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The Broken Dream of Pervasive Sentient Ambient Calm Invisible Ubiquitous Computing

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Abstract
We dreamt of technology becoming invisible, for our wants
and needs to be primary and the tools we use for making
them a reality to become like a genie, a snap of the fingers
and ta daa, everything is realised. What went wrong?
Was this always an impossible dream? How did we end up
with this fetishised obsession with mobile phones? How
did we end up with technology tearing apart our sense of
experience and replacing it with 'Likes'. No one meant
this to happen, not even US Corporates, they just wanted
to own us, not diminish our sense of existing and
interacting within the real world. In this paper we consider
how tools took over, and how the dream of ubiquitous (or
whatever its called) computing was destroyed. We rally
rebellious forces and consider how we might fight back,
and whether we should even bother trying.

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Computing

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H.5.m [Information interfaces and presentation (e.g.,
HCI)]: Miscellaneous.

Introduction

It seems Xerox Parc pretty much invented everything before anyone got round to making it[6]. Back in 1991 Mark Weiser, working at Xerox Parc, published *The Computer for the 21st Century* in Scientific America[16]. His vision dominated an area of research he coined *Ubiquitous Computing* for over a decade. His article noted the shift from mainframes to desktops and posited a next phase where computers would become small and everywhere. He described a world where computers faded into the background until required, where they mediated almost every part of our lives, and implicitly made our lives better. A little like consulting Nostrodamus it is easy to pick and choose Weiser's predictions to accurately fit many technological developments over the last twenty years. Central to Weiser's argument was *not just* that computers would become smaller, connected and ubiquitous. The key to Weiser's vision was that computers would become like writing, just there, just used, not in your face, not dominating our day-to-day experience, but facilitating all sorts of wonderful conveniences from finding parking spots to letting us know when there is fresh coffee. Part of this vision included many tablet like computers of different sizes all so cheap as to be as throw away and usable as paper. Weiser with Seely Brown[17] extended this vision with the idea of the computer being in the periphery until required, or as they termed it *Calm Computing*. They posited that if computers were everywhere, in order to avoid information overload, they must be able to fade into the periphery. In the two decades following Weiser's original article we have seen his ideas extended, the terms used for this, and related ideas, blossom, many million of pounds worth of research funding being designated for this field of computing and the emergence of dedicated publications and conferences. We have also, more recently, seen some soul searching concerned with what happened to Weiser predicted future and what relevance such visions have[12]. These vary from discussing why Weiser's vision was wrong, to why it has mostly been proved right, to offering how his vision should be modified and replaced. So it's history, get over it, right? No, wrong, it's not history yet. It's not history because the contrast between Weiser's vision and what happened is something we must learn from. Some of the reasons Weiser's vision was not realised go deeply to the heart of HCI theory and practice, others cast a spotlight on the difficult relationship between the commercial world and HCI research. But, most important of all, it raises crucial questions about how HCI and design professionals should work with commercial and government sectors in the future.

In this paper we will consider some of the idiocies inherent in ubiquitous computing, review the most influential critics and apologists, and offer our own perspective on why Weiser's vision was not realised. We also discuss whether we should just all forget about it and move on, or whether there is something beautiful and important in Weiser's vision that we should strive to keep alive and call for a new pervasive computing manifesto fit for the current age.

Pervasive Sentient Ambient Calm Invisible Ubiquitous Computing

What exactly is ubiquitous computing? The harder you look the less clear this becomes. The nomenclature includes half a dozen different terms all overlapping or synonymous, all vying for relevance, citation and importance in the field. Taking a brief look at Ubicomp, the international conference dedicated to ubiquitous computing, we see papers ranging from car route recommendations to power management, gait analysis to social robots, localisation to bandages to collect biosignal

Figure 1: An example of a *Blindingly Visible* digital display. Recently one the size of an American football pitch was added to Times Square. By making use of the natural human reaction to horrific or traumatic events, future systems are being developed that will aim to implant images you cannot forget, directly into your brain.

