Workgroup: RASPRG
Internet-Draft:
draft-irtf-rasprg-analysing-ietf-data-01
Published: 2 November 2026
Intended Status: Informational
Expires: 6 May 2027
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Analysing Internet Standards Data

Abstract

This document outlines some issues to consider when studying data relating to the Internet standards development ecosystem. It identifies observable components of standards development processes, proposes a taxonomy of possible measurements, and highlights methodological, interpretive, and ethical considerations. It is intended to support a range of uses, including monitoring standards development organisations (SDOs), evaluating the evolution of technical work, understanding technology deployment, and informing community, leadership, and governance discussions.

This document is submitted for consideration by the Research and Analysis of Standard-Setting Processes Research Group (RASPRG) in the IRTF. It is not an IETF product and is not a standard.

About This Document

This note is to be removed before publishing as an RFC.

The latest revision of this draft can be found at https://csperkins.github.io/draft-analysing-sdo-data/draft-irtf-rasprg-analysing-ietf-data.html. Status information for this document may be found at https://datatracker.ietf.org/doc/draft-irtf-rasprg-analysing-ietf-data/.

Discussion of this document takes place on the RASPRG Research Group mailing list (mailto:rasprg@irtf.org), which is archived at https://mailarchive.ietf.org/arch/browse/rasprg/. Subscribe at https://www.ietf.org/mailman/listinfo/rasprg/.

Source for this draft and an issue tracker can be found at https://github.com/csperkins/draft-analysing-sdo-data.

Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

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1. Introduction

Internet technologies are developed and standardised by a range of standards development organisations (SDOs), including the IETF, along with 3GPP, IEEE, ITU-T, W3C, and others. The standards these organisations produce underpin the interoperability and architectural evolution of the Internet and the Web.

Understanding how Internet standards are developed, including, for example, who participates in the standards process, what collaborations occur during the development of standards, how the process is organised and governed, and how the technical outputs evolve prior to publication, is important to support analysis and development of the standards ecosystem. Such analysis can assist with monitoring standards development organisations, evaluating the evolution of technical work, and understanding technology deployment, and can ultimately be used to inform community leadership and governance discussions [RFC9307].

This document outlines issues to consider for studying data from the Internet standards development ecosystem. It aims to:

* identify observable components of the Internet standards development ecosystem;

* describe considerations for measuring and analysing the standards development process;

* provide a taxonomy of possible measurements and analytical approaches;

* highlight methodological, interpretive, and ethical considerations;

* illustrate the application of these methods to the IETF, given the availability of rich data about the IETF participants, documents, processes, and communication channels;

* discuss the relevance and limits of applying these methods to other SDOs and the extent to which differences in governance, transparency, and data availability affect such analysis; and

* encourage reproducible research practises and transparent analysis.

This document does not prescribe specific metrics, define evaluation criteria, or recommend approaches to comparative rankings of standards bodies, groups, or participants.

2. Standards Development as a Socio-Technical System

Internet standards development can be understood as a socio-technical system in which technical artefacts, human participants,

organisational interests, and governance processes interact over time. Standards do not emerge solely from technical design choices, nor solely from institutional processes; rather, they arise through structured collaboration among individuals and organisations operating within formal [RFC2026] and informal rules [Cath2017] [Simcoe2011] [Simcoe2012] [Simcoe2014].

Technical outputs emerge from a process in which engineering choices interact with expertise, incentives, organisational structures, review processes, historical precedent, deployment constraints, and the cultural norms and practises of the standards community. At the same time, the organisational and cultural context is not fixed: governance structures, working practises, and community norms evolve together over time and these changes in turn shape future participation and technical decision-making [Baron2024].

For analytical purposes, standards development organisations can be viewed as comprising several interacting components:

* **Participants:** Participants are the individuals who contribute to standards development. They may include engineers, implementers, network operators, industry researchers, academics, independent contributors, civil society representatives, policymakers, and others with relevant expertise or interests. Participation criteria differ across SDOs. Some permit open participation, while others restrict and structure participation through organisational- or state-based membership, sometimes with additional exceptions or parallel open mechanisms.

