , ERCIM , Keio University, and Beihang University. The W3C staff (many of whom work physically at one of these institutions) is led by a director and CEO. A small management team is responsible for resource allocation and strategic planning on behalf of the staff. Regional offices play an important role in W3C being an international organization.

Some key components of the organization are:

- The Advisory Committee, composed of one representative from each W3C Member. The Advisory Committee has a number of review roles in the W3C Process, and they elect the Advisory Board and TAG.
- The Advisory Board, an advisory body elected by the Advisory Committee
- The Technical Architecture Group (TAG), which primarily seeks to document Web Architecture principles

The W3C Director and CEO, who assess consensus for W3C-wide decisions the chartered groups, populated by Member representatives and invited experts, and which produce most of W3C's deliverables according to the steps of the W3C Process.

Funding: W3C sources of revenue include W3C Member dues, research grants and other sources of private and public funding, and sponsorships and donations.

The Internet Society

The Internet Society describes itself a global leader on Internet policy, technical, economic, and social matters, and as the organisational home of the Internet Engineering Task Force (IETF). "Central to our success is the volunteer leadership provided by a dedicated and discerning Board of Trustees. We encourage interested individuals to consider serving on the board," it adds.

The Internet Society's by-laws specify that a total of four trustees are to be selected each year by ISOC's chapters, organization members, and the IETF. The number for each community changes annually to maintain the board's balance. In 2017, chapters will elect two Trustees; organization members and the IETF will each select one trustee. Following an orientation program, all new trustees will begin three-year terms commencing with the Annual General Meeting in June. Trustees are not paid for their service, but they can claim travel expenses.

The following is an extract from the W3C web site:

The Role of the Board of Trustees: In support of the organization's mission of preserving the open, global Internet, the board provides strategic direction, oversight, inspiration, support and advice. The board's role is strictly limited to governance, which is by definition, the creation of policies, and continuous monitoring of their proper implementation. In consultation with the CEO, the board sets up strategic goals and helps devise a high-level strategic action plan to reach them. Once the goals and plans are approved, the board oversees management's implementation and measures results of the actions taken in accordance with the plan. The board meets three or four times a year.

The European Centre of Medium Range Weather Forecasting

The following is an abridged version of the text on the ECMWF web site:

The European Centre of Medium Range Weather Forecasting (ECMWF) is a joint initiative by 22 EU Member States and 12 Co-operating States. Established in 1975, it has about 350 employees from over 30 countries. It is governed by a Council, the Director-General, and the Council's advisory committees. The ECMWF Council is made up of representatives from ECMWF's Member States and meets twice a year. The Director-General is the Centre's chief executive officer, and is appointed by the Council. He or she reports to the Council, and has overall responsibility for the work of the Centre. Six different committees advise the Council. These include the Scientific Advisory Committee, the Finance Committee, the Policy Advisory Committee, the Technical Advisory Committee, the Advisory Committee of Co-operating States and the Advisory Committee for Data Policy.

Funding: In 2014, ECMWF's annual budget of almost £55 million was funded largely by annual contributions from the Member and Co-operating States, according to a scale based on their gross national income. Significant funding is also provided from the sale of forecast and data products and from a variety of externally funded projects.

The intergovernmental Group on Earth Observations (GEO)

The following is an edited version of the text on the GEO web site:

Based in Switzerland, GEO was set up in 2005 by governments and international organisations, including the European Commission, to support sustainable development and sound environmental management. In particular, GEO is coordinating international efforts to build a Global Earth Observation System of Systems (GEOSS). The goal is to better integrate observing systems and share data by connecting existing infrastructures using common standards – an objective that has some similarities with the mission of the EOSC to make scientific data easily accessible.

Encompassing a broad set of scientific disciplines, GEOSS is conceived as a "system of systems" that addresses some interoperability issues. GEOSS brings together 400 million open data resources from more than 150 national and regional providers such as NASA and ESA; international organizations, such as WMO and the commercial sector, such as Digital Globe.

GEO itself is a partnership of 104 member governments and the European Commission; and 115 participating organizations, including various scientific or technical bodies, such as the European Space Agency, the Belmont forum, ICSU, IEEE and GEANT.

GEO has a multi-layered governance structure. The GEO plenary is the highest decision-making body, composed of "Principals" at the senior-official level of government, or their "Alternates", representing GEO member governments and participating organizations. Plenary meetings are held once a year and decisions are taken through consensus.

An executive committee oversees GEO's activities when the plenary is not in session. The committee consists of 16 representatives nominated by the five GEO regional caucuses, including four each from Asia/Oceania and Europe, three each from the Americas and Africa, and two from the Commonwealth of Independent States. The committee is also responsible for guiding GEO's secretariat. The GEO members elect four members to serve as co-chairs. They preside over both the plenary and the executive committee.

Reporting to the GEO executive committee and plenary, the programme board oversees the establishment of the multi-year GEO work programmes and works to align proposed activities with GEO priorities and committed resources. GEO members and participating organizations nominate representatives to the programme board. Three participating organizations from the programme board have observer seats on the executive committee.

The GEO plenary establishes working groups to address various aspects of GEOSS implementation and provide a mechanism for members of the GEO community to engage full in the work of GEO. Working groups provide high-level review, advice, recommendations and support in the ongoing development and implementation of GEO's 2016-2025 strategic plan.

Funding: Although members of GEO are not required to pay compulsory annual dues, they are encouraged to contribute financial resources, "to the greatest extent possible, in addition to the human, intellectual and programmatic resources needed to fully implement GEOSS."

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Huawei	Toyota

Academia

Aalto University	Politecnico di Milano
Aix-Marseille University	Trinity College Dublin
Chalmers University of Technology	TU Berlin
ESADE Business & Law School	University College London
ETH-Zurich	University of Amsterdam
Karolinska Institutet	University of Birmingham
King's College London	University of Bologna
KTH Royal Institute of Technology	University of Eastern Finland
KU Leuven	University of Luxembourg
Medical University of Warsaw	University of Pisa
NTNU - Norwegian University of Science and Technology	University of Twente
Pierre and Marie Curie University	University of Warwick

Public organisations

Barcelona Supercomputing Center	Fraunhofer
CNRS - Centre National de la Recherche Scientifique	Innovate UK
CERN	Innovation Norway
The COST Association	Research Data Alliance Europe
Eureka	Republic of South Africa - Department for Science and Technology
European Space Agency	Tekes – The Finnish Funding Agency for Innovation

Consortia and EU projects

ACM Europe Policy Committee
ATTRACT
DIRS – Deusto International Research School
ERC=Science2

Associate Members

European University Association (EUA)
Association of Commonwealth Universities (ACU)
Hospital Saint Joan de Deu
ICHOM – International Consortium for Health Outcomes Measurements

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