

The Everyday Experience of Connectivity Limits – Insights from French Students during the Covid Pandemic

L'expérience quotidienne des limites à la connectivité – Le cas d'étudiants français en 2020-2021

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ABSTRACT

From Ubiquitous Computing to the recent deployment of 5G technology, public discourses assume ever increasing levels of connectivity, whether in geographical availability, in reliability, or in speed. However slowdowns, breakdowns, and unavailability are an integral part of the experience of everyday connectivity. We conducted critical incident interviews with 10 students (aged 22-25) to understand how they dealt with the various connectivity limits they faced during the COVID19 pandemic, but also how they deliberately set limits at times. Our results show the complex relations that people develop with their internet connection. We outline the informants' difficulties to identify and understand the nature of the connection's problems they usually face, leading to a lack of control. We present how they react to such problems, the anticipation strategies and coping mechanisms they develop. We finally present situations in which informants deliberately set their own limits. Overall, we emphasize the shift from a shared and localized connection (WiFi) to a personal and mobile one (4G), combined to increased pressure for maintaining connectivity.

CCS CONCEPTS

• **Networks** → **Network reliability**; • **Human-centered computing** → **Mobile computing**; **User studies**.

KEYWORDS

Limits, user experience, connectivity, sufficiency

RÉSUMÉ

De l'informatique ambiante au déploiement récent de la 5G, les discours sur la numérisation supposent des niveaux de connectivité toujours croissants, que ce soit par une plus grande disponibilité géographique, par une augmentation de la fiabilité, ou par des vitesses de transfert accrues. Pour autant les moments d'indisponibilité et les

limitations font partie intégrante de l'expérience ordinaire du numérique. Nous enquêtons sur la façon dont les usagers comprennent, bidouillent et s'adaptent aux limites de connexion. Mais aussi comment ils se fixent délibérément des limites. Nous avons mené 10 entretiens critiques avec des étudiants de 22 à 25 ans pour comprendre comment ils géraient les limites à la connectivité en 2020-2021. Nous identifions un ensemble de situations problématiques et décrivons la difficulté des usagers à identifier et comprendre la nature de leur problèmes, menant à une absence de contrôle. Nous discutons les stratégies d'anticipation et les mécanismes de contournement mis en place par nos informateurs, notamment la bascule d'une connexion partagée (wifi) à une connexion individualisée (4G). Nous présentons enfin un ensemble de situations pour lesquelles nos informateurs se fixent délibérément des limites.

MOTS-CLÉS

Limites, expérience utilisateur, connectivité, suffisance

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1 INTRODUCTION

The experience of digital services is increasingly mediated by cloud infrastructures requiring constant connectivity. Digital services are imagined and often presented as ubiquitous, scalable, and limitless [5, 29]. Yet breakdowns, the practical experience of limits and the “messiness” of connectivity are an integral part of the everyday experience of ubiquitous computing [5].

Breakdowns have proved particularly fruitful to study, especially for Science and Technology Studies (STS) scholars, who have leveraged them to conduct ‘ethnography of infrastructure’ [33], i.e., leverage moments where infrastructure becomes visible and can be engaged with. In the HCI and Ubicomp literature, the discussions around *seamful design* [9] have most prominently tackled the question of breakdowns and technical constraints, suggesting that ‘seams’ could be turned into resources for design, rather than ‘fixed’.

We turn our focus to the way in which connectivity breakdowns, seams and limits are experienced in everyday life. Such experiences

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have been studied for instance by looking at how capped Internet connections are managed by families [11, 13], or how people handle bad connectivity in rural areas [2]. Our hypothesis is that such experiences are common and pervasive even in well connected urban areas of the global north, just less acknowledged [5]. We investigate this hypothesis by looking at students' experience of connectivity limits during the Covid'19 pandemic. The extreme amounts of connectivity needed during the lock-downs offered us a rich field to investigate how connectivity breakdowns and limits were perceived, endured, mitigated, negotiated, wished for or even deliberately set-up. We formulated four research questions to explore these issues : 1) What are the forms of connectivity moderation that are imposed or those that are chosen? 2) Which (if any) of the connectivity limits are perceived as acceptable? 3) How do informants react to connectivity limits and issues over the short term and the long term? 4) What pushed informants to modify their habits?

Better understanding the positive and negative experiences of connectivity limits could support the design of digital sufficiency strategies [31]. Identifying desired, acceptable, and non-renegotiable digital limits, and the interplay of individual and social forces pushing for or against connectivity, we can imagine our future relationship to connectivity, and inspire design and regulation recommendations.

We conducted 10 interviews with students aged 22-25 in France in June and July 2021. We used the critical incident interview technique [16] to cover a year of connectivity and identify experiences of interest like problematic issues with connectivity. We also interviewed a cultural animator of student residences to provide more contextual and historical information.

Our data analysis allowed us to identify several insights that we believe will be interesting for the HCI community. The first theme relates to the difficulty to correctly diagnose connectivity issues. This was caused by the impossibility to perceive the source of problems in the first place. This was associated to misinterpretation, caused by a lack of infrastructure awareness and knowledge about networks inner workings. Our second theme covers the wide range of reactions (or anticipatory actions) informants had when they faced friction. They resorted in majority to avoidance strategies rather than corrective ones. Over time, one-time reactions build into change of practices. We noticed this especially for connecting to the Internet, with a shift from WiFi to 4G, changes of provider, or increased data plans. Finally, caught up in a usual limitless connectivity, our last theme explores desired limits and self-moderation, outlining situations in which informants deliberately set-up limits.

2 RELATED WORK

The development and diffusion of wireless networks and increasingly compact electronics led to promises and expectations of permanent connectivity [37, 38]. Yet experiences of limits and breakdowns abound [5]. These experiences have been explored from multiple angles in the literature, sometimes considering it as a problem to be solved [23], something to design with or around [9], or a desirable outcome to foster and design for [40].

2.1 Breakdowns and limits as problems to be solved

Major disruptions of infrastructures has been a significant concern for the domain of crisis informatics. In this context, the experience of limits can be life threatening, impede rescue efforts, or local organizing [34]. Many responses have been proposed, ranging from the creation of mobile ad-hoc networks (MANET) [24], repairing or strengthening existing ones [17], prioritizing some users or content over other [25].

Interventions seeking to establish networks and connectivity in areas with limited or no access have also been studied and discussed in the context of ICT4D (Information and Communication Technology for Development) [10], and rural computing [2, 15]. Here, the motivation is often to expand beyond existing limits, increase user agency, or improve the resilience of networks. Here some have noticed a paradox in which "fixes" foster increased use rate, leading to more slowdowns [41].

2.2 The opacity of everyday networking

Another line of inquiry focuses rather on the way limits can be handled and made more explicit to end-users. An example are capped connections. Chetty and colleagues have studied these limits in South-African households [12]. For instance using a probe to investigate how people perceive internet connection limitations when exposed to high traffic on the local network [13]. They identify how lack of connection visibility leads to uncertainties in the ways connectivity is conceived and understood by users. This leads to the impossibility of managing or collectively balancing the use of internet at home. They also show that providing users with a connectivity managing tool give them arguments and concrete examples when they complain to their internet providers. Access to a connection representation at home finally raise the level of users' connectivity comprehension.