  Participation models affect standards development by shaping both who is able to contribute, and how they are permitted to contribute. Open participation can broaden the pool of contributors and make it easier for individuals to join without specific institutional affiliation, potentially increasing diversity of experience and viewpoints. At the same time, openness does not eliminate all the barriers to participation. Effective participation may still depend on having sufficient time, funding, employer support, travel resources, and familiarity with the processes, tools, and norms of the community. Membership-based models can provide clearer institutional commitment and resourcing, but they can also limit participation to those acting through recognised organisations or membership categories [Cath2021a] [Cath2023] [Baron2024].

* **Organisations:** Participants are often affiliated with organisations such as companies, consultancies, academic institutions, civil society groups, or governments. These organisations may provide support for participation, including but not limited to funding, staff time, technical or other expertise, and implementation or operational experience.

  The relationship between participants and organisations is not equally visible across SDOs. In some models, participation is

individual and so any recorded affiliation may be incomplete, and may reflect a specific contribution rather than the sustained view of the participant. In other models, where individuals participate on behalf of a clearly indicated affiliation, there may be a clearer link to an institutional position.

Even where affiliations are recorded, they may not fully describe the organisational context. A company may be a subsidiary of another company (or in the process of becoming so), and consultants or contractors may work for clients whose interests are not directly visible in participation records.

* **Technical Groups:** SDOs typically organise their work through technical groups such as working groups, research groups, study group, committees, or similar bodies. These groups define scope, coordinate discussion, and develop technical outputs. They are not always organised as a single flat layer, with hierarchical and other structures in use.

  The number, names, and functions of these structures differ across organisations. In some cases, they reflect administrative oversight or broad technical areas; in others, they distinguish between different forms of technical development.

* **Artefacts:** Standards development processes generate artefacts such as drafts, specifications, recommendations, reports, agendas, minutes, presentations, issue trackers, and final published standards. These artefacts provide an observable record of technical development. Revision histories, references, and relationships between artefacts may help reveal aspects such as participation dynamics, design iteration, and the evolution of the underlying technologies subject to standardisation.

  Different SDOs vary in how openly they make such information available and in how easily it can be accessed and reused. Artefact availability can support the work of participants, researchers, and other observers, but collecting, maintaining, publishing, and organising this information also imposes costs on SDOs.

* **Collaboration Infrastructure:** Standards development requires communication and collaboration among participants to propose work, discuss technical issues, review contributions, coordinate activity, resolve disagreements, and build support for possible outcomes. SDOs therefore rely on systems such as mailing lists, messaging systems, code repositories, teleconferences, and meetings to facilitate this debate.

  The mix of communication, collaboration, and coordination mechanisms differs across SDOs, often to support the other attributes described.

* **Governance Structures:** Standards bodies have formal governance structures, with charters specifying the scope of different activities, defined leadership roles, review and approval stages, appeals processes, voting rules, consensus procedures, and so on. These structures define how work is initiated, scoped, reviewed, approved, and contested.

  At the same time, influence is also exercised through reputation, recognised expertise, community norms, procedural familiarity, and control over agendas, drafting, or review capacity. Governance structures therefore shape how decisions are made, how priorities are established, how disagreements are managed, and, ultimately, how influence is distributed within standards development [Farrell2012] [Simcoe2011] [Simcoe2012] [RFC7282] [Khare2022] [Barnes2024] [Zhang2025].

* **Standards Implementation and Deployment:** Implementation usually occurs outside the formal standards process, and may be voluntary by interested parties or mandated by policy in certain jurisdictions.

  In many cases, publication of a standard does not by itself require implementation. Adoption may therefore vary widely. Some standards are widely deployed, while others see limited or no implementation. Adoption may also be shaped by factors outside the standards process, including regulation, procurement, cost, and compatibility with existing systems.

  Data on implementation and operational use is often difficult to find [RFC5218] [Nikkhah2017] [McQuistin2021] [RFC8980] [RFC8963].

Measuring SDO activity is challenging. Observable metrics such as publication counts, message volume, attendance figures, authorship, or leadership roles can provide useful evidence, but each captures only part of the standards process. Analysis of artefacts and patterns of communication from the collaboration infrastructure (e.g., analysis of mailing list messages) can provide more detail and nuance, at the expense of additional complexity, but even these cannot provide a complete view [RFC9307] [Khare2022] [Barnes2024] [McQuistin2021].

