

## **1. Executive Summary**

The 114th meeting of the Internet Engineering Task Force (IETF) was held in Philadelphia, USA, in late July 2022. This was the IETF's second hybrid meeting after the start of the COVID-19 pandemic and over 600 people from dozens of countries attended in person.

After consultation with the IETF community, the organization put in place several mitigation measures to minimize the potential spread of COVID-19. These included a vaccination requirement, mandatory use of high-quality masks, freely available high-quality masks, freely available rapid tests, and encouraged daily rapid testing. As a result of community embrace of these measures during the meeting, only 2.57% of attendees tested positive for COVID-19 during the meeting or within the following three days. Half of these tested positive on or before the first official day of meetings, suggesting exposure prior to traveling to the meeting based on a median three-day virus incubation period.

This paper explains the pandemic environment at the time of the meeting, the mitigations utilized, and the lessons learned. This paper can inform future IETF hybrid meetings during the COVID-19 pandemic (or potentially the later endemic phase) as well as other professional meetings that other organizations may hold.

## **2. IETF Meetings During the COVID-19 Pandemic**

### **a. Prior to COVID & Early Pandemic**

Prior to the COVID-19 pandemic, the IETF met in person three times each year, rotating between North America, Europe, and Asia. These meetings have been traditionally held in March, July, and November of each year. Starting from the first IETF meeting in 1986, the organization has tracked participation over the years<sup>1</sup> which has recently ranged between roughly 1,000 - 1,600 participants each meeting.

The IETF has supported remote participation for almost 10 years, with formal remote support starting back in 2013, using products based on standards developed in IETF working groups. However, before COVID, the overall meeting structure and practices were designed to advantage in-person attendees during working group meetings and true integration of remote and onsite participants had not been a goal. That being said, due to the IETF's role in creating Internet standards and working between meetings on a globally distributed, asynchronous basis, the IETF had mature tools and work processes to support remote collaboration. This was an essential foundational element that was a part of the IETF's tools, processes, and work culture that prepared the group well for the shift to remote work forced by the pandemic.

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<sup>1</sup> See IETF Datatracker stats for attendance over time at <https://datatracker.ietf.org/stats/meeting/overview/>.

It became apparent to the IETF's administrative and operations teams that the pandemic that emerged in early 2020 would significantly impair the IETF's ability to meet in person March 21-27, 2020 in Vancouver, Canada, for IETF-107<sup>2</sup>. The first official communication to the IETF community about this occurred on February 2, 2020<sup>3</sup>, when the IETF announced travel restrictions would likely impact attendance. A subsequent update was shared on February 24, 2020<sup>4</sup>, explaining likely mitigations and other issues. Those mitigations and issues were further expanded in a communication on March 4, 2020<sup>5</sup>. Ultimately, the in-person meeting had to be canceled and the meeting shifted to fully online, as communicated on March 10, 2020<sup>6</sup>. While this is outside of the scope of this document, the IETF was fortunate to have an event insurance policy that covered pandemic-related cancellation and was able to pursue an insurance claim and receive a settlement (it is no longer practical to affordably secure insurance with similar coverage at this time).

Including IETF-107 in March 2020, the IETF subsequently met virtually for six meetings over two years, including through IETF-112 in November 2021. Over this time significant investments in and improvements to IETF online meeting participation tools were made, particularly to the Meetecho real-time communications tool<sup>7</sup> used for all working group meetings. So while the IETF's remote tools and processes were mature beforehand, the IETF community and the organizations and people supporting the IETF came together to meaningfully advance these tools and processes.

## b. Transition to Hybrid Meetings

While the IETF was able to successfully weather the pandemic for two years from 2020 and 2021, it became clear that an inability to meet in person was negatively impacting new and existing work<sup>8</sup>, as measured by Internet-Drafts submitted (see figure below). Looking more specifically at new -00 drafts (first drafts), there was a 16% drop in new drafts in 2020 when meetings went online compared to the prior year and a further 7% drop in 2021 compared to 2020 - an overall drop of 22% when comparing 2021 to 2019, before COVID. The organization also had fewer Birds of a Feather (BoF) proposals - which are typically a first step before creation of a new working group - another way to

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<sup>2</sup> See proceedings from IETF-107 at <https://datatracker.ietf.org/meeting/107/proceedings>.

<sup>3</sup> See email of February 2, 2020 at <https://mailarchive.ietf.org/arch/msg/ietf-announce/hNRWBvEwgwQIapmNtw2EP1uIS1o/>.

<sup>4</sup> See email of February 24, 2020 at [https://mailarchive.ietf.org/arch/msg/ietf-announce/legMcsx2H\\_OEVLVtyEst\\_O-7qmY/](https://mailarchive.ietf.org/arch/msg/ietf-announce/legMcsx2H_OEVLVtyEst_O-7qmY/).

<sup>5</sup> See email of March 4, 2020 at <https://mailarchive.ietf.org/arch/msg/ietf-announce/uMUo7ib0WfVmnXeulBI0-RqENcs/>.

