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Towards gadget-free internet services: A roadmap of the Naked world

Ijaz Ahmad[a,*], Tanesh Kumar[a], Madhusanka Liyanage[a], Mika Ylianttila[a], Timo Koskela[b], Timo Braysy[a], Antti Anttonen[c], Vesa Pentikinen[c], Juha- Pekka Soininen[c], Jyrki Huusko[c]

[a] Centre for Wireless Communications (CWC), University of Oulu, P.O.Box 4500, FI 90014, Finland
[b] Center for Ubiquitous Computing, University of Oulu, P.O.Box 4500, FI 90014, Finland
[c] VTT Technical Research Centre of Finland, 90570 Oulu, Finland

A B S T R A C T

This paper presents a roadmap for the transition from current gadget-centric digital services towards a gadget-free services environment called the Naked world. The main idea of the Naked world is that all the services which are currently provided by gadgets will be provided by the infrastructure, thus no gadgets will be needed to use any kind of digital services. When a user in the Naked world intends to use a service, the infrastructure senses the user, the nearby intelligent surrounding launches an interactive user interface, performs identification through biometric identities, provides the service, and then closes the session when the user finishes the job. Therefore, the Naked world comprises highly intelligent and context-aware interactive environments. The vision of the Naked world is an evolution towards a user-friendly and ubiquitously available digital services, which is naturally bounded by the technological advancement. Henceforth, this paper presents the essential technologies and functional requirements along with the current and forthcoming novel technological concepts and challenges for the realization of the Naked world.

1. Introduction

Since the invention of the computer, one main trend for its use has been to provide digital services that automate routines, simplify tasks, or just entertain the user. The technical inventions have miniaturized computers and created communication networks that connect computers together. We have experienced the transition from mainframes to PCs, laptops, smart phones, embedded computers, wearables, and other gadgets towards ubiquitous computing in general. At the network side we have seen similar evolution. Internet is no longer a network of computers. Currently we talk about the Internet of Things (IoT) (Palattella et al., 2016) and semantic information-centric networks (Xiao et al., 2016). In the area of digital services, the focus has moved from applications and systems to ambient intelligence and smart environments that are built in mash-up principles, exploit massive amounts of collected information, and utilize shared and distributed resources.

This paper evaluates the vision of the Naked world that is under investigation in the Naked Approach Project (Aikio et al., 2016).

* Corresponding author.
E-mail addresses: ijaz.ahmad@oulu.fi (I. Ahmad), tanesh.kumar@oulu.fi (T. Kumar), madhusanka.liyanage@oulu.fi (M. Liyanage), mika.ylianttila@oulu.fi (M. Ylianttila), timo.koskela@oulu.fi (T. Koskela), timo.braysy@oulu.fi (T. Braysy), Antti.Anttonen@vtt.fi (A. Anttonen), Vesa.Pentikainen@vtt.fi (V. Pentikinen), Juha-Pekka.Soininen@vtt.fi (J.-P. Soininen), Jyrki.Huusko@vtt.fi (J. Huusko).

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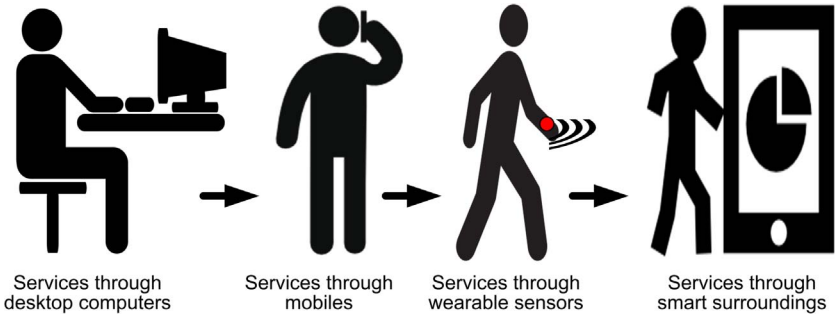

Fig. 1. The transformation of digital services and modes of access towards the Naked world.