There are several reasons for this. One is that critical aspects of standards development are hard to observe directly. The culture of the SDOs, influence of individuals, groups, and ideas, agenda setting, informal coordination, negotiation, and the practical exercise of power and authority may not be well represented by any single metric, or group of metrics, and are extremely challenging to infer from communication patterns or even the content of archived messages [Simcoe2011] [Khare2022]. Further, the available context is often limited. Data availability and quality vary across SDOs, and different parts of the process are not equally observable. Even within a single SDO, some information may be incomplete, difficult to access, inconsistently structured, or unavailable. Context and

insights from participant interviews may reveal more detail [Cath2021a], but such ethnographic research requires specific expertise to be effective [Cath2021b].

Combining multiple data sources introduces additional challenges. Observations from different SDOs, or from different parts of a single SDO, may not share stable identifiers, identifiers may change over time, and the same entity may appear in different forms across records. Voluntary declarations, non-standard terminology, and organisational changes such as mergers or acquisitions may further complicate linkage.

Metrics, artefacts, and other data sources may also differ in accuracy, representativeness, and relevance. Not all artefacts have the same significance, not all forms of participation have the same effect, and visible activity does not necessarily correspond to implementation, adoption, or wider impact. Measures should therefore be interpreted cautiously and, where possible, considered alongside complementary indicators [RFC9307] [McQuistin2021].

3. Analysing the IETF

IETF participation is open to all, with no formal membership. Individuals can participate by joining the mailing lists, contributing to discussions, submitting Internet-Drafts, and attending meetings. Contributions ordinarily reflect the opinion of participants, and not necessarily their affiliation [RFC2026].

The IETF has a hierarchical group structure, comprising technical working groups organised into distinct areas, along with a corresponding hierarchy of management roles that individuals may fill including working group chairs and area directors [Barnes2024] [Baron2024].

Reflecting its open participation model, much of the IETF's processes are publicly observable through open records and dedicated APIs. Mailing lists are a central forum for working group discussion, alongside meetings. Some groups also use externally hosted repositories, for example on GitHub, to support artefact preparation and issue discussion [Welzl2021] [Khare2022].

3.1. Datatracker

The IETF Datatracker (https://datatracker.ietf.org/) is the main source of day-to-day and historical data about the operation of the IETF. It can be accessed via the website or programmatically using a REST API and provides information about:

* Participants including names, email addresses, pronouns, biographies, and photos, and external resources such as personal websites, GitHub usernames, and Orcid identifiers. The Datatracker maintains a record of the different names and email addresses used by individuals.

* Artefacts such as RFCs, Internet-drafts, meeting agendas, participation records (blue sheets), working group charters, conflict reviews, shepherd write-ups, liaison statements, minutes, and presentation slides, including:

  - Metadata such as the title, name ("draft-ietf-..."), revision, date, state, and where appropriate abstract, working group, RFC number and publication stream, status on the standards track, area director, and document shepherd.

  - Submissions (e.g., different revisions of internet-drafts) with document name, revision, date, title, abstract, authors, group, and metadata about documents the submission replaces.

  - Authors with email address, affiliation, and country.

  - Events such as state changes state, expiration, details of IESG processing, IETF last call, directorate reviews, IANA reviews, etc., with the document name, revision, date, and responsible person.

  - Relationships including normative and informative references, and document replaced, updated, or obsoleted.

* Working groups, research groups, area directorates, review teams, and leadership bodies such as the IESG, IRSG, and IAB, including the group name and acronym, group state, relationships between groups (e.g., working groups are organised in areas), the mailing list, charter text, milestones, and who occupies key roles in the group.

* IESG processing, including ballot positions, the text of comments and discusses, and scheduling of the IESG review [Hares2022].

* Directorate membership and directorate reviews, including the document, reviewer, outcome, data, and the review text.

* Meetings, including both plenary and interim meetings, with venues, dates, and times, details of what groups met in what time slots, and registration and attendance data.

* IPR disclosures including the document that the IPR relates to, the person making disclosure, details of the patent, and licensing terms [Rysman2008].

The Datatracker has been developed over time, and this is reflected in the data that is available, with more recent data being significantly more complete than earlier data. Datatracker profiles are only required for a subset of IETF activities (e.g., draft submission, meeting registration), and so a number of active participants do not have a profile [RFC9307].