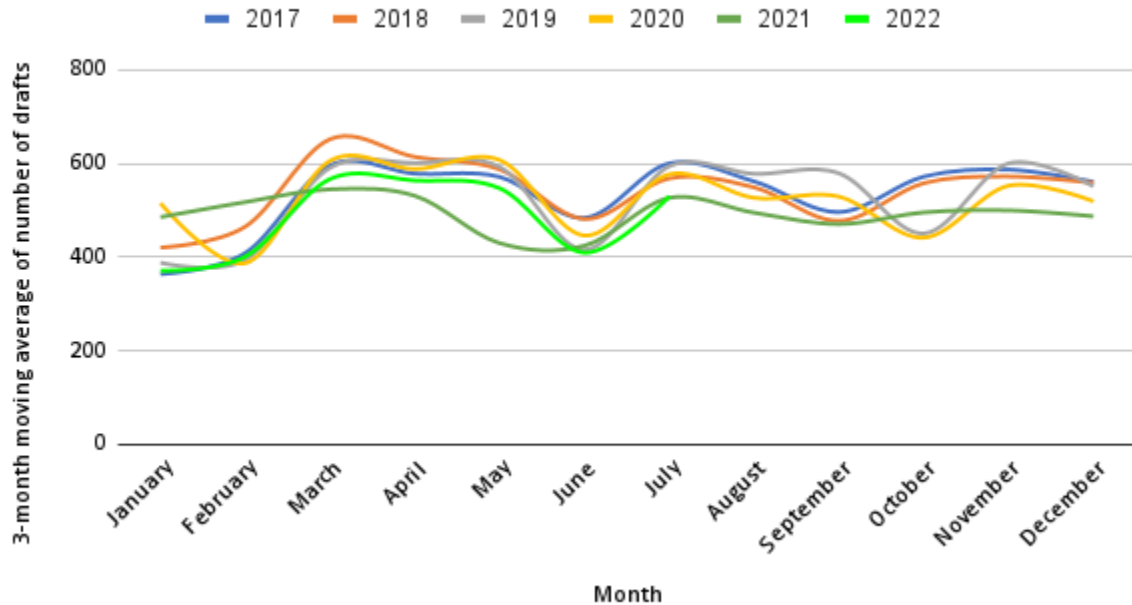
<sup>6</sup> See email of March 10, 2020 at <https://mailarchive.ietf.org/arch/msg/ietf-announce/WnC93yQanxb1GhOGYU97vFxc5RU/>.

<sup>7</sup> For details about Meetecho, see their website at <https://www.meetecho.com>.

<sup>8</sup> See slides from the IETF Chair at IETF-111, slides 9 - 13 at <https://datatracker.ietf.org/meeting/111/materials/slides-111-ietf-sessa-ietf-chair-report-00>.

gauge new work. In addition, surveys of meeting participants<sup>9</sup> increasingly recorded a desire by some people to begin to return to in-person meetings.

### Internet-drafts published



As a result, the IETF prepared for a new hybrid meeting model starting with IETF-113<sup>10</sup> in Vienna, Austria, from March 19-25, 2022. The meeting coincided with a slight reduction in global COVID infections and loosening government restrictions on travel. Roughly 20% of participants chose to attend the meeting in person.

A significant enabler to successful hybrid meetings was a significant enhancement over the prior two years to the key Meetecho tool used by the IETF. This tool integrated real-time remote video participation in working group meetings, managing the queue for discussion and questions, text-based chat, and video that can cover in-person and remote presenters as well as working group chairs, and enables screen and presentation sharing by the lead presenter at any given moment. The tools and processes supporting hybrid meetings were intended to ensure a rich experience for remote attendees and to put them on more equal footing with in-person participants during working group meetings.

The hybrid meeting model has continued in 2022. All indications are that even after COVID becomes endemic that the hybrid meeting model is here to stay.

<sup>9</sup> See for example the post-meeting survey results from IETF-111 at <https://www.ietf.org/blog/ietf-111-post-meeting-survey/>.

<sup>10</sup> See the hybrid meeting information and agenda for IETF-113 at <https://www.ietf.org/how/meetings/113/>.

**c. IETF-114 in Philadelphia**

The 114th meeting<sup>11</sup> was held in Philadelphia, USA, from July 23-29, 2022. Like IETF-113, it was a hybrid meeting. In addition, it was preceded by a Hackaton on July 23-24, 2022. Event staff from the IETF Secretariat and the IETF's Network Operations Center (NOC) team began arriving at the meeting venue on July 19 2022, to prepare everything in advance.

In the months leading up to this meeting a new Omicron mutation (BA.5) of COVID-19 began to emerge and supersede earlier strains<sup>12</sup>. While the IETF had hoped to loosen COVID mitigation measures for IETF-114 compared to the prior meeting, that turned out not to be possible based on the COVID trends.

Those negative trends prompted the IETF, following consultation with the IETF community, to put in place specific COVID mitigations to minimize the potential for infections during the meeting, as detailed later in this document. At a high level, we believe these mitigations were effective and prevented potential widespread infection or even a so-called super-spreader event.

**3. State of COVID in July 2022**

**a. Vaccination rates**

The majority of IETF meeting participants are from the US and in July 2022 the US vaccination rate stood at 68% fully vaccinated, 79% partially vaccinated, with 48% having received one booster and 31% having received two boosters. The next largest group of participants were from the EU which had 73% fully vaccinated, 75% partially vaccinated, 53% with one booster and 6% with two boosters.

**b. Travel restrictions**

In July 2022, the US CDC required all travelers to the US to be fully vaccinated. In mid-June 2022, the US CDC removed the requirements for a pre-departure test though this was still required by some countries to which participants would be returning.

**c. Mask requirements**

The state of Pennsylvania and city of Philadelphia had no mask restrictions in July 2022, however mask wearing was encouraged and businesses were free to set their own mask policy.

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<sup>11</sup> See the hybrid meeting information and agenda for IETF-114 at <https://www.ietf.org/how/meetings/114/>.