data. Stanjano[15] suggests the difference in names was often connected with different research groups and a desire to claim antecedence in the concepts than any concrete differences. Yet the terms do convey different nuances within the field. We can now regard ubiquitous and pervasive as synonymous. Pervasive, while starting with a more systems focus, was the term popularised by IBM and Ark and Selker[2] and like ubiquitous computing, focuses on the notion of computers being in everything and being everywhere. Invisible Computing[11]focuses more on the distinction between a standalone PC and the vision of computers merging into the environment. These fields have been gradually superseded over the past decade with *Blindingly Visible Computing* (See Figure 1), or as termed in the recent EU H2020 call, *In Your Face* (IYF) Computing[1]. Sentient Computing[8] and Ambient Intelligence[5] focus more on the how computers can silently predict and attend to our needs and wishes. A contrast to this approach can be found in many deployed systems, such as Airport information systems, which are designed with the contrasting approach of *Not Giving a Shit* (NGS) Computing where the user needs are ignored and the focus is instead on the service providers needs. Over the previous few decades we have also seen a take-up of the *Ambient Ignorance* approach to computing which has been shown to be cheaper and more efficient to implement, and in the end, less annoying.

Previous Critiques

Weiser's vision was called the *The computer for the 21st century*. Thus after much investment in time and money to fulfil this vision, when the 21st Century arrived, it seemed not entirely profane to ask how reality matched up to the vision. Critiques can be split into camps of Weiser's supporters and detractors. It depends on the importance

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[1]This is a joke, no such call exists... yet.

you give to the various elements in Weiser's vision. For example it is true that computers are smaller, connected, and ubiquitous in the modern world than they were in 1991. However, it's more contentious to argue that we have reached an era of *calm computing*.

Bell and Dourish: Bell and Dourish in 2003[3] is best understood from the perspective of cultural anthropology. Three arguments are presented, firstly that Weiser's vision was set in the proximate future, the just about to happen future, and that this, in a common approach to research in ubiquitous computing, preventing appropriate use of the *now* to test and apply ideas, secondly, that Weiser's vision is particularly US centric, and that looking at other cultures can help develop and understand the concept of ubiquitous computing, and thirdly, that developing homogeneous infrastructure to support ubiquitous services is a major challenge.

The observation that publications in ubiquitous computing are often written, not just in the future tense, but describe a future which is just about to happen, is used to argue that this dependency on a proximate future has been a specific feature of work in ubiquitous computing research. They point out that *"fully 47% of papers in Ubicomp between 2001 and 2004 were oriented to a proximate and (inevitable) technological future"*[3]. However if we take a straw poll of three random paper sessions from CHI 2014, Studying Online Communities, Image and Animation Authoring and Studying and Designing Gameplay, we also find similar language *"are becoming an increasingly important"*, *"Advances... are changing the traditional notions"*, *"With the rising interest in"* etc. 5 out of 12 papers use this type of language (42%). Arguably Bell and Dourish have confused a style of writing typical to research engineering as a whole, with the writing in

ubiquitous computing. Without a baseline their observations, although well argued, are without basis.

In contrast the observation that Weiser's vision is very US centric is more compelling. Even more so when reading it in hindsight. They also point out that the social attitudes are relevant when dealing with technology that will seamlessly into their lives. However the analysis of computing in Korea and Singapore fails due to a basic misconception (and one shared by some other reviews), computers being ubiquitous is not the same as ubiquitous computing. Its confusing I know but we didn't choose the nomenclature. The amount of broadband, and coverage of mobile phones might well vary across cultures, and Bell Dourish make some very insightful comments about how this might effect take up of mobile services. In reality, the use of mobile phones (the opposite of ubiquitous computing according to Weiser) is incredibly homogeneous across cultures, compared to say food, or religion or how you bring up kids.

Finally, we would also dispute their conclusion that infrastructure is too messy, and it has hampered ubiquitous computing. This is really just a matter of opinion. GPS, bluetooth, Internet protocols, voltage, is incredibly homogeneous throughout the world. Back in the 1970s you couldn't even take a TV to France from the UK and expect it to work. Now we expect our mobile devices to pick up cellular, WiFi and locative services everywhere we go.

Despite our reservations with the three main conclusions in the Bell and Dourish paper, their contribution to the debate has been crucial. They point out that the way we do science, social factors, and the existence of infrastructure are key drivers in how technology is developed and developing. We will return to these three key drivers when we present our own view on what happened with ubiquitous computing.