3.2. RFC Editor

The RFC Editor makes the RFCs, and the RFC index, available in a machine readable form at https://www.rfc-editor.org/rfc-index.xml. The RFC index includes titles, authors, publication date, status, abstract, publication stream, name of the precursor Internet-Draft, and the IETF area and working group that developed the RFC, if appropriate. This information is also available in the IETF Datatracker [RFC8729].

Information about RFC errata is available on the RFC Editor website at https://www.rfc-editor.org/errata.php. This data is also available in machine readable form [McQuistin2023].

3.3. Mailing List Archives

The IETF maintains public mail archives at https://mailarchive.ietf.org/ that are also available in machine readable form via IMAP from imap.ietf.org. The recent mail archives are essentially complete, but some historical lists that were not originally hosted by the IETF are missing. Spam emails have largely, but not entirely, been removed from the archive. As of March 2026, the IETF mail archive contains approximately 3 million messages from almost 1400 mailing lists, around 40GB of data, with some messages dating back to the late 1980s.

The are significant data quality problems with older messages in the IETF mail archive, due to problems with the original messages rather than the archive, that make them difficult to process [Niedermayer2017] [McQuistin2023] [Khare2022].

3.4. Meeting Recordings and Chat Archives

The IETF makes video recordings of its plenary meetings, and many interim meetings, available on YouTube (https://www.youtube.com/user/ietf) and via the Meetecho player. The latter is linked from the meeting materials page in the Datatracker, and provides synchronised replay of the chat, polls, etc., in addition to the video. Auto-generated meeting transcripts are available, but with significant limitations on accuracy. In recent years, professional manual transcriptions are available for plenaries and a limited number of meeting sessions.

Audio recordings of IETF plenary meetings from IETF 49 through to IETF 106 are available at https://get.ietf.org/archive/audio.

The IETF makes use of interactive chat during meetings. Jabber was used prior to 2021, with archives at https://get.ietf.org/archive/jabber/. More recently, Zulip has been used accessible at zulip.ietf.org.

3.5. GitHub

Some IETF working groups, and some participants, make extensive use of GitHub for artefact development and issue tracking. The IETF does not maintain a complete list of GitHub repositories associated with its work, but the IETF Datatracker contains links to a subset of GitHub repositories, organisations, and user profiles. Internet-drafts developed using some widely used tools also include links to the related GitHub repository in their boilerplate text.

The following information is available using the GitHub API:

* Information about GitHub users that contribute (e.g., username, email address, and other biography information).

* Contributions and changes, by way of Git commits, made by those users to documents.

* Discussion that takes place through comments and issues.

At the time of writing, use of Github in the IETF has been steadily increasing for a number of years [Khare2022].

3.6. Surveys

The IETF LLC provides annual reports on its activities, and conducts annual community surveys to understand demographics, participation trends, and perceptions of the IETF, and post-meeting surveys to seek operational feedback on the meetings. These reports and survey results are available at https://www.ietf.org/reports/.

4. Analysing Other SDOs

Standards relevant to the Internet and the Web are also developed within the 3GPP, IEEE, ITU-T, W3C, and others. Each organisation has its own governance model, participation structure, institutional culture, and data availability. These differences affect both what can be observed, and how observations should be interpreted [Simcoe2014] [Cath2021a].

4.1. Data Availability Across SDOs

SDOs vary considerably in terms of what data that they make publicly available about their activities, and how easily that data can be accessed and processed.

For example, the W3C provides a REST API at https://api.w3.org, covering metadata about documents, participants, affiliations, and groups, and also maintains a public mailing list archive. W3C groups make extensive use of GitHub for document development and issue tracking. The W3C operates under a membership model, in which participation is primarily through affiliated organisations. This affects how data about participants and their contributions should be

interpreted, particularly when being compared to data from the IETF and other SDOs with individual participation models.

The ITU-T and 3GPP both operate under membership-based models where access to documents, meeting records, and contribution data is typically restricted to member organisations. Some ITU-T Recommendations are made publicly available after publication, while the 3GPP makes its specifications available at https://www.3gpp.org/specifications, and 3GPP and ETSI mailing list archives are publicly archived at https://list.etsi.org/ The working documents, contributions, and meeting records are generally not accessible to non-members.

Differences in data availability mean that the methods applicable to the IETF, where rich longitudinal data is publicly available, may not be replicable across all SDOs. Any analyses should account for these availability differences [RFC9307].