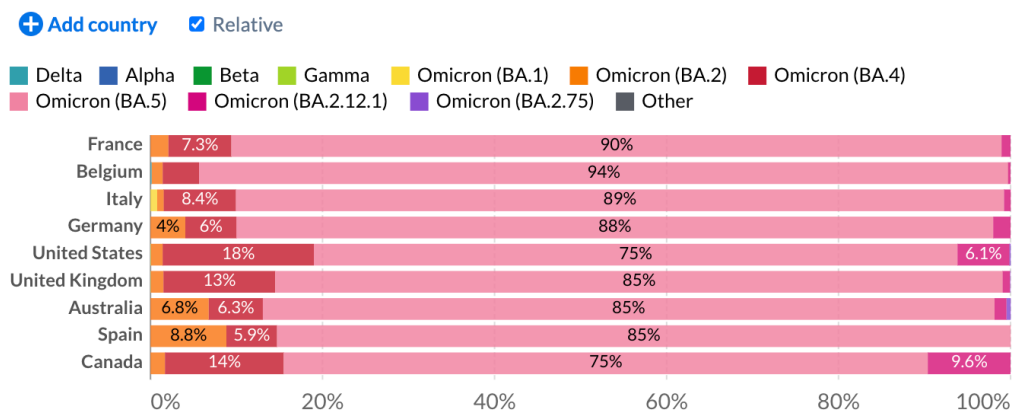
<sup>12</sup> See for example "The BA.5 Story", by Eric Topol, on June 27, 2022 at <https://erictopol.substack.com/p/the-ba5-story>.

d. Rise of Omicron BA.5 Variant

Compared to the start of 2022, a new BA.5 “Omicron” variant has emerged and become the dominant strain around the world<sup>13</sup>, comprising 75% or more of current infections as of just after IETF-114 On August 1, 2022. It certainly appears<sup>14</sup> that this variant continues to lead to illness and in some cases hospitalization or even death; it is not a hoped for completely mild variant and like other variants can spread easily<sup>15</sup>.

SARS-CoV-2 sequences by variant, Aug 1, 2022

The share of analyzed sequences in the preceding two weeks that correspond to each variant group. This share may not reflect the complete breakdown of cases since only a fraction of all cases are sequenced.



Source: GISAID, via CoVariants.org – Last updated 3 August 2022  
 OurWorldInData.org/coronavirus • CC BY  
 Note: Recently-discovered or actively-monitored variants may be overrepresented, as suspected cases of these variants are likely to be sequenced preferentially or faster than other cases.

e. Availability of Therapeutic Drugs

For those that have become infected, in some countries health agencies have authorized a range of therapeutic drugs that can reduce the severity and duration of illness. For example, in the US, the FDA has authorized drugs such as Paxlovid<sup>16</sup>.

However, using the case of IETF-114 in the US, many meeting participants are not residents of the US and did not have health insurance coverage in the US. This in some

<sup>13</sup> See Our World in Data chart from August 1, 2022, at <https://ourworldindata.org/grapher/covid-variants-bar?time=2022-08-01&country=CAN~BWA~ESP~ZAF~AUS~GBR~USA~DEU~ITA~BEL~FRA>.

<sup>14</sup> See Nature article “What Omicron’s BA.4 and BA.5 variants mean for the pandemic”, from June 23, 2022, at <https://www.nature.com/articles/d41586-022-01730-y>.

<sup>15</sup> Reportedly many people are even infected asymptotically, see <https://www.npr.org/2022/08/19/1118402942/omicron-variant-unaware-covid-research-study>.

<sup>16</sup> See US Food and Drug Administration press release announcing broader availability of Paxlovid on July 6, 2022 at <https://www.fda.gov/news-events/press-announcements/coronavirus-covid-19-update-fda-authorizes-pharmacists-prescribe-paxlovid-certain-limitations>.

cases may make it difficult to obtain some of these treatments, though we have no reports from people that were infected at IETF-114 having any difficulty obtaining sufficient medical care.

f. **Weather in Philadelphia**

Since COVID can spread in an aerosol form<sup>17</sup>, the temperature and humidity of the environment can play a role in the spread of the virus<sup>18</sup>. This meeting was held during Philadelphia's summertime, which is typically quite hot and humid. The outdoor temperatures during the meeting<sup>19</sup> ranged between a low of 74F (23C) and high of 99F (37C), with periodic heat advisories and very high humidity.

This meant that the meeting and hotel rooms were continuously air conditioned with the forced air systems typical of the United States. It also meant that it was easy for participants to meet with others outside for meals and other activities. The outdoor heat and humidity would suggest that COVID aerosols outside would tend to drop to the ground rather than hang in or circulate for long periods in the air. Indoor forced air-style air conditioning also appears to have kept airflow high and helped with the turnover of air in meeting and hotel rooms.

4. **COVID Mitigations for IETF-114**

a. **Vaccination Requirement**

Since vaccines have proven highly effective in preventing serious illness and death due to COVID infection, the IETF required that all in-person attendees be vaccinated<sup>20</sup>. Due to the global nature of the IETF and the varying national standards of vaccination, the IETF asked that vaccination be consistent with the World Health Organization (WHO)

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<sup>17</sup> See the paper "Ten scientific reasons in support of airborne transmission of SARS-CoV-2", by Greenhalgh, et. al., on April 15, 2021, in *The Lancet*, Volume 397, Issue 10285, at [https://www.thelancet.com/article/S0140-6736\(21\)00869-2/fulltext#%20](https://www.thelancet.com/article/S0140-6736(21)00869-2/fulltext#%20). See also the FAQs of the World Health Organization, "How does COVID-19 spread between people", at <https://www.who.int/news-room/questions-and-answers/item/coronavirus-disease-covid-19-how-is-it-transmitted>, last updated December 21, 2021, as of the time of this paper. Finally, see also the paper "What were the historical reasons for the resistance to recognizing airborne transmission during the COVID-19 pandemic?", by Jimenez, et. al., in the *International Journal of Indoor Air Environment and Health*, Volume 38, Issue 8, on August 21, 2022, at <https://onlinelibrary.wiley.com/doi/10.1111/ina.13070>.