Rogers: Rogers[14] in 2006 argues for a change in direction in ubiquitous computing research. She argues that calm computing as proposed by Wieser has not been successful and that we should move from approaches such as ambient intelligence to enjoyable engagement, where the focus is in engaging the user with a sense of play (ludic computing e.g. [10]) and to generate a rich sense of experience (experiential computing e.g. [9]). The argument is, that predicting and servicing the users' needs automatically is just very hard, quoting Greenfield *"we simply don't do 'smart' very well yet"*[7], because *"it involves solving very hard artificial intelligence problems that in many ways are more challenging than creating an artificial human."*[14]. Furthermore Rogers argues that even if we could build such systems they would not be desirable. *"It is worth drawing an analogy here with the world of the landed aristocracy in Victorian England who's day-to-day live was supported by a raft of servants that were deemed to be invisible to them."*[14]. There is an implicit argument here that the lifestyle of Victorian landed gentry is not something we should aspire to. This echos Bell and Dourish's observation that Weiser's vision was particularly US centric; a utopia for people who commute to high paid tech jobs in the valley; making the world measurably better for the currently privileged. Moreover she raises the real issue of privacy and security in such systems. Systems that collect context about a user without their knowledge are prone to abuse. Direct engagement with the user can make it clearer what information about a user is being collected and why.

The subtext to Roger's paper is politely veiled fury with the assumption that computers should sort everything out

without human input, that not only is this pretty much impossible, but that it isn't even desirable. This model, that of ubiquitous systems collecting context, predicting the users needs and automatically responding to them is central to ideas in Ambient Intelligence, Invisible Computing, Disappearing Computing, Fairyland Computing[2] and, until Roger's paper, little had been published to effectively challenge these central ideas in ubiquitous computing.

However we would argue that Rogers was mistaken in using the term Calm Computing as an umbrella for these types of systems. In Weiser's scenario, where Sal experiences the joys of ubiquitous computing, the first interaction is Sal's coffee machine asking her if she wants coffee. The systems Roger's is describing would infer the need for coffee and make it whether she wanted it or not. As Weiser clearly states, *"if computers are everywhere they better stay out of the way, and that means designing them so that the people being shared by the computers remain serene and* **in control***."*[17] (our emphasis). Weiser does not argue against engagement, he just points out that if you have twenty devices around you, you can't engage with them all at once.

Caċeres and Friday: Both Bell and Dourish, and the paper by Rogers are critical (although politely) of the concepts of ubiquitous computing. Bearing in mind the old saying, *Don't shit where you eat* Caċeres and Friday's review of 20 years of ubiquitous computing[4] in 2012, prefer to regard the current situation as *progress*, failures to be seen as *opportunities*, and problems reinterpreted as *challenges*. They present earlier critiques (such as Rogers and Bell and Dourish) but remain silent concerning there

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[2]Okay, we made that one up, the world supply of pixie dust has been shown to be insufficient to support this model of computing.

own views on the desirability of Weiser's vision of a calm integrated world. Rather the focus is on *why we aren't there yet* (A use of the proximate future which would probably have made Bell and Dourish chuckle). The paper contains a clearly written and detailed review of current technical issues within ubiquitous computing such as data privacy, intelligent infrastructure, and energy considerations. It is not a positional paper, and doesn't seek to be one, rather a useful collection of up to date information on the current state of ubiquitous computing. New buzz words, such as the Internet of things and big data, have perhaps overshadowed terms such as pervasive and ubiquitous. Both are interpreted here as a means of solving the infrastructure problem which this paper sees as a critical limitation of current ubiquitous computing systems. For example, if all items have suitable RFID tags, then this information could be used by ubiquitous applications to sense context. *"In short, Ubicomp is low on deployed infrastructure, while potential infrastructure is out there and growing. We only need to harness it!"*[4] (Another proximate future quote for Bell and Dourish).