4.2. Integrating Data Across SDOs

Efforts to understand the wider standardisation landscape requires combining data across multiple SDOs.

The various Internet SDOs do not share common identifiers for participants, organisations, documents, or other metadata. An individual that participates across multiple SDOs may appear under different names, email addresses, or usernames in the records of each SDO. Resolving these identifies requires suitable entity resolution mechanisms, and the risk of both incorrect matches (where two unrelated entities are linked together) and missed matches (where one entity has multiple, separate records in each SDO). The same risks apply to affiliations: companies may be recorded under different names, abbreviations, or subsidiary identities across SDOs.

Standards developed within one organisation may reference, build upon, or be coordinated with work at another SDO, but these relationships are not reliably captured in any shared record. Reconstructing these relationships requires either manual effort, or natural language processing of document content, introducing the risk of errors. Liaison statements, and other formal and informal communications between SDOs, are common, but are not always publicly archived.

The different SDOs operate on different timescales and following different processes. Comparing activity across organisations at a given point in time may not reflect equivalent stages of development.

Finally, differences in governance and participation models affect which comparisons are meaningful. Data analyses, and the interpretation of them, must consider that apparent differences between SDOs may reflect structural factors (e.g., open vs. membership-based participation) rather than substantive differences in behaviour or outcomes [Simcoe2014].

5. Data Processing

Significant processing effort is required to clean, normalise, and link data records before they can be processed.

The same participant may appear across each of the data sources with different identifiers, including names, email addresses, usernames. These identifiers may change over time. Entity resolution (using exact and heuristic matching) is feasible in many instances, but requires careful validation to prevent the introduction of errors into later analyses. Entity resolution of organisations is similarly challenging, where companies may be subsidiaries of another, might merge or be acquired, or, given the unstructured nature of the dataset, appear under different names (to illustrate the scope of the entity resolution problem note that, as of May 2026, there are 282 variants of the name "Huawei" in the IETF Datatracker). Information external to the Datatracker, and other data sources, is often needed to process organisational data [Khare2022] [McQuistin2021].

Participants may have more than one affiliation, including across the lifetime of a particular contribution (e.g., an Internet-Draft). Affiliation data is only recorded for a subset of activities, and may need to be inferred (e.g., from corporate domain names) in other cases. Affiliation data, where recorded, indicates the participant's affiliation at moment in time for a particular contribution, making it difficult to form a continuous history.

Document life cycles are non-linear, and documents might pass through multiple working groups, be replaced or updated by later drafts, and change authorship and status over time. There are numerous exceptions to the published document life cycle.

Working group and research group leadership, and membership of bodes such as the IESG, IRSG, and IAB, is difficult to accurately reconstruct. Knowing who chaired a working group during a particular period, or which area a given group belonged to at a given time, requires the reconstruction of a timeline from historical event records held in the Datatracker. These records can be incomplete or inconsistently formatted [Barnes2024] [Baron2024].

Email metadata and message content presents a number of challenges. A significant number of messages contain malformed or archaic header fields that cannot easily be processed using widely used email parsing libraries and need correction. Mail clients perform the threading of messages in different ways, with the separation between new and quoted text becoming unclear. Natural language processing of message content requires contextualisation, with informal conventions, technical vocabulary, and the use of acronyms, all of which may evolve over time, presenting challenges that are unique to the dataset [Niedermayer2017] [Welzl2021].

The quality of the IETF dataset degrades significantly for historical records. Data that was not gathered by the Datatracker at the time,

or that has been subject to partial backfilling later, must be treated with caution, both in terms of data processing and later analyses [RFC9307].

6. Ethics and Data Protection

Data is made available by the IETF, and other Internet SDOs, subject to their particular privacy and data protection policies and terms of use. For the IETF, these are described at https://www.ietf.org/privacy-statement/; other SDOs will have their own policies.

The available data includes considerable amounts of personal information that is potentially sensitive and subject to legal restrictions on processing and use in many jurisdictions (e.g., the GDPR in Europe). Researchers must ensure that their use of such data conforms to any applicable regulations. It is important to note that the regulations that apply to research use of such data may differ from those that apply to the IETF, or other SDOs, with regards to their use of the data as part of the standards process.