<sup>18</sup> See the paper "Role of meteorological factors in the transmission of SARS-CoV-2 in the United States", by Ma, et. al., on June 14, 2021, in *Nature Communications*, Volume 12, Article number 3602, at <https://www.nature.com/articles/s41467-021-23866-7>. See also the paper "The transmission of SARS-CoV-2 is likely comodulated by temperature and by relative humidity", by Raies, et. al., in *PLOS ONE* on July 29, 2021, at <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0255212#sec009>.

<sup>19</sup> See AccuWeather's historical weather data for Philadelphia in July 2022 at <https://www.accuweather.com/en/us/philadelphia/19102/july-weather/350540>.

<sup>20</sup> See IETF-114 meeting registration FAQs at <https://www.ietf.org/how/meetings/114/faq/#registration>.



Emergency Use List<sup>21</sup>. The IETF asked in-person attendees to certify that they met the WHO's criteria but the organization did not undertake to verify individual attendee vaccination records. This was felt to be too administratively burdensome given the many countries from which participants typically come (59 countries for IETF-114, both in-person and remote), each with varying record types and other intricacies as well as reflecting the general policy of the IETF to work on a trust basis. As a result, the IETF depended on the honesty of participants as well as their interest in maintaining their personal health and reputation.

**b. Mask Requirement**

Given that masks have proven effective at reducing the spread of COVID, the IETF required that all in-person attendees wear masks while in the IETF meeting rooms, except while eating or drinking but not in the common areas which other hotel guests were free to use. Similar to the challenge faced with different vaccines around the world, the availability of different types of masks also varied. Since it was clear that cloth or surgical masks were inferior to other masks<sup>22</sup>, the IETF required each person to wear an FFP2/N95 mask, KN95/KF94/FFP3 mask, or locally certified equivalent.

The only exception for wearing a mask other than when eating or drinking was for working group chairs or presenters who were actively speaking; participants making comments or asking questions from the floor microphones were expected to remain masked. Though removing a mask was possible in these situations, many people chose to remain masked, and this did not appear to degrade audio quality for in-person or remote participants.

The IETF also provided free KN95 masks for any participant and purchased roughly 2,500 masks in various colors to support this. Many people took advantage of this, enabling them to change masks at least daily and even to match the color of the mask to their clothing. Providing free masks also reduced a potential cost burden for participants and ensured there were no excuses for non-compliance with the mask policy.

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<sup>21</sup> See the World Health Organization list of COVID-19 vaccines at <https://extranet.who.int/pqweb/vaccines/vaccinescovid-19-vaccine-eul-issued>.

<sup>22</sup> See fact sheet on different types of masks reducing COVID-19 infection or transmission from the American Conference of Governmental Industrial Hygienists (ACGIH) Pandemic Response Task Force at <https://www.acgih.org/covid-19-fact-sheet-worker-resp/>. See also the article "What can masks do? Part 1: The science behind COVID-19 protection", by Brosseau, et. al., from the University of Minnesota's Center for Infectious Disease Research and Policy, on October 14, 2021, at <https://www.cidrap.umn.edu/news-perspective/2021/10/commentary-what-can-masks-do-part-1-science-behind-covid-19-protection>. Finally, additional information can be found in the article "Effectiveness of Face Mask or Respirator Use in Indoor Public Settings for Prevention of SARS-CoV-2 Infection — California, February–December 2021", by Andrejko, et. al., in the US Centers for Disease Control and Prevention weekly publication Volume 71, on February 11, 2022, at <https://www.cdc.gov/mmwr/volumes/71/wr/mm7106e1.htm>.

People that felt they were unable to mask for some reason, such as one person noting a medical issue, were required to participate remotely.

Hotel staff working in IETF meeting areas were not required to wear masks.

**c. Acceptance of COVID Policy to Register**

The IETF required acceptance of the following policy to register to attend in person. Those that did not wish to accept this policy were encouraged to participate online.

*I will take necessary precautions while attending IETF 114, including complying with all COVID-related requirements that apply to the event venue or that are otherwise communicated to me by the IETF. While taking such precautions may reduce risk, any in person participation includes possible exposure to, and illness from, infectious diseases. By choosing to attend IETF 114 in person, I knowingly and freely assume all such risks related to illness and infectious diseases, such as COVID, even if arising from the negligence or fault of the IETF LLC, or its agents or partners. Further, I waive and release IETF LLC, and its contractors, agents and partners from and against claims arising from injury, loss, sickness or death from contraction or spread of COVID or other communicable disease due to travel to or attendance at an event hosted by the IETF.*

**d. Free On-Site COVID Tests**

The IETF made available free Rapid Antigen Tests for attendees and encouraged daily testing. To support this, the IETF Secretariat purchased roughly 1,600 single-test kits and made these available in an area adjacent to the IETF registration desk, along with masks. To encourage participants to test frequently, The IETF Secretariat handed out silly stickers upon receipt of a dated photo showing proof of a recent test result.



**e. IETF Badge Notations**

The IETF Secretariat also made available three different, uniquely-shaped pins, to visually indicate interaction preferences color). These were green, yellow, and red - each with a different shape - to correspond to different levels of preferred caution, such as from hugs and handshakes to fist bumps or no-touch greetings (different shapes were



used in order to account for green-red colorblindness). The IETF Secretariat also had stickers to indicate no handshake and to indicate a negative COVID test. It appears that people made extensive use of these.



#### f. Reporting & Quarantine for Positive Tests

The meeting FAQs<sup>23</sup> included directions for what to do if you tested positive. That included emailing a support address to communicate a positive test. Anyone testing positive was asked to quarantine according to local guidelines (which in the U.S. appear to vary from 5 days from onset of symptoms to receiving a negative test). Infected individuals were also asked to place a do not disturb sign on their door so that the hotel cleaning staff would not enter the room.