Research on home networks have also been conducted in British [36] and North American contexts [28]. This line of work argues for "managing the contingencies that inevitably occur in realizing change [in networks], and in coordinating digital plumbing" [35]. This supports the idea that the everyday experience of computing and connectivity is far from seamless, and that connectivity management and awareness could be better supported and designed for [14, 18, 21], something our work contributes to, going beyond home networks to consider connectivity experiences more broadly.

2.3 Seamful design, incorporating breakdowns and technological limits

Seamful design emerged as a reaction to notions of transparency, naturalness and disappearance prevalent in Ubiquitous Computing discourse [8]. Notably Chalmers and colleagues argued for better considering uncertainty in respect to sensing, reasoning and other forms of inference on human activity, but also behaviors emerging from technological inaccuracies to fit into existing practices [9]. Overall seamful design emphasizes the heterogeneous nature of technical infrastructures, and how desires of seamlessness may actually reduce agency by obscuring how technology behaves and what users can do [8]. The argument goes further in that seams

are an integral facet of complex digital infrastructures, and rather than seeking to fix them, it may be more fruitful to understand where they appear and design around them. By looking at limits and breakdowns, we seek to uncover those seams in the context of students' connectivity.

2.4 Slow computing

With expanding connectivity reaching outside the workplace, Hallnäs and Redström argued that designers had to move away from efficiency and reflect on how technology could “slow-down” in order to be meaningfully embedded in everyday environments over long periods of time [19]. This involves supporting mental rest through disconnection or deliberate slowness, and overall services less geared towards consumption [26, 27].

Slow computing also engages with the question of temporalities, seeking to create lasting systems, that can be used, repaired, and mended across multiple generations and lifespans [3]. Considering slow experiences can help us think beyond immediacy, i.e., what is slow to someone and considered a limit, may be normal for another or maybe desired in some circumstances. Documenting cases in which slowness is desirable and situations in which it is not could help us bring a more nuanced view on the experience of limits.

2.5 Studying disconnection and self-imposed limits

A more recent investigation line focuses on disconnections and limits to connectivity with ecological considerations in mind. Widdicks and colleagues studied how to foster a possible decrease of data consumption, susceptible to break the “cornucopian paradigm” [38]. They argue for research looking into supporting the acceptance of disconnection, by understanding everyday use of internet and the existing practices of moderation in usage.

For instance, the authors investigated how forced Internet disconnections affect people in their daily lives [40]. They identify several disconnection management strategies : 1) moving some activities offline, 2) replacing some connected activities with non-connected activities, 3) planning a limit on usage, 4) rationing, postponing, and batching Internet use and 5) in some situations, the impossibility to disconnect. The authors note a very fine intertwining between daily life and internet use. They identify that work practices (emails, collaborative writing, online work environment) are impossible to negotiate individually. Finally they list three “big” categories of limits than should be explored to decrease everyday connectivity and data consumption : values (disconnection to value “real life”), activities themselves (nature and usefulness) and design (customization, settings, etc.). In another study, Hill, Widdicks and Hazas explore means to limit daily connection by mastering the connection functionality of mobile OS (IOS or Android) [20]. They conclude that it is really challenging to intervene on a mobile connection through the OS. This is caused by the repeated changes on openness policies, an incomplete access to the logs of connectivity uses and too intrusive possible interventions. In her MA thesis, Beignon discusses the experience of using of “dumb phone”, and the frictions it creates in everyday life in Sweden [4]. She suggests directions for re-thinking public infrastructures to accommodate lower levels of connectivity.

Our current work follows this broad line of inquiry, looking into student practices when experiencing limits to connectivity and deciding to limit their use of online services and content.

3 METHODS

We conducted a set of interviews over the summer 2021. We were initially interested in understanding connectivity limits encountered in student housing, and the ways they would individually or collectively negotiate these limits.

3.1 Informants

We interviewed 10 students between 22 and 25 years old (average: 22 years and 7 months). And complemented them with the interview of a cultural animator of a student residence (59 years old). Informants were studying in different disciplines : digital culture, network engineering, computer science, penal law, ecology, clinical psychology. A large majority of participants declared a good or very good level of internet/computer expertise, only one student declared an average level.

The majority of the students lived in their own apartment or student room (n=9) and in the french city of Nantes (n=7). One (P9) lived in a rural house with her mother (during the lockdowns too) and two lived as a couple in their own apartment (P5, P8). During the lockdowns, one student spent a part (September to February) of the school year (2020/2021) in a bigger apartment with roommates. Only two students (P3, P4) left their apartment to go to their parents' house, four of them spent the lockdowns mostly alone and two with their partner. Table 1 details the participants' situations.

3.2 Recruitment and interview procedure

We recruited informants using several sources: personal contacts (one of the authors being a student), Facebook groups and institutional intermediaries (“official” mailing lists, cultural animators). Interviews lasted on average 90 minutes and were conducted in French. The first author conducted all the interviews.

We conducted 4 interviews in Nantes, France, face-to-face, and 7 using the video conferencing application Zoom. The interview guide produced collaboratively for the inquiry was reviewed once (after the first interview). All interviews were recorded (audio, audio and video when Zoom was used) and complemented with notes. The interviews were transcribed a first time using an automatic transcription software (trint.com). We then refined and corrected these transcriptions for accuracy.

3.3 Data Collection

To support participants' recollection of connectivity problems, we used the critical interview method [16]. Using this method, we were able to collect details of at least two instances of connection problems for each participant.

The interview started with general questions: disciplinary area of the students, place of living, equipment and connection(s) at disposal, digital hobbies. The second part of the interview was dedicated to the “critical moments” considered. We asked participants to recall and explain these moments through different dimensions of their experience: situation of use, manifestation of the problem

	Household types	Locations	Devices	Types of onnectivity
P1	Student residence	- Nantes, France - Urban area	- Cell phone - Laptot	- 3G cell phone / 3G hotspot - WiFi, unstable on evening
P2	Student residence	- Nantes, France - Urban area	- Cell phone - Laptot	- 4G cell phone / 4G hotspot - WiFi, unstable on evening
	Mother's house	- Toulon, France - Urban area	- Cell phone - Laptot	- 4G cell phone / 4G hotspot - WiFi, malfunctioning
P3	Student residence	- Nantes, France - Urban area	- Cell phone - Laptot	- 4G cell phone / 4G hotspot - WiFi, unstable at noon / on evening
	Parent's house	- Vendée, France - Countryside	- Cell phone - Laptot	- 4G cell phone / 4G hotspot - Good WiFi
P4	Student residence	- Nantes, France - Urban area	- Cell phone - Laptot	- 4G cell phone / 4G hotspot, only H+ in a apartment
	Parent's house	- Vendée, France - Countryside	- Cell phone - Laptot	- 4G cell phone / 4G hotspot - Good WiFi
P5	Student residence	- Lyon, France - Urban area	- Cell phone - Laptot	- 4G cell phone / 4G hotspot - Good ethernet connection
	Individual apartment, living as a couple	- Lyon, France - Urban area	- Cell phone - Laptot - Desktop PC	- Good WiFi - 4G cell phone / 4G hotspot, malfunctioning in the apartment
P6	Individual apartment	- Nantes, France - Urban area	- Cell phone - Laptot - Desktop PC	- 4G cell phone / 4G hotspot - Malfunctioning 4G router and then, good WiFi
P7	Individual apartment	- Toulouse, France - Urban area	- Cell phone - Old laptot	- 4G cell phone / 4G hotspot - Good WiFi
P8	Individual apartment, living as a couple	- Nantes, France - Urban area	- Cell phone - Laptot - Desktop PC - Smartwatch - Alexa	- 4G cell phone - Good WiFi
	Parent's house	- Nantes, France - Urban area	- Cell phone - Laptot - Smartwatch	- 4G cell phone - Good WiFi
P9	Parent's house	- Dordogne, France - Countryside	- Cell phone - Old laptot	- Nothing, and then a 4G cell phone / 4G hotspot, with connection failures sometimes
P10	Individual apartment	- Nantes, France - Urban area	- Cell phone - Old laptot	- 4G cell phone / 4G hotspot

Table 1: Participants' situations.