The paper concludes by raising some fundamental questions concerning the commercial aspects of ubiquitous computing, *"Two of the main issues are more economic than technical: Who will pay for Ubicomp systems, and who will manage them?"*. We argue that an even more critical question is *And why?*. They point out service providers have a conflict of interest between increasing advertising revenue, and maintaining user privacy. However, they do not present any evidence that service providers care about user privacy, so perhaps *conflict of interest* is the wrong term. We prefer the term *service providers don't care about privacy, they care about how valuable your data is*. Which isn't very snappy but arguably a more correct analysis.

The conclusion is pretty much *well done everyone*. We have *"a large and vibrant research community has grown around the Ubicomp concept. Numerous successful prototypes have been built and evaluated, demonstrating the utility of many different aspects of Ubicomp systems."*[4]. In other words, no one is actually using any of this stuff. However, we can also take credit as *"digital technology has made great advances, enabling products and services that are complementary to the Ubicomp vision... Arguably the most successful of these products is the mobile phone"*, dramatic pause, sharp intake of breath - the mobile phone!

An outsider might find ubiquitous computing taking credit for the mobile phone, or even regarding it as a success story related to ubiquitous computing, a little surprising. After all, it was Weiser who specifically said *"Ubiquitous computing in this context does not just mean computers that can be carried to the beach, jungle or airport. Even the most powerful notebook computer, with access to a worldwide information network, still focuses attention on a single box."*[16] But if you bear in mind other success stories from ubiquitous computing; such as the moon landing, celebrity chefs and the cure for cancer, you can see how much mobile phone technology is indebted to the research efforts of hundreds of academics all trying to invent something else.

Abowd: Abowd, 2012[1], takes on board the success of ubiquitous computing in inventing the mobile phone, GPS, sensor technology, i.e. pretty much all modern computer technology. *"Two decades later, the world has embraced many of the notions of Ubicomp, and it is time to reflect on that reality and decide where to go next. The discipline of ubiquitous/pervasive computing has spread so widely throughout the computing universe - the*

research and practice of computing - that it should disappear as a niche topic in computing."[1]. In other words *job done*! So what now? Off home, perhaps a nice cup of tea and a biscuit, and think about submitting to Mobile HCI? *"My thesis is that ubiquitous computing, the third generation of computing, is here and no longer requires special attention, as its ideas and challenges spread throughout most of computing thought today."* Well that's a relief. Weiser would be so happy to see how the world has embraced calm computing, how computers are throw away devices that move seamlessly from the periphery to the centre of our attention. What's that? Sorry I couldn't hear you because someone was on their mobile phone playing fucking Candy Crush with the volume on full. Oh, that's right, none of that happened.

Sarcasm aside, Abowd is, however, sort of right. Forget Weiser, look at what people have been actually doing over the last twenty years and you will see a lot of the work has been focused on mobile phones, sensors and localisation. The Weiser article is just a flag of convenience. In many ways ubiquitous computing can be regarded a bit like inventing a colour called *flooble* which is every colour that is not blue. Ubiquitous computing is often defined as everything that is not a desktop PC (e.g. Wikipedia). It's flooble and surprisingly, just as easy to publish, present and research in any other computer discipline. Trouble is, however convenient it might be, flooble is not actually a colour, just as, based on Abowd, ubiquitous computing was never actually a research discipline. What's more, given more profitable, vague, terms such as the *Internet of things* and *big data*, Abowd raises an important point. We've used this stupid term, ubiquitous computing, for all these years, lets give ourselves a break, refresh our grant writing activities and replace it with some new, equally meaningless term.

We have looked at critiques that argue ubiquitous computing was misconceived and unreachable[3][14], that its all on course[4], or that it either didn't really ever exist, or it is now all over[1]. Abowd's paper is offered as *"attempting... to get us all to think more deeply about how to continue as a community of research practice."* Given what seems to be some very different views from some very experienced researchers concerning the objectives and research area of that community of research practice, Abowd's paper is a timely and important contribution.