In addition, the IETF Secretariat reminded attendees at the conclusion of the meeting to report any subsequent positive tests for a period of three days after the end of the meeting, since this might indicate that an infection had occurred during the meeting itself and would be useful for tracking COVID-related statistics for IETF meetings.

#### g. IETF Social Event COVID Policy

The IETF social event<sup>24</sup> took place on July 26, 2022, at the Barnes Foundation museum in Philadelphia and it was attended by roughly 400 people. Prior to the IETF meeting, the hosts of the social event did not anticipate needing masks given that there was a large outdoor patio for people to use, that most people would be eating and drinking during the event, and that prior to the emergence of Omicron that COVID cases were trending down in Philadelphia.

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<sup>23</sup> See the COVID FAQs for IETF-114 at <https://www.ietf.org/how/meetings/114/faq/#covidmeasures>.

<sup>24</sup> See information about the IETF-114 social event at <https://www.ietf.org/how/meetings/114/social/>.

As it happened, Omicron prompted a local surge in cases and several IETF participants tested positive upon arrival or after the first day of the meeting. The result was that the hosts adjusted the policy and required masks to attend, except when eating or drinking. In addition, staff at the social venue were all required to wear a mask.

Compliance with this policy change was excellent and no issues were reported. Many people also took advantage of the outdoor space, which further minimized infection risks when eating or drinking, and since the number of attendees was limited people were not too tightly packed.

#### h. Informal CO2 Monitoring

One of the co-authors, Jason, purchased an Aranet4 CO2 monitor<sup>25</sup> for informal observation of CO2 levels<sup>26</sup> (see photo on the next page). He took this monitor with him to various meeting rooms and the monitor was set to take a measurement every 1 minute. In some of these rooms he remained stationary for the duration of the session while in others he moved around to a few positions around the room.

During all monitored meetings the readings were in a good range of below 1,000 ppm of CO2. During most meetings the range was between roughly 675 - 990 ppm and he observed that leaving the door(s) to a room open helped maintain or reduce CO2 levels. He also observed that CO2 levels would tend to rise as meeting time elapsed, starting in the 600s and ending in the 700s-900s ppm.

During the plenary he observed the start of a rise in CO2 from and asked the IETF Secretariat to open all the doors at the back of the ballroom. Once this happened, the CO2 levels stopped rising and then declined to lower levels (and it always remained well below 1,000 ppm).

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<sup>25</sup> See the Aranet4 product for details at <https://aranet.com/products/aranet4/>.

<sup>26</sup> CO2 levels have been studied as a proxy for indoor risk of COVID-19 transmission. For further reading, see the paper "Risk of indoor airborne infection transmission estimated from carbon dioxide concentration", by Rudnick & Milton, in the International Journal of Indoor Environment and Health, Volume 13, Issue 3, on October 23, 2003, at <https://onlinelibrary.wiley.com/doi/10.1034/j.1600-0668.2003.00189.x>. See also the paper "Exhaled CO2 as a COVID-19 Infection Risk Proxy for Different Indoor Environments and Activities", by Peng & Jimenez, on April 5, 2021, on the website of the US National Library of Medicine at <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8043197/>. Finally, see also the paper "A guideline to limit indoor airborne transmission of COVID-19", by Bazant & Bush, on April 13, 2021, from the Proceedings of the National Academy of Sciences of the USA at <https://www.pnas.org/doi/10.1073/pnas.2018995118>.



## 5. COVID Statistics

### a. Statistics for IETF-114

There were 622 people registered to attend on site in Philadelphia<sup>27</sup>, and 805 people registered to participate remotely<sup>28</sup>, a total of 1,427 participants. In addition, the Hackathon that preceded the IETF meeting was attended by 224 people in person<sup>29</sup> and 51 people remotely<sup>30</sup>, a total of 275 participants.

Of the participants a total of 11 people tested positive, a 1.84% positivity rate. In addition, 5 people in the IETF Secretariat staff also tested positive. If we include those people in the statistics then we have 16 of 622 people test positive, a 2.57% positivity rate.

Several of these people had to extend the date of their return travel because of their infection and various degrees of illness. None of the people were hospitalized and none died because of infection.

Without the vaccination and mask requirements, the availability of free rapid tests (and encouragement to test daily), and regular reminders to mask, it is our opinion based on the easy ability of the BA.5 variant to spread that the positivity rate would have been far higher.

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<sup>27</sup> See the list of registered in person attendees for the IETF-114 meeting at <https://registration.ietf.org/114/participants/onsite/>.

<sup>28</sup> See the list of registered remote attendees for the IETF-114 meeting at <https://registration.ietf.org/114/participants/remotel/>.

<sup>29</sup> See the list of registered in person attendees for the IETF-114 hackathon at [https://registration.ietf.org/114/participants/hackathon\\_onsite/](https://registration.ietf.org/114/participants/hackathon_onsite/).

<sup>30</sup> See the list of registered remote attendees for the IETF-114 hackathon at [https://registration.ietf.org/114/participants/hackathon\\_remotel/](https://registration.ietf.org/114/participants/hackathon_remotel/).

**b. Timeline of Infection Reports**

Below is a timeline of case reports by attendees. It is interesting to note the likelihood that the first eight reports (50% of the 16 reports) occurred on or before the first official day of the meeting. Based on a rough median 3-day incubation period<sup>31</sup> for the Omicron variant, this suggests many of those people were exposed to the virus before coming to the IETF meeting, at the first day of the hackathon, or in the case of five members of the IETF Secretariat that arrived prior to the meeting, through close group contact before the official start of the meeting. The reports up to three days after the meeting are also likely attributable to exposure during the meeting itself.