(including perception), reactions to the problem encountered, solution(s) found, problem's frequency. During this second part of the interview, we also asked the informants if they had modified or adapted their use in response to connectivity problems. If so, we asked them how.

We dedicated the third part of the interview to the personal limits that participants voluntarily set up. We explored these limits according to two modalities: voluntary connection cuts and moderation in use (without cutting off the Internet totally). During the discussion, the reasons, the way of doing and the modalities of these "voluntary" limits were discussed with the participants.

We then asked the participants several general questions in order to better situate their profile: what kind of Internet use mattered to them? Did the Covid-19 pandemic change their practices at work or in their studies, in their leisure activities or in their social relationships? The interview ended with more generic questions such as age and how they felt about their digital literacy.

3.4 Analysis method

We used Braun and Clark's [6, 7] method to conduct a thematic analysis of the ten interviews. Following their recommended analysis phases, we first familiarized ourselves with the data by reviewing the various interviews' transcripts. Each member of the research team then completed an initial coding. We compared and pooled them during a face-to-face workshop where the entire research team was present. This workshop allowed us to establish a number of initial codes that were refined and improved throughout the

analysis process. As the Braun and Clark method allows to mix an inductive and deductive approaches, we chose from the start to code endured and chosen limits (as we explicitly asked about it during the interview). Multiple iterations were carried out during dedicated meetings in order to determine the different codes used for the thematic analysis. We used a spreadsheet in combination with some scripts to code the interviews and count the occurrences of each code. This counting was not meant to perform a quantitative data analysis but was used to orient ourselves in the data, as the analysis was conducted over several months. Several re-codings were conducted during the analysis to refine the relevance of the chosen codes and themes.

Finally, and after several back and forth between themes and interviews, the analysis made us choose the following overarching themes: (1) Diagnosing challenges, (2) Dealing with connection issues by avoiding them and (3) When limits become acceptable. We develop these themes in the results, within the next section of the article.

4 RESULTS

We conducted the study with students, several were living in collective housing, at their parents' house, or in shared apartments. We had the hypothesis that it would be a place in which informants experienced limits, especially during moments of remote teaching and social distancing, and that it could lead to collective negotiation around these limits. More precisely we started with the following research questions: 1) What are the forms of connectivity moderation that are imposed or those that are chosen? 2) Which (if any) of the connectivity limits are perceived as acceptable? 3) How do informants react to connectivity limits and issues over the short term and the long term? 4) What pushed informants to modify their practices? The interviews pushed us to reframe these initial questions in the themes we discuss in this section.

As we discuss below, informants did experience connectivity issues. For instance, P1 had untimely cuttings off during whatsapp conversations with her family. Several informants (P1, P2, P3, P4, P6) reported connectivity issues (slowdowns and breakdowns) during online sessions of collaborative work, using videoconferencing or text processors. P9 experienced three weeks without any internet access and P10 was forced to rely solely on her cellphone during months to follow online courses or deal with administrative procedures. Two participants (P7, P8) experienced physical cable cuttings during civil engineering, or maintenance operations, shutting down the internet in their area during hours. Through these different problematic situations, the challenge of understanding networking issues surfaced quickly, and became an important theme. But the acceptability of limits, and the ability to negotiate connectivity was much less straightforward (echoing [39]). It also became clear that connectivity issues were challenging and had to be circumvented, gradually leading to more individualized connections with students often switching to 4G in case of problems.

4.1 Diagnosing challenges

In contrast to the idea of pervasive and limitless connectivity, all informants experienced breakdowns in one way or another. It is

not that “it worked” or it did not, rather breakdowns and hyper-connectivity (intense and prolonged internet use) co-existed in the life of our informants. The limits informants experienced varied in intensity, sometimes involving limited bandwidth, sometimes unreliable connections, slowdowns or breakdowns.

A common pattern in the interviews was the lack of ability for informants to diagnose the issues they encountered. Identifying the source of connectivity limits has an important impact on the perceived capacity to act and the type of actions that are carried out to resolve the issue. Our hypothesis is that not being able to understand what is the source of problems makes them harder to endure, harder to solve and even provokes reactions that are counter-productive.

4.1.1 Perceiving connectivity and predicting its unreliability. It was difficult for informants to describe precisely the connectivity problems they encountered. They used a wide diversity of metaphoric terms to put into words what exactly was not working. Connection was sometimes “slow”, there were “cuts”, it “froze”, there were “low bandwidth” or “bugs”. Sometimes it just “stopped working”, intermittently or completely. Informants often use a precise description of the problem but from the way a device or software point of view, rarely from a networking one: “I had really, really bad bandwidth. Sometimes I couldn’t put the camera on the videos, videos took forever to load, uh a page took...not a lot of time but more time than normal you know...instead of loading it in I don’t know... 0.20 seconds, it took one or two seconds sometimes to load” (P6).

It was hard to understand whether the connectivity issues were coming from actual connection problems, from the informants’ device or software, or from other sources (network side, server-side or e.g. from their conversation partner). This provoked frustration for almost every informant, for instance, P5 explained “there have been moments when, you know, the connection stops in the middle and ok, it’s not the end of the world, but it’s super frustrating when it’s 11pm and you want to go to bed, you don’t want to be frustrated”.

Not being able to predict when a connectivity breakdown would happen was very stressful too. Because informants had already experienced them, they were expecting that more would happen but could not predict when. This is particularly acute during audio or video conversations: “Well, not every night, that’s why sometimes, when I had important calls, I was afraid that it would happen because I didn’t know if it would happen or not. The surprise effect.” (P1).

While some connectivity issues were rare, others were recurring, happening everyday, as expressed by P3 “Yeah, I think it happened every time with Lily, it seems to me that at every meeting [video-conference], it did happen. When we were doing it for a class”. In this case, it is unclear whether the recurring nature of the issue led to the ability to predict repetitions. In any case, it did not seem to lead to a change in technology, communication channel, or meeting strategy.

4.1.2 Diverse interpretation strategies. The variations and the frequency of the slowdowns/breakdowns were often a good track to follow as an attempt to understand the connection issue. Some informants identified specific times of days as more problematic than others: “I would say that it was frequent. I don’t know if it’s my impression or the reality, but I have still the impression that [it is during] specific time periods, so like in the evening [...]” (P4).

Whenever a problem occurred, informants had difficulties locating its exact source. One of the most common explanation provided by informants was that the connectivity issue was caused by too many people using the connection at the same time. This was how they rationalized it but were not sure whether it was true or not. For instance, this supposition is made for the evening issues encountered: “In the evening it wasn’t okay, there weren’t necessarily any problems I think, yeah, well in the evening, like I told you uh it was pretty boring uh during the lockdown and then after the lockdown it was better. I don’t know if people maybe left the residence to go to their parents’ house you know.” (P2).

