

Standing on the Platforms of Giants

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Standardized platforms make it easier for developers to create and sell software. Yet as recent lawsuits have shown (e.g., Epic versus Apple), platform dominance may also lead to anticompetitive practices. How will this play out in the IoT?

THREE YEARS AGO, the U.S. Government barred the Chinese mobile phone giant Huawei from collaborating with U.S. companies “without a government license.” Shortly after, Google revoked Huawei’s license to its Android OS, putting a severe dent into Huawei’s smartphone business. While Huawei continues to develop and sell Android-powered Smartphones, simply without the official Google Services such as the Play Store or Google Maps, buying their phones outside of China has since come with significant drawbacks for consumers.

Soon after the 2019 announcement of barring Huawei, the company announced the development of an in-house OS called “Harmony” as a “Plan B,” intending to be able to replace both Android and Windows in their lineup. Initially devised as an OS for IoT devices (based on Huawei’s real-time OS, LiteOS), the name “Harmony OS” has since been expanded also to include a smartphones OS (by forking open-source Android). Many of Huawei’s latest smartphones can now run both open-source Android directly or install their fork, Harmony OS, which is supposed to execute both Android and native “Harmony apps” (which have a different format from Android apps).

CHOICE WORLDS

Ever since the 2019 ban, I have been following the development of Harmony OS with some interest. It has been a while since there was an alternative to Android and iOS. In the early days of the smartphone, many platforms competed for consumer attention. Until 2010, Symbian OS was the most popular smartphone OS by far, until it was eclipsed in 2011 by both Android and iOS. Other platform options included Microsoft’s windows phone OS, RIM’s BlackBerry OS, and Palm’s webOS. None of these are around anymore

these days. For better or worse, creating smartphone apps these days requires investing only in (at most) two platforms.

In principle, this is a good thing. Allowing developers to capture the entire market with only two versions of their apps (Android and iOS) certainly brings substantial cost savings. Even if one only supports a single platform, the economics of scale still means that any released version can reach millions of potential users. Today’s respective app stores are testimony to this, featuring millions of apps for both platforms.

However, as, e.g., the recent lawsuit between epic games and Apple has shown, there is a considerable downside to having so few platforms in the smartphone market. The company controlling the platform wields significant power over those writing applications for it, or even building the hardware (as the Huawei case shows). This becomes particularly critical once we move beyond games and premium smartphones selling for over a thousand dollars into smart homes and electricity grids.

OF APIS AND POWER METERS

The idea of a standardized platform is hardly new—hundreds of years ago, the standardized power grid created the household appliance industry. Similarly, the standardized shipping container leapfrogged global trade. Bill Gates is often credited with being the first to realize the power of digital platforms for his Windows OS, and how building a thriving ecosystem around it can create self-strengthening network effects (more apps lead to more users that lure in more developers who create more apps).

In the IoT, no dominating platforms have yet emerged. While many systems use the same architectural approach as Web servers, “REpresentational State Transfer,” which makes accessing them from third-party services possible, no out-of-the-box interaction is usually possible. In addition, many devices use differing low-power radio technology, such as Zigbee or Z-Wave, which are incompatible and traditionally require a custom “hub” to connect them to

one's Home WiFi. In my last column, I mentioned the upcoming "Matter" standard for the IoT, which is set to unify many of these communication standards. However, interoperability will always remain limited, as there is simply no benefit for a manufacturer to let a competitor take complete control of their devices.

Of course, this is only the "Smart Home" side of the IoT—things get even more complicated when you look into the "industrial" side of the IoT, where a whole set of different requirements exist (and even more standards abound), or the smart grid, where standards are crucial, yet few countries have yet established them.

VOTING WITH YOUR THUMBS

Whether Harmony OS will succeed is still far from clear. As of now, it will only be able to do so if Huawei can provide strong enough substitutions for the essential Google Services it is missing (e.g., Petal Maps versus Google Maps). Yet, at the same time, it needs to entice developers to write native code, lest it remains a niche product for those consumers who want the premium Huawei hardware and are willing to use a (potentially) less-than-ideal OS that comes with it.