Researchers must ensure that their research, in particular research that involves personal data from the IETF or other SDOs, is conducted ethically and with respect for persons, in careful consideration of the risks and benefits of the work, taking care to ensure that those who bear the risk also gain some benefit, and with respect for the law and public interest. Researchers should consult with their organisation's Institutional Review Board, Research Ethics Committee, or similar, prior to conducting research that might raise ethical concerns, and are referred to the guidance in the Menlo Report [Menlo], the Belmont Report [Belmont], and the ACM Policy on Research Involving Human Participants and Subjects [ACM] for further discussion of issues around ethical conduct of research.

Researchers are reminded that while data may be public, the implications of that data are not always well-known. For example, data that can be collected from the IETF Datatracker makes it possible to derive measures of the effectiveness of individuals in certain roles that, if presented out of context, might be considered sensitive [RFC9307]. It is inappropriate to publish data about specific individuals without their explicit consent.

Finally, we note that researchers must take care to avoid disruption to the Internet standards process. In part, this requires that they consult with the operations staff in the IETF LLC, or other SDOs, to ensure their data access does not cause operational difficulties (e.g., overload of servers that might disrupt an ongoing meeting). More broadly, researchers should ensure that any results that might be considered sensitive or disruptive are responsibly disclosed to the affected parties prior to publication. The effective operation of the Internet standards process directly affects critical global infrastructure, and researchers should be mindful of this when presenting results.

7. Recommendations

Analysis of Internet standards development data is useful to support transparency and provide insight into the health, structure, and evolution of the Internet standards ecosystem, including patterns of participation, collaboration, concentration, and the development of technologies [RFC9518]. It can inform discussions within SDOs and provide indicators of how technical work progresses over time [Simcoe2006] [Simcoe2012] [Ganglmair2025]. Such analysis can also inform broader Internet governance questions, such as how decision-making is structured, how participation is distributed, and the extent of centralisation in these processes [RFC9518]. This information can be useful to external stakeholders, including regulators, policy makers, and civil society, seeking to understand how standards are developed and governed.

Analysis of standards development is constrained by what can be observed. Important aspects of the Internet standards development process, such as informal discussions ("many fine lunches and dinners" [Rose1989]), trust relationships, institutional memory, cultural norms, and the exercise of influence may be only partially visible. In addition, available data is often incomplete, inconsistently structured, and shaped by changes in tools and processes over time, with historical records in particular being sparse or unreliable.

As a result, analyses based on these data provide only a partial view of the process. Quantitative metrics such as message volume, authorship, participation counts, or leadership roles can be useful indicators, but do not directly capture influence, authority, or impact [Simcoe2011] [Khare2022]. They should therefore be interpreted with care and in context, rather than in isolation.

Where data is derived or reconstructed (e.g., via entity resolution, affiliation inference, or automated extraction) it is important to retain a clear link to the original sources. The provenance of such transformations should be documented, and derived data should be distinguishable from primary records [RFC9307]. This allows results to be checked and, where necessary, corrected.

SDOs can support analysis of their processes by ensuring that the data they produce remains consistent, well-structured, and accessible over time. This includes maintaining clear, timestamped documentation of artefacts and processes, recording changes and their implications, and using consistent data formats and identifiers. Providing structured access to data, for example through stable and well-documented APIs can be especially helpful. When introducing changes to tools, processes, or working practises, it is important to consider how these affect what is recorded and how it can be analysed. Where changes introduce discontinuities these should be clearly documented, including their scope and implications, so that their impact on the data can be understood and accounted for in subsequent analysis.

Comparisons across standards development organisations require particular care. Differences in governance, participation models, and transparency affect both what is observable and how it should be interpreted. Apparent differences between organisations may reflect these structural factors rather than substantive differences in behaviour or outcomes [Simcoe2014].

Finally, although much of the data used in this type of analysis is publicly available, its use still raises ethical questions. Analyses can have implications for individuals and organisations, especially if results are presented without sufficient context. Researchers should take care in how findings are reported, particularly where they relate to identifiable participants.

7.1. Recommendations for the IETF

* **Preserving a centralised and stable data access:** The Datatracker provides a central interface for structured data about IETF activity. Maintaining this role, including stable identifiers, consistent schemas, and well-documented APIs, supports reproducible and longitudinal analysis. Where data is maintained across multiple systems, stable references to authoritative sources help ensure consistency and integration.