Our informants attempted to interpret the breakdowns’ causes, but without a correct perception of the problems and therefore a wobbling diagnosis, their interpretations remained partial and speculative. P10 offer us a really good illustration of this foggy atmosphere, in which understanding how the problem occurs is quite impossible: “Sometimes it worked again, sometimes it didn’t. There are risks of ‘saturation’, I don’t really know why. But, we were two on it. But it happened even when I was alone. So, I don’t know. But from time to time it cut out.”

This impossibility to understand the roots of the breakdowns led informants to sometimes let it go, and blame the problem onto “the device”: “it doesn’t connect. Or it doesn’t even appear, it depends on the mood [of the device].” (P10), or onto the internet provider: “I had a WiFi connection. But it’s true that there are still bugs because it was Free¹, I have the impression that Free was the source of all my problems.” (P7). These misinterpretations also led informants to perform actions “in vain”: “Yeah, you even have that moment where you wonder if it’s your phone that’s buggy and then you start trying to turn it off and on and everything... well I do that all the time but...” (P.7).

Ultimately, sometimes the informant had isolated several potential causes without knowing which one was the good one. For instance, P6: “Yes, yes, that’s right, because my phone, well, it’s a bit damaged, I didn’t have a phone anymore, they gave me this one. So, I don’t know if it’s from the phone, I don’t know if it’s from the Free antenna.”

4.2 Dealing with connection issues by avoiding them

Like Chetty and al. had already pointed out [13], the impossibility to correctly perceive the connectivity issues and thus the struggle to diagnose is strongly restricting user agency in correcting faced connectivity issues. But this fact doesn’t mean a absence of user reactions. On the contrary, we now present the various ways our informants faced uncertainty, slowdowns, and breakdowns.

Because they had issues understanding or even locating the source of the issue, informants mainly displayed avoidance strategies: trying to bypass the issue rather than attempting to directly solving it. We identified different strategies: short-term reactions, anticipation, change of habits and long-term responses. Reactions and coping strategies also revealed the intricacy between connectivity (and the issues going with it) and the construction of everyday social relations.

¹Free is a french ISP

4.2.1 Switching from WiFi to 4G. In case of slowdowns, breakdowns or erratic connectivity, the most common strategy consisted in switching from a WiFi to a 4G connection. Which the informants did using their smartphones as hotspots. It was considered the easiest solution as it did not require understanding what the issue was, or where it was coming from. The rapidity of the switch was seen as a big advantage, especially for everyday use and strongly engaging activities. This even happened sometimes for minor inconveniences as described by P3: *“So with my internship, I haven’t had any problems for the moment, I’m on WiFi. Well, there are just a few things sometimes, when I think it’s not going fast enough, because I don’t like waiting, I switch to 4G. It’s really because I cannot [...] endure waiting”*.

Rather than in reaction, the switch to 4G could also happen in anticipation to breakdowns, in situations in which informants found them too risky to happen. P1 described how she would switch to 4G before a remote internship interview: *“if I have problems with WiFi, I switch to 4G and it works better [...] And sometimes I shared my 4G connection for my laptop, especially when I had interviews for my internship. I could not risk it. So... knowing that it breaks and all, ... I would share my connection.”*

Three students (P4, P9, P10) even chose to rely only on a 4G subscription (without WiFi) as it was cheaper, simpler to subscribe (it did not require opening a new line, a particularly long process in rural areas) and considered more reliable.

However, 4G hotspots led to problems of their own, for instance smartphones overheating and battery drain, as well as problems with tethering or connection sharing: *“At the beginning I just had my 4G phone connection. I was using it to connect my computer to the internet. So I was connected to the Internet via my phone, which made my phone overheat, so it was really impossible, it discharged super fast, you had to recharge it three or four times a day, which is not normal.”* (P6).

4.2.2 Location and Environmental Changes. Another reaction consisted in changing location or making changes to the surrounding environment. For instance, P4 and P5 described opening windows or doors in their apartment to improve network connectivity. While P6 described experimenting with the location of his router also considering walls, doors and windows for deciding on where it should go.

Moving to another room was also a reaction to connectivity problems: *“At my moms [...] my room is at the rear end of the house [...] I was in my room for the interview, but it’s the room which already has a bad connection. [...] so I moved to the living room which is really close to the router, but this did not really solve the problem.”* (P2).

In more serious situations, informants moved to other places, this was a quite common reaction, with seven informants describing doing so. Four described moving to the university for better connectivity. *“Once I went to the university 20 minutes before an interview, sorry not even, 10 minutes before my interview [...], I really needed a place with proper WiFi”* (P4).

While others moved to friends or partners, as e.g. P10, *“when I really could not follow Zoom classes, I visited [my partner], it happened a few times”*. P9 who stayed at his parents in the countryside described moving to an internet cafe: *“there was one 20km from home. [...] I went there once or twice”*. P9 was wrapping up university

work remotely after a year abroad, she did not have a mobile data plan and suffered from bad connectivity at home. She considered this a last resort solution.

4.2.3 Communication and Negotiation. In informants accounts, connection was often a relational endeavour. This involved warning remote interlocutors of potential problems: *“So I don’t really like it when ... for example when, you’re in the middle of a discussion and suddenly I don’t answer anymore, like it makes me uncomfortable, so uh I prefer to warn [people with] ‘I’m sorry’, ‘there’s a bug’, ‘it’s not my fault’.* (P2).

Within households, discussions about connectivity happened frequently, i.e., informants checking with others household members whether their connection was still running as expected, or whether they experienced problems. This could turn into negotiations about priority use: *“So it depends which days, because sometimes my father is working remotely. So when there are cuts or slowdowns, it bothers him a bit. So often we talk about it, he comes see me and asks if I’m downloading something, to figure out where the slowdown is coming from. My brother as well. My brother plays, but often when he [dad] does not work. Same thing, my father checks on him asking ‘are you downloading anything?’ Overall we discuss it quite often.”* (P3).

To our surprise we found very little cases for support and sharing among neighbours, whether through giving access to WiFi or staying at a neighbour for a while. P9 being the only one seeking support, by asking neighbours where to find the closest library or cafe. In addition to our observations of a general shift to 4G, this suggests that connectivity is considered a personal issue.

4.2.4 Downgrading and shifting use. More technical interventions consisted in “downgrading”, anticipating problems and trying to circumvent them. Reducing video quality for streaming services or video conferencing was a common strategy, as well as stopping video upload or switching to audio only video-conferencing.

Another form of downgrading consisted in shifting use. For instance, by downloading content ahead of use. P2 and P6 described downloading cloud-based content to work locally rather than online, while P1, P2, P3, and P8 described downloading content from a streaming service ahead of listening or watching. P4, P6 and P10 described moving activity from their PC to their smartphone.

Shifting use could also involve waiting for better “connectivity weather”, i.e. waiting for other users to stop their activities, like P2 waiting for her mom to be done: *“she has her little plan well defined, from this hour to this one there is this show, then that one she watches. So I wait for her to go to bed to launch Netflix”*.

4.2.5 Giving up. In many circumstances when the network was too unreliable, informants would simply give up on some of their digital activities: video and audio streaming, video-calls, or games (P1, P2, P4, P5, P6, P8, P10). These renunciations were often followed by a shift to another activity: *“It is rather when I watch something using streaming, like a video, that I will get frustrated, and I will tell myself: ‘ok I’ll read a book’; so I stop looking at a my screen altogether.”* (P4), or *“it happens to be slow at home, when it happens I tell myself: it’s not a good time to work, I’ll go to the kitchen and come back later, I am very patient.”* (P10).