The Naked world vision pushes the ubiquitous computing and ambient intelligence concepts technologically into extreme and extends those concepts with the vision of ubiquitous interaction into a gadget-free way of life, called the Naked world. By gadget, we mean any electronic tool or machine that has the capability to offer any digital service e.g. smart phones, laptops, tablet computers and smart wearable devices. The main idea of the Naked world concept is that any user can live *"naked"* which means that users can access digital services without having to carry or wear any personal gadgets. In the Naked world, services and User Interfaces (UIs) appear and become active from surrounding environment when needed, and disappear and become inactive when not needed, as shown in Fig. 1.

The Naked world vision is technically and socially a huge challenge. For example, it requires totally embedded user interaction infrastructure solutions available everywhere. Similarly, the Naked world requires new ways of offering services based on novel business models and collaboration among all the stakeholders including vendors, infrastructure owners, operators and users. Therefore, the Naked world vision may not be practical or realistic to our comprehension at this moment. However, in more limited spaces the benefits and value of some of its ideas and solutions have been demonstrated already by ambient intelligence and smart environments research (Remagnino et al., 2005). Thus, the vision of the Naked world requires investigation of technologies and solutions needed for the transformation towards such an intelligent and context-aware environment. Before evaluating the potential architectural choices, we present a holistic view of different requirements supporting the vision of the Naked world. This leads us to a conceptual roadmap presenting how services will be moved to the infrastructure.

This paper presents some promising technological concepts and challenges in the scope of the Naked world. These technologies in principle support appearing/disappearing UIs, versatile services, storing and sharing of data and services, identification and authentication processes, and enabling connectivity between the entities and services. This paper is organized as follows. Section 2 describes the background of the evolution process towards the Naked world. In Section 3, the roadmap towards nakedness is introduced with a focus on how the services will be transferred to the infrastructure. Key requirements and generic architecture concepts of the Naked world are presented in Section 4 followed by discussion in Section 5. Section 6 concludes the paper.

2. Background

The Internet has evolved from connecting only computers towards pervasive Internet of people and things (Perera et al., 2014), enabled by the underlying communication systems that evolved from a network-centric design paradigm towards a user-centric paradigm (Crisler et al., 2003; Liu, 2015). Similarly, simple computing systems have evolved towards high-capacity and intelligent context-aware systems that understand the user behavior and environment, and offer diverse sets of services accordingly (Perera et al., 2014). Consequently, the service providers using these technologies adopted new modes of service offerings not only to maximize their own benefits but to meet the user requirements of ease of use and costs. For instance, service providers offer higher storage and computing resources to their customers, thus relinquishing the need of user owned high capacity storage and computing resources.

The Naked world envisions even further technological development to enable an environment where users will be able to access and use all types of digital services without owning or carrying any type of computing or storage devices. This will also require new modes of service offering. For example, service providers will need to profile users more accurately not only by the physical demand attributes (e.g., speed, spatial distribution, device capabilities), but also by the physiological attributes (e.g., sensory response time, language difference) and personal attributes (e.g. content preference, service consumption habits, quality tolerance). However, such profiling will open the challenges of user privacy. Therefore, the Naked world requires dramatic development not only in the technology side, but also in terms of legislation and regulations to ensure user privacy.

To make the Naked world concept more comprehensible, consider a virtual environment in which users wear gadgets to sense or simulate their presence and interact with the environment. In Immersive Virtual Reality (IVR) (Kilteni et al., 2013) an environment is replicated and the users' physical presence interacting with the environment is simulated. Generation of perceptual illusions of ownership in IVR through a virtual body acting as the real body has already been proven (Kilteni et al., 2013). The Naked world can be considered as a practical extension of IVR from virtual to a real environment through the technological development discussed in the following sections. However, unlike virtual environments, the Naked world will comprise highly context aware environments to offer services based on user needs and requirements.

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