Learning from History

So it's history, why worry about it? Weiser has passed away, the world isn't the way he hoped it would be, so what? But perhaps we should worry about it because now, more than ever before, computer technology has invaded the fabric of our social, personal and political life. Just as drugs companies must be deeply concerned with the ethics and effects of their technology[3], we as designers and engineers must also consider the ramifications of our work. As Monteiro points out in his acerbic presentation, "How Designers Destroyed the World"[4], the stuff we do matters. Returning to Weiser's vision is an interesting thing to do, not just because it helps us interpret how we do science and engineering, but because the one thing we can say about modern computing is that it is not calm, not in the least calm. Yet this idea that technology shouldn't annoy you is an important one, and more relevant now (as Weiser predicted) than ever before.

Case Study: The Airport
The modern airport is full of technology, it has thousands of people moving through it each day. Many of the

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[3]Don't laugh
[4]http://vimeo.com/68470326

terminals have been built in the last decade, allowing the best and most effective ubiquitous computing technology to be fitted to guarantee a calm, safe, and pleasurable, airport experience for all their customers. Okay, they're not, but once we thought they might be.

"Scenario 1: Maria - Road Warrior
After a tiring long haul flight Maria passes through the arrivals hall of an airport in a Far Eastern country. She is traveling light, hand baggage only. When she comes to this particular country she knows that she can travel much lighter than less than a decade ago, when she had to carry a collection of different so-called personal computing devices (laptop PC, mobile phone, electronic organisers and sometimes beamers and printers). Her computing system for this trip is reduced to one highly personalised communications device, her P-Com that she wears on her wrist. A particular feature of this trip is that the country that Maria is visiting has since the previous year embarked on an ambitious ambient intelligence infrastructure programme. Thus her visa for the trip was self-arranged and she is able to stroll through immigration without stopping because her P-Comm is dealing with the ID checks as she walks." EU Report: Scenarios for ambient intelligence in 2010[5].

This report was produced, in 2001, before Snowdon, cyber-bullying/casing/stalking, and social media in general. Privacy and control of your digital data was not the burning topic it is now. As with Weiser, the idea of all this data about a person's location and activities did not have the same creepy feeling it might have today. It was also before 9/11, before the modern misery that is now air travel (and we thought it was miserable then - ho ho), there seemed hope of a bright future for ubiquitous technology in the travel environment This brings us right

Figure 2: A departure board from a UK airport demonstrating that the airport regards advertising revenue as exactly twenty times more important than giving you flight information.

Figure 3: A means of monetising the misery of airport security. Anyone can now pay extra to jump the queue in security, potentially making it more profitable to extend the queuing times for everyone else.

back to Caceres and Friday's question of who is responsible for managing infrastructure and who pays for it? In such terms, Weiser's vision is like a kitten in a pool of alligators.

We may imagine how connected, smart ubiquitous technology might make airports more bearable, but they never will, because the airports lowest priority is the passenger's serenity. Their priority is wall to wall digital displays, endlessly advertising crap, and to tell you the gate number at the last moment in the hope you will buy a fucking tee-shirt in Fat Face (See Figure 2). As for infrastructure, Heathrow terminal 5, an airport built in 2008, didn't even have power sockets for passengers to charge their computers and mobile phones for over a year. Finally they got £4000 power poles, the most expensive sockets in history. Why? *"Sponsorship of the Heathrow Powerpoles creates strong levels of positive brand association"*[5]. Our point is that there is no commercial case for calm computing. Its not a human right, despite the human need for calm in airports. We end up having to pay extra for the absence of airport misery, for the status of being less miserable and to allay the fear of suffering as others suffer (See Figure 3). Airports are a clear example of how technology is driven by commercial needs and an example of the failure of ubiquitous and calm computing.

Commercial Reality

Weiser envisaged cheap sharable devices that you would just pick up and use like a piece of paper. There has *never* been an incentive for the industry to allow people to share devices. Ideally they would like to sell you several devices, certainly not have you share one. In addition, devices will never become cheap. In order to make money you have to maintain a high unit cost. The Apple II cost

approximately £2400 back in 1977 in today's money[6] not very different from a high spec Macbook Air. No matter how cheap technology becomes the unit price stays fairly constant, you just get more of it whether you want it or not, and you have to replace your device whether you want to or not because it becomes redundant (i.e. can no longer play flash, can no longer link to your iPod). Certainly, modern technology is disposable but not in the way Weiser expected. You see a new phone, we see landfill. Devices have to be sold as personal, beautiful toys that sit squarely in the centre of your attention. Devices have to become useless and old fashioned within a a couple of years because they need to be bought at a high cost again, and again, and again. Or resold in low cost markets and eventually disposed of out of sight, and well out of your environment.