4.2.6 Persisting. Alternatively, when the connection was limited many informants persisted trying to load content or follow on with

their digital activities. P4 described how she kept trying to load content even when confronted to limitations: *"I have the feeling of being... yes I am truly screen-dependent, regardless of the connection level, I will stick to whatever there is."*

While fixing the issue was hard, especially when the cause was really unclear, many informants described insisting (P2, P3, P4, P5, P6). This ranged from rejoining a video-conference when the connection dropped (often described as being "kicked-out"), to reloading content, to restarting WiFi, rebooting network drivers, turning 4G on and off, and finally restarting devices and routers. These trials were sometimes repeated several times.

4.2.7 From short-term to long-term responses. Connectivity issues led half of the informants to longer-term changes, this involved adding data to one's plan (in order to sustain a broader use of 4G), changing Internet Service Provider or mobile contract, or switching technology (as we mentioned 3 informants moved from WiFi to a 4G only data plan). Finally two informants described changing their ISP router or installing a repeater to get better network.

4.3 When limits become acceptable

While breakdowns and slowdowns were often stressful experiences that required interventions, we also discussed with informants situations in which this was not the case and even moments when they deliberately limited their connectivity.

4.3.1 Non problematic endured limits. Interestingly, some limits were imposed ones but were not identified as annoying (n=5). When the situation was socially pleasant and valued (like with family), some informants could give-up their connection: *"I was happy to be back with my family so I didn't miss it much. [...] I had downloaded music into my phone, so I could also use it offline."* (P9). If the situation was not of particular urgency, or was casual and could be relaunched easily, limits did not appear problematic: *"Well sometimes we called each other with Marie. Especially during the lock-downs, just for a little zoom aperitif and there were cuts. But it was not disturbing, it was funny."* (P1).

4.3.2 Motivation behind chosen limits. All but one informants described that, at times, they deliberately chose to limit their connection (i.e. their online activities). They described these practices as a form of moderation. Several reasons had motivated our informants to moderate their use and set-up a 'digital hygiene', from seeking a better separation between professional activity and private life, to the preservation of face-to-face social activities, and caring about attention dynamics. Chosen limits often occurred in the context of relationships with others, particularly with friends or during family gatherings.

Chosen limits were deployed at a personal level, like P4: *"it always gives me an environment, how can I put it... an additional piece of information to absorb and uh... I try to... I try to get back to silence because using my phone also means having a lot of music, video content that is running, it's also a lot of that, [...] I try to have silence and even at the visual level, to, to just have... the real you know... not... the screen"*. However, this was generally a struggle, as already discussed in the literature [22, 32].

For seven informants, limiting one's digital consumption was tightly connected to limiting time spent online. For P1, it was a

matter of "mental health". P2 explained that she felt it was "dull" to keep looking at pictures and stories of people. For P3, it was when stuck playing video games: *"Well, I'm starting to get a bit tired of it, I realize that I'm playing just to play or I'm not having fun playing. So I'm really getting tired of it, so I quit, I say to myself, well here I am not going to be on the computer just to be on the computer."*

Compulsive use of social media or video platforms often led to a lack of meaning in the activity: *"Well, you don't feel good, you feel half bad, how can I put it? You really have the impression that what you're doing doesn't make sense, and so you say "why am I doing this? Well, it doesn't make sense, and uh... to make sense again you stop doing it and you change a little bit and then you go back to it because you're... too used to it in fact."* (P6). Sometimes it was too much information to digest: *"Well, for example, I like to watch YouTube videos or listen to podcasts, or things like that and for me it makes sense because I'm storing information. But sometimes, I get too much information and I can't process it anymore and I'm thinking, well this is useless what am I doing?"* (P6). Overall, these restrictions become endured instead of pleasing when performed for too long.

The second most cited reason (n=6) was separating professional from personal aspects of one's life. It was a way to focus on the moment and the other person being present. For example, focusing on one's holiday. Spending time offline is seen as a treat to oneself (P3). Being "there", in the world, is also one of the goals when limiting one's activities online. For example, *"I realize that if I spend my days on a screen, I'm going to be a little...I'm going to be a little in my head and uh...so that's what I try to do when I turn off my phone. That's kind of the goal, to be a little less in my head."* (P4).

Two informants also mentioned how they tried to limit their connection because they wanted to limit the amount of electromagnetic waves their body is subjected to.

4.3.3 Setting up chosen limits. Informants often expressed a real difficulty to moderate uses they found problematic. In this perspective, they tried varied approaches: stopping an ongoing activity, turning off notifications or even move the device away: *"Very concretely... when I'm cooking, it's really the kind of thing, or when I'm doing the dishes, and well, it's situations where it really allows me to concentrate on what I'm doing and not have my phone."* (P4). Informants had diverse manners to set-up connection limits and to enforce them. Most of them at the smartphone level.

One of the main way was to simply increase the physical distance from their devices (n=5), especially smartphones: *"I'm so used to having a phone with me all the time that I leave it at home, I tell myself, well, I'm going out, I'm not taking it and... I'm going to do my shopping without taking it or... anything without taking it and that way, well, it'll already provide some time off."* (P6).

A few informants (n=3) had more drastic strategies to enforce limits. For example, P5 turned off WiFi at key moments: *"We turn off the WiFi at midnight, because it prevents us from being on WiFi and doing what I was saying, scrolling until 2 am."* Some informants deleted problematic applications, trying to delete the problem in the process: *"I was scrolling and then I was spending too much time. I wasn't happy with myself. So I deleted the app."* (P10). Other ways include installing web browser extensions that automatically block certain websites after a given time (P6). Or, like P9, installing an

application to manage her work time: *“It’s tempting while I’m working to look at the phone, when there’s a moment when I get stuck on something, or I have to think about it and finally I get lost and I go to my phone, so it’s a little bit tiring and that’s why I had downloaded this app.”*

5 DISCUSSION

Our results confirm insights from Chetty et al. about the existing challenges when it comes to understanding everyday connectivity limits [13]. Devices, operating systems and applications do not provide enough information to empower people in managing everyday internet use and fixing the connectivity issues they encounter [12]. It seems that in the long run, this lack of actionable insights may have led to the switch to 4G, which removes a level of intermediation (routers and local networks). This may be especially the case as limits are increasingly becoming hard to negotiate in everyday situations, as Widdicks et al. have recently noted [39]. Nonetheless we see interesting opportunities in the will to set-up a better digital hygiene, which is also in line with past work on slow computing [19].

5.1 Individualisation of connectivity

With informants’ expectations of constant connectivity (especially during the pandemic), friction drove them away from their default and presumed reliable networking protocol WiFi to 4G. This was particularly the case when informants experienced drops in their WiFi connection and needed to regain connectivity quickly.

While WiFi is still largely used, we notice a progressive shift to 4/5G, and the associated individualization of connectivity. This can be related to many factors: economical ones (avoiding two subscriptions), comfort (e.g. avoiding logging in at the university or on other unknown networks), and even reliability.

In contrast, reduced battery life, as well as lack of network coverage were generally coming with wider 4G uses. However, it didn’t lead to a 4G disaffection.

