Ambient Privacy with Wireless Grids: Forging New Concepts of Relationship in 21st Century Information Society

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Abstract

This study combines ambient intelligence with wireless grids to investigate ambient privacy in socio-technical interactions in emerging and next generation technology-pervasive environments. The research literature on 21st century social sciences, ambient intelligence, wireless grids, futures studies, and privacy provides a theoretical framework for the exploration of ambient privacy in 21st century environments. Use experience with WeJay social radio is explored in a virtual distributed environment. The research design incorporates a case study approach, employing multiple methods of inquiry and analysis. Findings related to ambient privacy at the early design stage of an aware-enabled wireless grid product draw on the concepts of underdesign, privacy by design (PbD), and sensitive information, contributing to the forging of new technology-people-information relationships and understandings. This paper makes a contribution to the literature in several domains through development of the ambient privacy concept. This research proposes an ambient privacy interaction dynamic; an ambient privacy research framework; and an agenda to guide ambient privacy research and practice for a 21st century information society.

1. Introduction

This study combines ambient intelligence (AmI) with wireless grids to investigate ambient privacy in technology-people-information interactions in emerging and next generation technology-pervasive environments. This research is significant because it contributes to an understanding of privacy in new forms of aware-enabled, dynamic networked environments and to the development of the ambient privacy concept. The main aim of this paper is to explore use experience with emerging and next generation technologies in terms of conceptualizations of privacy and ambient privacy, drawing on the concepts of underdesign [1], privacy by design (PbD) [2], and information sensitivity [3].

This research on ambient intelligence with wireless grids focuses on the WeJay edgeware product, an early pre-standards social radio application, representing the first wireless grid tool to emerge through the Wireless Grids Innovation Testbed (WiGiT) Lab at the School of Information Studies, Syracuse University. WeJay was developed by Wireless Grids Corporation (WGC) under license to Syracuse University, and provided to the WiGiT Lab for further evaluation and testing. Using a case study approach and multiple methods of data collection, an experimental setup was created to investigate use experience with WeJay social radio. Quantitative data based on use activity was gathered as well as qualitative data about use experience in the form of interviews, focus groups, and a survey. In analyzing the qualitative and quantitative data gathered, content analysis and descriptive statistics techniques were used, respectively. In support of the conceptual and theoretical framework guiding this study, a review of the research literature was conducted across the domains of 21st century social sciences, ambient intelligence, future studies, privacy, and wireless grids.

This research paper is motivated by the work of McKnight, Sharif, and Van de Wijngaert [4] who found that changes of both a social and mental nature, from a user perspective, would be required to navigate the diffusion stages of a smart wireless grids application. Concerns around the use of this technology centered on issues related to security, privacy, and trust. The researchers further suggested that possibly even changes in the underlying technology might be required. Considerable social and mental changes have occurred in relation to technology generally and to wireless grid applications in particular. A confluence of factors, some of which include, technology-pervasive learning environments [5]; social networking sites (SSN) [6]; evolving Internet spaces (McKnight in a 2007 NSF/OECD workshop paper on the future of the Internet); new approaches to privacy [2]; improved understandings of information sensitivity [3]; and mobile technologies [7], are facilitating rapid social and mental.

Definitions for key terms used are drawn from the research literature and presented below to provide context for this study.

Wireless grids are defined as "an emerging form of network for sharing resources, creating resources, facilitating connections across devices (smartphones, sensors, etc.) and enabling, ad hoc interactions" [8]. As such, wireless grids refer to new forms of networking, resource generation and sharing, and connectivity across heterogeneous devices in support of dynamic (ad hoc) interactions [8]. Wireless grids are said to be human-centered in the sense that they provide: "A human centric open access gateway to shared resources for mobile and wireless electronic devices interconnecting at least one device to at least one other device or resource. A device can establish a grid and become a member of one or more wireless grids" (Open Specs for Wireless Grid Technical Requirements, v0.1, 2012). The human-centered focus of wireless grids is articulated in terms of their open, distributed and multi-grid features.

Dourish and Bell (*Divining a Digital Future*, 2011) noted that ambient intelligence (AmI) emerged from the domain of ubiquitous computing and is variously referred to as pervasive or proactive computing, or Internet of Things (IoT). De Ruyter and Aarts [9] describe AmI as, "the embedding and integrating, on a mass scale, of technologies that are sensitive and responsive to humans in everyday environments in increasingly invisible and unobtrusive ways." This study aligns with the mission statement of the Wireless Grids Innovation Testbed (WiGiT) Lab "to investigate all aspects of human interaction with the multitude of devices and information technologies that exist and those that are emerging and to develop and share insights that will enhance our relationship with technology and realize our human potential." As such, this paper is concerned with privacy in terms of people and their interactions in relation to information and each other, supported by aware-enabled wireless grid environments.