		Case Reports		Est. Exposure
Friday	7/22/22	1	Day before meeting	7/19/22
Saturday	7/23/22	1	Start of Hackathon	7/20/22
Sunday	7/24/22	2	2nd day of Hackathon	7/21/22
Monday	7/25/22	4	1st day of meeting	7/22/22
Tuesday	7/26/22	0	2nd day of meeting	7/23/22
Wednesday	7/27/22	1	3rd day of meeting	7/24/22
Thursday	7/28/22	0	4th day of meeting	7/25/22
Friday	7/29/22	1	Final day of meeting	7/26/22
Saturday	7/30/22	0	1 day after meeting	7/27/22
Sunday	7/31/22	4	2 days after meeting	7/28/22
Monday	8/1/22	2	3 days after meeting	7/29/22

**c. Comparison to IETF-113**

When comparing the 114th meeting with the 113th meeting, it is challenging given these occurred in two different countries, in two different seasons (very hot vs. moderately cold), and with the state of COVID variants in different places and times (i.e., BA.2 vs. BA.5 prevalence). In addition, there were more participants at IETF-114, so presumably a relatively greater density of participants per square meter of space (which would tend to correlate with a higher risk of positivity, all other factors being equal).

Despite these differences, at IETF-113 there were 9 reported cases among participants, which is a 2.87% positivity rate. As with IETF-114, several of these participants had to extend their date of return travel in order to demonstrate a negative test or be sufficiently healthy and no longer be likely to spread the virus. Finally, none of the people were hospitalized and none died because of infection.

<sup>31</sup> See paper “Shorter serial intervals in SARS-CoV-2 cases with Omicron BA.1 variant compared with Delta variant, the Netherlands, 13 to 26 December 2021”, by Backer, et. al., on the website of the US National Library of Medicine at <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8832521/>.

d. **Comparison to Other Meetings (Non-IETF)**

It is interesting to compare the IETF's experience with those of other conferences. In the earliest days of the pandemic in February 2020, for example, Biogen met in Boston with no COVID mitigations (since the pandemic was only then just emerging). A paper suggested that 100 attendees were infected as a result of exposure at the meeting and that those people went on to further spur up to 330,000 cases around the world<sup>32 33</sup>.

Looking at a smaller scale example, a group of seventy New York City judges met in the USA in May 2022 with no COVID mitigations. According to news reports, twenty of those tested positive following the event (28.5% of attendees)<sup>34</sup>. Another example, though lacking statistics, was the television industry's annual "upfront" advertising event in New York City in May 2022. The only mitigation was a vaccine requirement, and most people went without masks, leading to reports of widespread infections among attendees<sup>35</sup>.

One further example of widespread infection at meetings appears to have happened at the RSA Conference in June 2022 in San Francisco. Among over 26,000 attendees, many informally reported becoming infected because their attendance, though good statistics are not available<sup>36</sup>. Other examples can be found on social media<sup>37</sup>.

In contrast, the American Astronomical Society (AAS) held their 240th meeting in Pasadena, USA, from June 12-16, 2022. Over 2,000 people attended in person, and they required masking, required vaccination or proof of prior infection, and encouraged daily testing. They ultimately reported up to 18 positive cases<sup>38</sup>.

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<sup>32</sup> See Mass Live news article, "A very different and early stage: 2 years ago, a Biogen conference in Boston sparked a COVID super-spreader event", by Will Catcher, from March 9, 2022, at <https://www.masslive.com/coronavirus/2022/03/a-very-different-and-early-stage-2-years-ago-a-biogen-conference-in-boston-sparked-a-covid-super-spreader-event.html>.

<sup>33</sup> See paper published in Science, Volume 371, Issue 6529, "Phylogenetic analysis of SARS-CoV-2 in Boston highlights the impact of superspreading events", by Lemieux, et. al., on December 10, 2020, at <https://www.science.org/doi/10.1126/science.abe3261>.

<sup>34</sup> See New York Times article, "70 N.Y. Judges Went on a Montauk Retreat. 20 Came Down With the Virus", by Jonah Bromwich, published May 18, 2022, at <https://www.nytimes.com/2022/05/18/nyregion/ny-judges-covid-montauk-retreat.html>.

<sup>35</sup> See Deadline article, "How Upfronts 2022 Became Covid Superspreader Event", by Nellie Andreeva, on May 25, 2022, at <https://deadline.com/2022/05/upfronts-2022-covid-superspreader-event-1235032892/>.

<sup>36</sup> See article in The Register, "RSAC branded a 'super spreader event' as attendees share COVID-19 test results", by Jessica Lyons Hardcastle, on June 16, 2022, at [https://www.theregister.com/2022/06/16/rsa\\_covid\\_risk/](https://www.theregister.com/2022/06/16/rsa_covid_risk/).

<sup>37</sup> One person at <https://twitter.com/atomicpopWI/status/1557906505898151936> reported a 50% positivity rate from a 700 person conference in August 2022. Another reported at <https://twitter.com/mekki/status/1563197937559035905> that most of their team attending a meeting tested positive in August 2022.

<sup>38</sup> See blog post on the website of the American Astronomical Society, "AAS 240, COVID-19, and Safety Precautions for Conferences", posted June 29, 2022, at <https://aas.org/posts/news/2022/06/aas-240-covid-19-and-safety-precautions-conferences>.

One final example was the Vision Sciences Society (VSS) annual meeting, which was held in St. Petersburg, Florida, USA, from May 13 - 18, 2022. Over 1,400 people attended in person and the organizers required proof of vaccination and required masks. They noted that 11.6% reported a positive test during or just after the meeting, and that based on Omicron's incubation period, that an estimated 7% of participants were likely infected during the meeting<sup>39 40</sup>.