The shift to 4G may also be explained by the way connectivity quality is now part of ones’ presentation to the outside world. This surfaced clearly when informants discussed remote interviewing, where the issue at hand was not simply the risk of technical problems that could have been partly solved by shifting to a phone call, but also of how the connectivity represented the person as serious, dedicated or in control of technology.

This individualization of connection makes it more challenging to collectively discuss and negotiate limits to connectivity. Data caps, speed limitation, or other forms of collective control on connectivity can be seen as infringing on ones personal connection, rather than a form of collective management over a shared common resource.

5.2 Collective injunctions

Our study also highlighted a tension between the individual connection space, of one’s home or of one’s smartphone on the one side and the highly socially engaging collective connected uses on the other side.

Informants preferred “being there” with their family and friends when they were meeting face to face, they however strongly relied

on Internet to maintain friendship and family bonds, especially during lockdowns. The absence of connection during lockdowns has been reported as highly problematic (at a psychological level) by our informants.

Most of them told us about the difficult situations they faced when they experienced limits while engaging with other people online. Sometimes slowdowns were impossible or really hard to manage, because of the strong pressure of being online. Zoom classes and internships interviews were especially cited by participants.

Unfortunately, some situations led to detrimental consequences. One informant (P10) experienced a situation where she only had connection on her smartphone, with tethering not working. This was an important source of stress. For pursuing some administrative tasks she had to go onsite and this wasn’t possible during her working days. Again, we see here that connectivity involves high social representation stakes but also the capacity to access some essential public services or to maintain an affective relationship with others.

Permanent connectivity habits play an important role in our social lives today and it appeared evident for informants that it had to be maintained, sometimes like a skill to be demonstrated. Personal expectations cohabits with strong injunctions, set-up by authority figures like professors or work management. A interesting way to pursue our study could be to investigate the social representations mechanisms involved in our common connectivity uses in relation to our everyday social institutions : work, studies, family, friends or even citizenship.

5.3 Understanding the interplay between non-chosen and chosen limits

Identifying acceptable paths to digital sufficiency requires understanding the interplay between chosen and non-chosen limits. First, we can identify parameters that facilitate limits acceptance. In our results, a key parameter was the strong difference in terms of perception between personal and professional context. Non-chosen limits that lead to detrimental consequences were mostly experienced in professional or administrative contexts. On the other end, chosen limits were most often implemented in personal and individual contexts. This brings forward the question of the right to disconnect as an important right in professional contexts. For all informants, too much connectivity, i.e., spending too much time on one’s device, was considered negatively. This issue connects our results with the growing body of research that demonstrate the design strategies used by digital content providers to hook people. Setting up accepted limits would certainly start with dismantling deceptive patterns designed to keep people online. In that line, the notion of sufficiency could also be fruitful to define the key moment when connectivity is enough but not too much. This can be understood both in terms of quality of connection but also in terms of amount of time.

5.4 Long-term responses and the cornucopian paradigm

Despite a lack of intelligibility, informants felt more comfortable trying to address connectivity issues technically rather than negotiating or compromising on their social activities. Some remediation strategies or changes were easier to implement than others. It was for example very easy to switch from WiFi to 4G while it was generally very difficult to ask for rescheduling a meeting or a work session.

As issues kept occurring, informants described longer term reactions such as switching operator or ISP, changing their data plan, or changing their main connectivity provider (from ISP to mobile). These could also happen in anticipation of upcoming events: a new semester, a change of housing situation, etc. For our informants this was balanced with economical constraints.

Overall, longer term connectivity changes feed the cornucopian paradigm [29]. Informants were caught with increased demands to be online, to present themselves online, and be perceived as responsible of their connection quality. This led to temporary fixes and workarounds but also many stressful situations, which in the long run accumulate and lead to changes and increase in connectivity capabilities, whether in terms of coverage/availability, in data plan, or devices. This movement, in return, increases the expectations one has on others, redefining what is considered as “normal”. Here the increasing switch to mobile connections has a detrimental ecological impact client-side: 4G networks are more energy intensive than WiFi and drain the battery faster, reducing device life span on the long run.

6 LIMITATIONS

Our study looked into the experiences of a limited number of people: 10 students of a homogeneous age (22-25), who all reported a good control of digital tools. Our results must be put into perspective with studies focusing on other populations, less comfortable with digital uses. The study took place in France, where Internet access is widespread and data plans relatively cheap compared to other countries.

We should also note that the period covered by our interviews was the height of the Covid 19 pandemic distancing measures. This allowed us to access a field where the digital limits were strongly felt. But it was an exceptional period. We can consider that the pressure to be online felt by the informants were probably stronger than in a non-pandemic situation. Some accounts happened during lock-down periods which limited the range of possible reactions and anticipations.

Finally, with results based on declarative data it would be useful to complement the study with other sources and collection methods, and triangulate our results. Logs, diaries or even shadowing observations would be very relevant to gain more situated insights on connectivity experiences.

7 RECOMMENDATIONS

We set out to study endured and desired connectivity limits. Our end goal was to understand how to support digital sufficiency and manage pro-actively limits to connectivity. We noticed that despite

frequent issues, from slowdowns to complete breakdowns, connectivity is now assumed. Peer pressure builds a sense of what a ‘proper’ connection should be. Combined to the digitization of many public services and remote classes for distancing purposes during the covid pandemic, the result is an expectation of permanent reliable connectivity. These connectivity expectations were disempowering as connection information tends to be hidden away, offering little opportunities for negotiation or control.

7.1 Supporting diagnoses to foster resilience or repair

It was challenging for informants to diagnose connectivity issues, the “number of bars” gave some basic information, but this was not enough to understand whether video-conference would work well for instance. While diagnosis tools are available, they are geared towards experts. There is space to develop a language to communicate about network status, both in terms of vocabulary and representations: upload and download capabilities, stability over time, the type of services or the number of users that can be accommodated at a time.

Lack of understanding sometimes resulted in folk theories on network behaviour which in turn pushed informants to react in ineffective ways. Some informants developed ideas about the network “weather”, but they had no way to do so in an informed manner besides reflecting on their every day experiences. Offering means to anticipate (or simply be aware of) network congestion, work on the lines or antennas, or other external conditions could be useful to end-users. Better information could enhance the agency of everyday users, and lead to better (re)actions or mitigation strategies. Given the complexity of networks today and the multiple failure points, visualization work could also be relevant to provide more intelligibility.

7.2 Supporting negotiation and control

Regarding desired limits, individual data on the time spent on devices and applications seemed to have a positive effect on several informants, by promoting awareness of their uses, and enabling some to take action. Indeed, several recent studies tend to show that an access to a personal screentime tracking could be interesting in order to “push” users to regulate their uses. For instance, by improving daily productivity or producing a need to regulate screentime, but not necessarily by reducing screentime itself [1, 30, 42]. At a collective level however, there is currently no way to reflect on connectivity and set up such limits. While we did not observe explicitly shared connections, this does not mean that we did not encounter communities sharing networks or networking experience. Indeed students sharing a hotspot at the university or in a café, families sharing their wifi. Connections are shared but not collectively managed.

Applications could offer a better awareness of network conditions, and provide ways to collectively regulate a shared common that is the bandwidth. This has already been explored by Tolmie et al. [36] or Poole et al. [28], but could be revisited with a stronger focus on the management of shared commons, exploring large scales (buildings or organizations, rather than the home setting), and with an ecological lens. Beyond specific recommendations, we also think

that the networking and HCI communities should work together on these issues as they each possess a unique perspective and expertise regarding how to deal with connectivity limits.