On the IoT side, things are far from settled, and we need to see how the Matter standard will change the landscape for consumer devices. Just as there is not enough diversity in the smartphone space, there currently is probably too much of it in the IoT space. Yet whatever standard(s) emerge, their existence will most likely further boost the number of available applications. As we have seen in the Web API space, a few standardized components ("stacks") allow the creation of increasingly sophisticated applications with low effort. At the same time, the size of the IoT market will prove even more challenging to regulate, forcing governments to monitor how much power each platform owner can exercise and to step in if it stifles innovation and consumer choice.

IN THIS ISSUE

For this special issue on "Grand Challenges," Guest Editors Sarah Clinch and Stephen Intille present seven articles from some of the top research labs in the field of pervasive computing. With the submission deadline for the issue falling on the 30th anniversary of Weiser's influential "The Computer for the 21st Century" (which was published in *Scientific American* in September 1991), this collection reflects how far we have come since and where to go next. Collectively, the seven articles set out an ambitious agenda that easily holds several hundred Ph.D. theses worth of research for

the coming years! You can find more details in their Guest Editors' Introduction later in this Issue.

We also have three additional feature articles in this issue. In "Toward City-Scale Litter Monitoring using Autonomous Ground Vehicles," authors Zhigang Yin, Mayowa Olapade, Mohan Liyanage, Farooq Dar, Agustín Zuniga, Naser Hossein Motlagh, Xiang Su, Sasu Tarkoma, Pan Hui, Petteri Nurmi, and Huber Flores present a vision for using autonomous ground vehicles for litter monitoring. Apart from drawing up key challenges in the space, they also report on a range of experiments to assess the feasibility of their ideas. In "Pervasive Augmented Reality—Technology and Ethics," authors Holger Regenbrecht, Sander Zwanenburg, and Tobias Langlotz reflect on the ethical implications of large-scale use of Augmented Reality. Based on current developments, their article sketches likely developments in the field and identifies ethical considerations that should be taken into account. Finally, authors Ovidiu-Ciprian Ungurean and Radu-Daniel Vatavu offer "Insights on the Perceptions and Preferences of Wheelchair Users for Interactions with Wearables." Based on structured interviews with 21 wheelchair users, they find that the two most important factors are ease-of-wearing and ease-of-donning/doffing the devices. Their article draws several essential recommendations for future work in accessible wearables.

Finally, you can find a Pervasive Health department in this issue, in which our former EIC Maria Ebling interviews Michael Rogan—founder of former eHealth startup Medaptive Health—on the challenges faced in designing apps to support people with an illness.

TEAM UPDATES

In this issue, we say goodbye to Editorial Board members Nicolai Marquardt and Gabe Cohn, who both have served two two-year terms with us and have been key sources of expert advice in human-computer interaction and embedded sensing system, respectively.

I am also thrilled to welcome a new Associate Editor-in-Chief (AEIC), Rajesh Balan! Rajesh is a professor at the Singapore Management University and has been working in the broad area of mobile systems for over two decades. You can contact him at rajesh@smu.edu.sg.

The current AEICs and their areas of expertise are thus as follows.

- › Oliver Amft: Pervasive Health.
- › Rajesh Balan: Mobile Systems.
- › Stephen Intille: Pervasive Health (Departments Editor).

- › Fahim Kawsar: Smart Homes, Enterprises, and Cities (Community Efforts).
- › Florian Michahelles: Internet of Things.
- › Junehwa Song: Social and Culture Computing.

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His research interests include usable privacy, pervasive displays, and ubiquitous computing. Langheinrich received his Ph.D. degree in computer science from ETH Zürich, Zürich, Switzerland. Contact him at langheinrich@ieee.org.