## 6. Observations and Areas to Watch for Future Meetings

### a. IETF Secretariat Staff Outbreak

As noted above, the staff of the IETF Secretariat arrive well in advance of the official start of the meeting to prepare. Unfortunately, roughly one quarter of the staff ultimately tested positive (including the Secretariat and NOC team), with the first report on July 22, 2022. While it is impossible to determine the source of transmission of the virus to any one person, it appears that there may have been some transmission within the team due to close proximity in the days leading up to the meeting. Secretariat staff frequently dines together and spends a great deal of time in close contact.

### b. Support of People Testing Positive

The IETF Secretariat also provided support for people testing positive by checking in on each person daily via email or other electronic means. They also delivered care packages from local drug stores, including items such as thermometers, over the counter pain medication, vitamins, snacks, and so on. They were also available to assist with doctor referrals or other assistance related to medical support.

While the main IETF hotel venue did not have room service, food delivery services such as DoorDash could be used by affected people - but someone from the hotel had to accept delivery at the main entrance and then deliver the food to the room. In addition, friends and colleagues of infected people also delivered meals and care packages in some cases.

Finally, the meeting FAQs noted that in case an affected person did not have health insurance coverage in the United States (such as those from other countries) and had to incur medical costs they could not afford (or their travel insurance did not cover or for which their employer would not pay) or other costs they could not afford (such as extra hotel charges for extending their stay due to quarantine) that they should request financial support via the IETF Secretariat. None of the affected people at IETF-114 made that request.

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<sup>39</sup> See tweet from the VSS <https://twitter.com/VSSMtg/status/1565453179038334977> signal

<sup>40</sup> See also the VSS event website at <https://www.visionosciences.org/health-protocols-at-vss/>, last checked on September 2, 2022.



**c. Switch to Remote Participation**

In most cases, participants that tested positive eventually felt well enough to participate in the IETF meeting via remote participation tools. While this was not the same as onsite participation, a number did at least benefit from being in the same time zone as the meeting and free of domestic distractions.

**d. Subsequent Return Travel**

Most medical guidance<sup>41</sup> suggests that for people to travel back home, especially by plane, they should have had five or more days since the onset of symptoms, feel well enough to travel, and have one negative COVID test. As a result, several of the people at IETF-114 that had tested positive delayed the date of their return travel by one or more days. While the guidance on how to proceed varies, especially for vaccinated people, it seems like a best practice to delay return travel until these criteria are met in order to ensure the person's health does not worsen during return travel and that they do not continue to spread the virus to others. In addition, it is of course highly recommended that recently recovered people wear a high-quality mask during such return travel in order to maximize precautions against further spread.

**e. Mask Compliance Issues**

As a general matter, compliance with the mask policy was excellent. It was noted at the beginning of the meeting during the Hackathon and on the first session of the first day's meeting that compliance was a bit spotty, in part because it seemed that once a few people were observed without a mask that others would follow suit. As a result, at the start of the Hackathon and at the start of the meeting, as well at the start of subsequent working group meetings, participants were reminded of the mask requirement. It appeared to help somewhat when it was communicated that there were several positive cases even at the beginning of the meeting.

In addition, it was important to have a plan in place for non-compliance (which we did) since it's always a possibility. In a few cases, some people had to be reminded to wear a mask. This tended to occur most often when people returned from outside, such as at lunch, and simply forgot to put their mask back on.

It was also very helpful for IETF leaders to model good behavior by consistently masking as this set an example for others to follow.

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<sup>41</sup> See US Centers for Disease Control COVID-19 travel guidance, last updated July 12, 2022 as of the time of this paper, at <https://www.cdc.gov/coronavirus/2019-ncov/travelers/index.html>.

One area noted for improvement was the specification of masks worn, with multiple examples observed of people wearing surgical masks or homemade cloth masks, which was not effectively policed, partially due to the disproportionately high number of staff quarantining. For future meetings it is likely that this will be actively policed with senior staff identifying those wearing masks below the required standard and offering them a free FFP2 replacement, in a range of colors.

## **7. Considerations for Future IETF Meetings**

The requirements for vaccination and masking were highly effective in preventing broad spread of infection among attendees. This should be paired with free masks, regular reminders to mask, free rapid COVID tests, encouraged daily COVID testing, and support of those reporting infection.

It is impossible to predict the exact situation that will face the IETF in subsequent meetings, as new COVID variants continue to emerge, infection rates fluctuate, new bivalent vaccines<sup>42</sup> will be available<sup>43</sup>, and local regulations continue to change. Nevertheless, it certainly appears that for the next meeting in November 2022, that the world will continue to deal with the COVID pandemic, though at some point it will shift to become endemic and thus mitigations will need to be adjusted accordingly<sup>44</sup>.

For the foreseeable future it seems well advised to continue the policy of required vaccination and masking. In addition, it does not appear that this policy had any significant negative affect on in-person attendance and in fact seems it may have had a positive effect on attendance in Philadelphia.

## **8. Advice for Other Meeting Organizers**

To some extent it can be difficult to compare the IETF's experience with the meetings of other organizations since each organization's culture and practices are unique. Despite that, for any meeting bringing together hundreds or more people, it seems prudent to take proven and reasonable steps to reduce the risk of COVID-19 spreading widely at an in-person meeting and thus protecting the health of attendees.

Specifically, it seems prudent for the health of attendees and staff to require vaccination,

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<sup>42</sup> See US National Public Radio website article "Moderna says its new 'bivalent' vaccine shows promise against COVID variants", by Rob Stein, from April 19, 2022, at <https://www.npr.org/sections/health-shots/2022/04/19/1093530113/moderna-bivalent-vaccine>.