8 CONCLUSION

We conducted our study in the midst of the Covid-19 pandemic, with particularly high connectivity expectations and intense use. This was especially the case for our informants, ten students who used Internet daily and for whom it was an integral part of their social activities: from leisure to studies and work. This allowed us to document problematic uses and the reactions to connectivity limits that people arguably faced everyday.

We found that everyday connectivity is a messy experience, full of slowdowns, temporary drops, breakdowns, and other phenomena hard to understand and solve. This led informants to circumvent issues in a wide variety of ways, and in the long run many switched to 4G with data-plans that felt limitless. In the meantime this permanent connectivity also led to desired moments of disconnection or more subtle forms of moderation.

Overall we note that as connectivity becomes part of everyday social interactions, but also studies and work, it also becomes much more personal. And although the underlying infrastructures are shared among users, it becomes increasingly challenging to limit ones connectivity.

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REFERENCES

- [1] Kaveh Abhari and Isaac Vaghefi. 2022. Screen Time and Productivity: An Extension of Goal-setting Theory to Explain Optimum Smartphone Use. *AIS Transactions on Human-Computer Interaction* 14, 3 (Sept. 2022), 254–288. <https://doi.org/10.17705/1thci.00169>
- [2] Abhinav Anand, Veljko Pejovic, Elizabeth M. Belding, and David L. Johnson. 2012. VillageCell: Cost Effective Cellular Connectivity in Rural Areas. In *Proceedings of the Fifth International Conference on Information and Communication Technologies and Development (ICTD '12)*. Association for Computing Machinery, New York, NY, USA, 180–189. <https://doi.org/10.1145/2160673.2160698>
- [3] Richard Banks, David Kirk, and Abigail Sellen. 2012. A Design Perspective on Three Technology Heirlooms. *Human-Computer Interaction* 27, 1-2 (April 2012), 63–91. <https://doi.org/10.1080/07370024.2012.656042>
- [4] Anaëlle Beignon. 2021. *Design for Obsolete Devices. : Exploring the Marginalization of Users of Obsolete Devices Regarding the Swedish Public Services' Digitalization*.
- [5] Genevieve Bell and Paul Dourish. 2007. Yesterday's Tomorrows: Notes on Ubiquitous Computing's Dominant Vision. *Personal and Ubiquitous Computing* 11, 2 (Jan. 2007), 133–143. <https://doi.org/10.1007/s00779-006-0071-x>
- [6] Virginia Braun and Victoria Clarke. 2006. Using Thematic Analysis in Psychology. *Qualitative Research in Psychology* 3, 2 (Jan. 2006), 77–101. <https://doi.org/10.1191/1478088706qp063oa>
- [7] Virginia Braun and Victoria Clarke. 2019. Reflecting on Reflexive Thematic Analysis. *Qualitative Research in Sport, Exercise and Health* 11, 4 (Aug. 2019), 589–597. <https://doi.org/10.1080/2159676X.2019.1628806>
- [8] Matthew Chalmers and Areti Galani. 2004. Seamless Interweaving: Heterogeneity in the Theory and Design of Interactive Systems. In *Proceedings of the 5th Conference on Designing Interactive Systems: Processes, Practices, Methods, and Techniques (DIS '04)*. Association for Computing Machinery, New York, NY, USA, 243–252. <https://doi.org/10.1145/1013115.1013149>
- [9] Matthew Chalmers and Ian Maccoll. 2003. *Seamful and Seamless Design in Ubiquitous Computing*. Technical Report. In Proceedings of Workshop At the Crossroads: The Interaction of HCI and Systems Issues in UbiComp. 2003.
- [10] Jay Chen. 2015. Computing within Limits and ICTD. *First Monday* (July 2015). <https://doi.org/10.5210/fm.v20i8.6124>
- [11] Marshini Chetty, Richard Banks, A.J. Brush, Jonathan Donner, and Rebecca Grinter. 2012. You're Capped: Understanding the Effects of Bandwidth Caps on Broadband Use in the Home. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. Association for Computing Machinery, New York, NY, USA, 3021–3030.
- [12] Marshini Chetty, Richard Banks, Richard Harper, Tim Regan, Abigail Sellen, Christos Gkantsidis, Thomas Karagiannis, and Peter Key. 2010. Who's Hogging the Bandwidth: The Consequences of Revealing the Invisible in the Home. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. Association for Computing Machinery, New York, NY, USA, 659–668.
- [13] Marshini Chetty, David Haslem, Andrew Baird, Ugochi Ofoha, Bethany Sumner, and Rebecca Grinter. 2011. Why Is My Internet Slow?: Making Network Speeds Visible. In *Proceedings of the 2011 Annual Conference on Human Factors in Computing Systems - CHI '11*. ACM Press, Vancouver, BC, Canada, 1889. <https://doi.org/10.1145/1978942.1979217>
- [14] Andy Crabtree, Richard Mortier, Tom Rodden, and Peter Tolmie. 2012. Unremarkable Networking: The Home Network as a Part of Everyday Life. In *Proceedings of the Designing Interactive Systems Conference (DIS '12)*. Association for Computing Machinery, New York, NY, USA, 554–563. <https://doi.org/10.1145/2317956.2318039>
- [15] Mark Davies, Alan Chamberlain, and Andy Crabtree. 2013. Issues and Understandings for Rural HCI Systems Development: Agile Approaches "In the Wild". In *HCI International 2013 - Posters' Extended Abstracts (Communications in Computer and Information Science)*, Constantine Stephanidis (Ed.). Springer, Berlin, Heidelberg, 22–26. https://doi.org/10.1007/978-3-642-39473-7_5
- [16] John C. Flanagan. 1954. The Critical Incident Technique. *Psychological Bulletin* 51, 4 (1954), 327–358. <https://doi.org/10.1037/h0061470>
- [17] S. Goel, S. Belardo, and L. Iwan. 2004. A Resilient Network That Can Operate under Duress: To Support Communication between Government Agencies during Crisis Situations. In *37th Annual Hawaii International Conference on System Sciences, 2004. Proceedings of The*. 11 pp.–. <https://doi.org/10.1109/HICSS.2004.1265312>
- [18] Rebecca E. Grinter, W. Keith Edwards, Marshini Chetty, Erika S. Poole, Ja-Young Sung, Jeonghwa Yang, Andy Crabtree, Peter Tolmie, Tom Rodden, Chris Greenhalgh, and Steve Benford. 2009. The Ins and Outs of Home Networking: The Case for Useful and Usable Domestic Networking. *ACM Transactions on Computer-Human Interaction* 16, 2 (June 2009), 8:1–8:28. <https://doi.org/10.1145/1534903.1534905>
- [19] Lars Hallnäs and Johan Redström. 2001. Slow Technology – Designing for Reflection. *Personal and Ubiquitous Computing* 5, 3 (Jan. 2001), 201–212. <https://doi.org/10.1007/PL00000019>
- [20] Joshua Hill, Kelly Widdicks, and Mike Hazas. 2020. Mapping the Scope of Software Interventions for Moderate Internet Use on Mobile Devices. *Proceedings of the 7th International Conference on ICT for Sustainability (June 2020)*, 204–212.
- [21] Juan David Hincapié Ramos, Aurélien Tabard, and Jakob E. Bardram. 2011. GridOrbit: An Infrastructure Awareness System for Increasing Contribution in Volunteer Computing. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '11)*. Association for Computing Machinery, New York, NY, USA, 1899–1908. <https://doi.org/10.1145/1978942.1979218>
- [22] Minsam Ko, Subin Yang, Joonwon Lee, Christian Heizmann, Jinyoung Jeong, Uichin Lee, Daehye Shin, Koji Yatani, Junehwa Song, and Kyong-Mee Chung. 2015. NUGU: A Group-based Intervention App for Improving Self-Regulation of Limiting Smartphone Use. In *Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing (CSCW '15)*. Association for Computing Machinery, New York, NY, USA, 1235–1245. <https://doi.org/10.1145/2675133.2675244>
- [23] Valentin Lachand, Christine Michel, and Aurélien Tabard. 2019. Toccatà: Supporting Classroom Orchestration with Activity Based Computing. *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies* 3, 2 (June 2019), 53:1–53:24. <https://doi.org/10.1145/3328924>
- [24] Yao-Nan Lien, Hung-Chin Jang, and Tzu-Chieh Tsai. 2009. A MANET Based Emergency Communication and Information System for Catastrophic Natural Disasters. In *2009 29th IEEE International Conference on Distributed Computing Systems Workshops*. 412–417. <https://doi.org/10.1109/ICDCSW.2009.72>
- [25] Patrick Lieser, Flor Alvarez, Paul Gardner-Stephen, Matthias Hollick, and Doreen Boehnstedt. 2017. Architecture for Responsive Emergency Communications Networks. In *2017 IEEE Global Humanitarian Technology Conference (GHTC)*. 1–9. <https://doi.org/10.1109/GHTC.2017.8239239>
- [26] William Odom, Richard Banks, Abigail Durrant, David Kirk, and James Pierce. 2012. Slow Technology: Critical Reflection and Future Directions. In *Proceedings of the Designing Interactive Systems Conference (DIS '12)*. Association for Computing Machinery, New York, NY, USA, 816–817. <https://doi.org/10.1145/2317956.2318088>
- [27] William T Odom, Abigail J Sellen, Richard Banks, David S Kirk, Tim Regan, Mark Selby, Jodi L Forlizzi, and John Zimmerman. 2014. Designing for Slowness, Anticipation and Re-Visitation: A Long Term Field Study of the Photobox. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. 1961–1970.