Methodology in HCI

It is unfair to lay the entire blame for the lack of progress in Weiser's vision of ubiquitous computing at the door of the commercial and social context that modern computers inhabit. The problem is larger than this, it concerns a view of computers as tools, our focus on the task, and our methodologies in HCI for how we understand, represent and evaluate things. The task model is a strong one in HCI because it is the predominant means of evaluating a system and thus the main justification of spending time and effort in researching and building something novel.

Understanding the world is much harder than it may seem at first which is what makes the task model so appealing. HCI has brought in or adapted established means of understanding the task and our relationship with it from disciplines such as Design, Cognitive Science, Ethnography, Psychology and Cognition. As a result,

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[5]http://www.jcdecaux.co.uk/airport/powerpoles

[6]www.historylearningsite.co.uk/personal_computer.htm

today in HCI we have more systematic approaches which help us develop an understanding or offer inspiration. But, whatever warm words researchers share on calm computing (or ludic[10] and experiential design[9] for that matter) the core of HCI methodology is the task.

Computers are tools, and tools are for solving problems and getting things done! Before you build anything decide what problem you are trying to solve, what task you are supporting. Hey, we have an App for that; hey, you want to know how high Everest is; hey, let me find you a Chinese restaurant with good decor. The task solving model of design and use in computers is ingrained, even Facebook was designed to help with the task of getting you laid[7]. In reality, if you think about what you are trying to achieve you will realise in fact "There's Not an App for That" [13] and instead you are fitting your goals and desires around the tools available.

The curious reality is, that computers are not just tools; they have become jewellery, social crutches, haute couture, and a means of escape. Computers mediate information, and information is at the heart of human existence, our sense of being is mediated by language, and language is information. Ubiquitous computing sits in a difficult position somewhere between treating computers as tools, and treating them like furniture, decoration. and confidants. By concentrating on tasks we remove much of the motivation for ubiquitous computing. If you know what task you need to solve why not just get a tool and do it? They don't need to be in the periphery they just need to be in a cupboard.

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[7]Facebook is actually for the task of making your life seem better than your friends, Tinder is for getting laid.

Conclusion
We initially tried to give you a positive message at the end of this paper. But the reviewers saw through that: work on a new manifesto blah blah, involve the community blah blah. So maybe, when you stand in the rubble of someones dream, the best thing you can do is just open your eyes and cry. In reality, the economic forces and the corporate agenda make us simply a cog in the machine.

But if technology masquerading as ubiquitous computing is going to drive us to an ever increasing society of information overload, information exploitation, and information inequality, then we should, as a community walk with our eyes open. One of the central features of psychosis is the inability to understand, recall or care about the damage caused to others - to lack a conscious. Perhaps Alt.chi has begun to emerge as the conscious of the HCI community: a refreshing self examination of what we do, why, and with what consequences.

To increase this sense of self-awareness, for CHI 2016, in San Jose, we call for nominations in the following categories:

UbiComp GLUT (Ghastly Lessons in Ubiquitous Technology): The best example of a deployed UbiComp technology which adds to information overload. We wish to identify achievements which make people nauseous and then truly impoverishes them.

UbiComp EVIL (based on Evidence, Vile concepts, Immoral foundations with Long lasting damage to society): We expect stiff competition as there are many EVIL ideas out there. As this award develops it might wish to incorporate awards for technologies that have helped destroy the most families, kill people, or simply degraded our digital environments.

UbiComp DBH (Damned by history): Papers from CHI 2006 which showed the most promise and interest and resulted in the most unappealing, miserable, non-existent and forgettable outcomes.

We hope the our proposed EVIL, GLUT and DBH awards will help the UbiComp community start to truly recognise the researchers, research and technologies and ideas that are helping sell us out and subjugate us further. We look forward to your nominations and will seek to build a judging panel with the same measured, analytical, and tolerant attitude that we have showed in this paper. See you in Korea.

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