<sup>43</sup> See UK government press release "First bivalent COVID-19 booster vaccine approved by UK medicines regulator" from August 15, 2022 at <https://www.gov.uk/government/news/first-bivalent-covid-19-booster-vaccine-approved-by-uk-medicines-regulator>.

<sup>44</sup> There may be a variety of alternative approaches that might be possible in the future, depending on factors such as the efficacy of a bivalent vaccine. For example, it may become possible to do without masking and instead rely on testing before entry each day, or any number of other potential approaches.

require masking with high-quality N95-type masks, provide a documented process for reporting infection, encourage and support quarantine, provide free high-quality masks, provide free rapid tests, encourage daily testing, and provide support to infected people. Organizers should also expect that attendees will arrive at the meeting having been recently exposed to the virus beforehand, but not yet symptomatic or testing positive on a rapid test.

Many meeting participants reported they only chose to attend in-person based on these mitigations. As a result, providing this information well in advance - before people would typically book travel - is recommended.

These mitigation tactics all work together in concert to provide the safest in-person attendance experience. We thus also recommend that all of these be used together as parts of a holistic approach rather than picking one or more of these tactics in a more piecemeal approach.

Organizations should also have meeting administration contingency plans and consider cross-training staff. That is because meeting staff often work and eat closely together and thus it is possible, as the IETF experienced, for a significant percentage of these staff to become infected at the same time and thus cause a small team of remaining people to pick up the slack and potentially perform new jobs.

Finally, to hold effective hybrid meetings, excellent online meeting tools must be made available to remote participants so that they have a good experience during working group meetings on more or less equal footing to in-person attendees. This can be more challenging than it appears and, in some cases, specialized tools such as Meetecho may be appropriate.

## **9. Conclusions**

The IETF's Internet standards development work has historically depended on three one-week face-to-face meetings per year at different locations around the world, complemented by significant online synchronous and asynchronous collaboration. The submission of new and updated Internet draft documents as well as meetings to discuss the formation of new working groups was negatively impacted by the COVID-19 pandemic, likely due in part to the temporary inability to meet in person.

The IETF community was thus interested in re-introducing the ability to meet in person as part of a new hybrid meeting structure, but in a way that was as safe as reasonably possible and which did not disadvantage remote participants during working group meetings. A key to this was the adoption of a range of COVID-19 mitigations that worked in concert to maintain a relatively low 2.57% positive test rate. That included requiring vaccination, requiring the use of high quality N95-type masks, providing free masks, regularly encouraging masks and having leaders model good masking behavior, providing free rapid tests, encouraging daily rapid testing, requesting notification of positive tests, requiring quarantine from the meeting,

and providing support as needed to people that tested positive and were in quarantine.

But holding an effective hybrid meeting also depended on technical tools and collaboration/work processes that provided a good experience no matter whether one attended in person. This was achieved in part through the meaningful improvement of the organization's many online collaboration tools, particularly Meetecho, during the first two years of the pandemic, in preparation for a future of hybrid meetings. It was also helped by a flexible IETF Secretariat team from AMS that had similarly prepared during this time for hybrid meeting operations and was even able to seamlessly adapt to a significant unavailability of staff due to infection early in the meeting. Lastly, the IETF also worked to come to consensus on meeting and collaboration practices that supported hybrid meetings, such as in the SHMOO working group<sup>45</sup>.

It is impossible to predict what the future will hold for the COVID-19 pandemic and when this will shift to enter the endemic period. But based on the current global health environment, available protective measures, and available technology tools, it is possible to hold effective hybrid meetings and the IETF anticipates that the need to operate in a hybrid meeting model is a permanent one. In addition, COVID-19 mitigations can be effective at minimizing the spread of the virus at IETF meetings and the organization should be flexible to adapting these mitigations as the health environment changes in the future.

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<sup>45</sup> For more information about the IETF's Stay Home Meet Online Occasionally Working Group (SHMOO), see <https://datatracker.ietf.org/wg/shmoo/about/>.

## 10. About the Authors

Alexa Morris<sup>46</sup> is the Managing Director of the IETF Secretariat. One of the IETF's Secretariat's key responsibilities is planning for, administering, and operating three IETF meetings each year. Alexa and the IETF Secretariat work for Association Management Solutions<sup>47</sup> (AMS) under contract to the IETF Administration LLC<sup>48</sup> (IETF LLC). She has over twenty years of experience running large professional meetings.

Jay Daley<sup>49</sup> is the Executive Director of the IETF LLC. He is responsible for ensuring the IETF's smooth operation, including IETF meetings, IT systems, financial performance, fundraising, legal compliance, and oversight of all contractors. He is also responsible for the extensive community consultation used as the basis for the key decisions on how IETF meetings are run.

Jason Livingood<sup>50</sup> chairs the IETF LLC Board of Directors<sup>51</sup>. He is employed by Comcast<sup>52</sup>, which was the co-sponsor of IETF-114<sup>53</sup> along with NBCUniversal<sup>54</sup>. The IETF-114 meeting was held in Philadelphia, where Comcast is headquartered and he is based.

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<sup>47</sup> For more information about Association Management Solutions, see their website at <https://www.amsl.com/>.

<sup>48</sup> For more information about the IETF Administration LLC, see their website at <https://www.ietf.org/about/administration/>.

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<sup>51</sup> For more information about the Board of the IETF Administration LLC, see their website at <https://www.ietf.org/about/administration/llc-board/>.

<sup>52</sup> For more information about IETF-114 co-sponsor Comcast, see their website at <https://corporate.comcast.com/company/xfinity>.

<sup>53</sup> Full details concerning the IETF-114 meeting are on the official IETF-114 meeting website at <https://www.ietf.org/how/meetings/114/>.

<sup>54</sup> For more information about IETF-114 co-sponsor NBCUniversal, see their website at <https://www.nbcuniversal.com/>.