- [28] Erika Shehan Poole, Marshini Chetty, Rebecca E. Grinter, and W. Keith Edwards. 2008. More than Meets the Eye: Transforming the User Experience of Home Network Management. In *Proceedings of the 7th ACM Conference on Designing Interactive Systems (DIS '08)*. Association for Computing Machinery, New York, NY, USA, 455–464. <https://doi.org/10.1145/1394445.1394494>
- [29] Chris Preist, Daniel Schien, and Eli Blevis. 2016. Understanding and Mitigating the Effects of Device and Cloud Service Design Decisions on the Environmental Footprint of Digital Infrastructure. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems (CHI '16)*. Association for Computing Machinery, New York, NY, USA, 1324–1337. <https://doi.org/10.1145/2858036.2858378>
- [30] John Rooksby, Parvin Asadzadeh, Mattias Rost, Alistair Morrison, and Matthew Chalmers. 2016. Personal Tracking of Screen Time on Digital Devices. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*. ACM, San Jose California USA, 284–296. <https://doi.org/10.1145/2858036.2858055>
- [31] Tilman Santarius, Jan C. T. Bieser, Vivian Frick, Mattias Höjer, Maïke Gossen, Lorenz M. Hilty, Eva Kern, Johanna Pohl, Friederike Rohde, and Steffen Lange. 2022. Digital Sufficiency: Conceptual Considerations for ICTs on a Finite Planet. *Annals of Telecommunications* (May 2022). <https://doi.org/10.1007/s12243-022-00914-x>
- [32] Sarita Yardi Schoenebeck. 2014. Giving up Twitter for Lent: How and Why We Take Breaks from Social Media. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (Toronto, Ontario, Canada) (CHI '14). Association for Computing Machinery, New York, NY, USA, 773–782. <https://doi.org/10.1145/2556288.2556983>
- [33] Susan Leigh Star. 1999. The Ethnography of Infrastructure. *American Behavioral Scientist* 43, 3 (Nov. 1999), 377–391. <https://doi.org/10.1177/00027649921955326>
- [34] Marion Lara Tan, Raj Prasanna, Kristin Stock, Emma Hudson-Doyle, Graham Leonard, and David Johnston. 2017. Mobile Applications in Crisis Informatics Literature: A Systematic Review. *International Journal of Disaster Risk Reduction* 24 (Sept. 2017), 297–311. <https://doi.org/10.1016/j.ijdrr.2017.06.009>
- [35] Peter Tolmie, Andy Crabtree, Stefan Egglegstone, Jan Humble, Chris Greenhalgh, and Tom Rodden. 2010. Digital Plumbing: The Mundane Work of Deploying UbiComp in the Home. *Personal and Ubiquitous Computing* 14, 3 (April 2010), 181–196. <https://doi.org/10.1007/s00779-009-0260-5>
- [36] Peter Tolmie, Andy Crabtree, Tom Rodden, Chris Greenhalgh, and Steve Benford. 2007. Making the Home Network at Home: Digital Housekeeping. In *ECSCW 2007*, Liam J. Bannon, Ina Wagner, Carl Gutwin, Richard H. R. Harper, and Kjeld Schmidt (Eds.). Springer, London, 331–350. https://doi.org/10.1007/978-1-84800-031-5_18
- [37] Mark Weiser. 1991. The Computer for the 21 St Century. *Scientific American* 265, 3 (1991), 94–105.
- [38] Kelly Widdicks, Oliver Bates, Mike Hazas, Adrian Friday, and Alastair R. Beresford. 2017. Demand Around the Clock: Time Use and Data Demand of Mobile Devices in Everyday Life. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems (CHI '17)*. Association for Computing Machinery, New York, NY, USA, 5361–5372. <https://doi.org/10.1145/3025453.3025730>
- [39] Kelly Widdicks and Daniel Pargman. 2019. Breaking the Cornucopian Paradigm: Towards Moderate Internet Use in Everyday Life. (2019), 8.
- [40] Kelly Widdicks, Tina Ringenson, Daniel Pargman, Vishnupriya Kuppusamy, and Patricia Lago. 2018. Undesigning the Internet: An Exploratory Study of Reducing Everyday Internet Connectivity. In *ICT4S2018. 5th International Conference on Information and Communication Technology for Sustainability*. 384–369. <https://doi.org/10.29007/s221>
- [41] Mariya Zheleva, Paul Schmitt, Morgan Vigil, and Elizabeth Belding. 2013. The Increased Bandwidth Fallacy: Performance and Usage in Rural Zambia. In *Proceedings of the 4th Annual Symposium on Computing for Development (ACM DEV-4 '13)*. Association for Computing Machinery, New York, NY, USA, 1–10. <https://doi.org/10.1145/2537052.2537060>
- [42] Laura Zimmermann. 2021. “Your Screen-Time App Is Keeping Track”: Consumers Are Happy to Monitor but Unlikely to Reduce Smartphone Usage. *Journal of the Association for Consumer Research* 6, 3 (July 2021), 377–382. <https://doi.org/10.1086/714365>