* **Data quality and consistency:** The data reflects changes in tools and practices over time, which can make it harder to interpret, especially for older records. Common data such as events, roles, group metadata, and document states may be inconsistent across time. Where possible, these differences should be made consistent or clearly documented.

* **Historical data and backfilling:** Historical data may be incomplete. Where records can be reconstructed with confidence, backfilling can improve coverage. Backfilled data should be clearly identified, and its provenance documented.

* **Provenance of derived data:** Where data is derived from primary sources (e.g., extraction from archival material), the relationship between source and derived data should be explicit. Original artefacts should be retained where possible, and derived records clearly distinguished to allow validation and correction.

* **Error reporting and correction:** Datasets will contain errors, particularly in historical or reconstructed records. Providing a transparent mechanism for reporting and correcting errors, along with maintaining a record of changes, improves reliability.

* **Impact of process and tooling changes:** Changes to tools and working practises affect what is recorded and how it can be analysed. Where such changes introduce differences in data structure or coverage (e.g., adoption of different collaboration platforms), these should be documented clearly, including their

scope and implications, to preserve comparability across groups and over time.

7.2. Recommendations for Researchers

Analysis of standards development data requires careful handling of both the data and its interpretation. The following practises can improve the robustness and reproducibility of such work:

* **Care in Datatracker use:** When using the Datatracker, it is preferable to download a local snapshot of the data, while respecting any access limits, and perform analysis on that copy. This avoids repeated queries to the live API.

* **Use versioned data snapshots:** The underlying datasets evolve over time. Analyses should be based on well-defined snapshots rather than live data, so that results can be reproduced and compared.

* **Document data processing steps:** Significant processing is often required before analysis, including cleaning, normalisation, and entity resolution. These steps can materially affect results and should be clearly documented, including any assumptions or heuristics used.

* **Handle identity and affiliation data with care:** Participants may appear under multiple identifiers, and affiliations may be incomplete, ambiguous, or change over time. Methods used to resolve identities or infer affiliations should be validated where possible and treated as approximations.

* **Account for incomplete and inconsistent data:** Not all aspects of the standards process are equally observable, and available data may be incomplete or inconsistent, particularly for historical records. Analyses should account for these limitations and avoid over-interpreting gaps or trends.

* **Separation of primary and inferred data:** Some data useful for analysis (e.g., identity resolution, affiliation inference) involves interpretation. Such data should be distinguishable from primary records, with clear documentation of how it was produced.

* **Be cautious in interpreting metrics:** Common metrics such as message volume, authorship, or participation counts do not directly capture influence, authority, or impact. Results should be interpreted in context and, where possible, supported by complementary evidence.

* **Consider the impact of tooling and process changes:** Changes in tools or working practises (e.g., use of different collaboration platforms) can affect what is recorded and how it is structured. These changes should be considered when interpreting longitudinal trends or comparing across groups.

* **Engage with the community:** Data alone provides an incomplete view of the standards process. Engagement with participants or domain experts can help interpret results and identify factors that are not visible in the data.

* **Support reproducibility and reuse:** Where possible, researchers should share datasets, code, and methods, subject to applicable policies and privacy considerations. This reduces duplication of effort and improves the reliability of results.

* **Contribute improvements where appropriate:** Effort spent cleaning or structuring data may be of broader value. Where feasible, contributing corrections or improvements back to shared data sources can benefit the wider community.

* **Consider ethical implications:** As discussed in the Ethics and Data Protection section, analysis may have implications for individuals or organisations. Care should be taken in how results are presented, particularly where they may be sensitive or open to misinterpretation.

8. Security Considerations

Research into the operation of the Internet standards development ecosystem does not directly affect the security of the Internet. Effective operation of the Internet standards process is, however, critical to the security of the network, and researchers studying the development of Internet standards must consider potential security implications of their results and ensure that any such implications are responsibly disclosed to the relevant SDO. Examples might include, but are not limited to, research that discovers attempts to subvert or disrupt the operation of the standards process.

9. IANA Considerations

This document has no IANA actions.

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Acknowledgments

This document builds on work funded, in part, by the UK Engineering and Physical Sciences Research Council under grants EP/S033564/1 and EP/S036075/1.

The authors wish to thank Niels ten Oever, Kesara Rathnayake, and the other members of the IRTF RASPRG for their helpful feedback.

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