2. Background

The social aspects of ambient intelligence (AmI) are addressed in the research literature by DeRuyter and Aarts [9] and the Ambient Intelligence Model [9] was extended to incorporate a social intelligence dimension. Russ, Hesse and Müller in a 2008 AIS SIGSAND conference paper articulated concerns of a social and societal nature in relation to privacy and autonomy in ambient information systems (AIS). Sebe [10] contributes a human-centered computing (HCC) perspective to AmI, drawing on earlier thinking about HCC by Canny. An HCC agenda was developed for the National Science Foundation (NSF) and more recently, the HCC area was reorganized by the NSF to form part of the broader area of Intelligent Information Systems (IIS).

Dourish (*Where the Action Is*, 2001) provides a history of interaction, noting that human-computer interaction styles could encompass the: technological, political, economic, and in Grudin's conceptualization, the world of the user and the social setting. Focusing on embodied interactions as, "the creation, manipulation, and sharing of meaning through engaged interaction with artifacts." Dourish is concerned with tangible and social perspectives of interactions and their implications for interactive systems going forward. Concepts such as privacy, public, sensitive, or secret are approached by Dourish as social and cultural practices.

Both wireless grid and ambient intelligent environments are characterized as supportive of social, collaborative, sharing, and interactive capabilities. The theoretical perspective underlying this study of aware-enabled wireless grid environments in support of developing notions of ambient privacy in 21st century society is presented in section 3.

3. Literature review

Focusing on socio-technical interactions, this paper reviews current literature for emerging insights across a number of domains. The development of a theoretical perspective for privacy in an ambient information society is advanced through a discussion of social interactions, framed around the literature of 21st century social sciences; ambient intelligence; privacy; wireless grids; and the workplace of the future.

3.1. Social sciences for the 21st century

Technology-pervasive environments are enabling the gathering of data in unprecedented ways, which Nicholas Christakis, in a 2012 online interview, views as 21st century social sciences. Considered from this perspective, information contributed, gathered, and analyzed on a pervasively large scale, holds great potential for learning about and understanding human interaction and for the realizing of enhanced human capabilities. Johnson et al. [7] survey and discuss key trends for teaching, learning, and creative inquiry on a near-, mid-, and far-term horizon. Among key trends highlighted are openness and the use of new sources of data for personalization. The concept of 'open', as used by Johnson et al., is defined to mean "free, copyable, remixable, and without any barriers to access or interaction."

The emergence of social network sites (SSNs) is articulated by Boyd [6] as 'networked publics' that are influencing and shaping the emerging dynamics for interaction and participation. Issues pertaining to the flow of information; information sharing; and how people interact with information and with each other, are addressed by Boyd [6], Baym (*Personal Connections in the Digital Age*, 2010), and Dourish

and Bell (*Divining a Digital Future*, 2011). Evolving notions of sharing, social, trust, privacy and interaction are addressed by a wide range of researchers including Papacharissi and Gibson (2011).

With the abundance of data generated in mobile environments, Johnson et al. [7] highlight the importance of learning analytics "for deciphering trends and patterns from educational big data." In understanding the potential, extent, and impact of analytics in relation to big data and social interaction, it is worth noting that an IEEE conference emphasizes the '5Vs' of big data as: Volume, Velocity, Variety, Value, and Veracity.

As technology-pervasive environments become more fluid, the opportunity for people to think and interact with more fluidity emerges. For example, in *Mindset*, Dweck encourages a movement beyond the *fixed mindset* to the *growth mindset* in support of elements such as: learning, a desire for ongoing development, and human potential.

3.2. Ambient intelligence

Based on the instantaneity of Twitter information streams, Papacharissi and de Fatima Oliverira [11] discuss the construction of an ambient information sharing environment. Erickson, in an article on *Geography and Community* (2010), discusses networked interactions among people and places in distributed communities, with technology platforms supportive of peripheral awareness and ambient intimacy. In research conducted for Forrester by Schadler and McCarthy in 2012, mobile technologies are advanced as the new driver of engagement. Smart, as in, products with embedded awareness, figure strongly in the engagement picture, as do sensor-based and wearable technologies, predictive analytics, and applications supportive of social interactions.

3.3. Wireless grids

For McKnight, a wireless grid as conceptualized by Aruba Networks "pertains to an array of WiFi routers managed as a grid" with a "focus close to the physical network" (email correspondence, 31 October 2013). By contrast, McKnight claims that for Wireless Grids Innovation Testbed (WiGiT) researchers, wireless grids are "abstracted away to a virtual space of users, machines and heterogeneous networks" with a flexibility "designed to work across multiple dimensions from cloud to edge, hence, wireless grid edgeware" (email correspondence, 18 November, 2013; WiGiT Open Specs v0.3, 10.24). Ramnarine-Rieks, McKnight, and Small [12] describe wireless grids as "an emerging infrastructure that will fundamentally change the way we think about and use computing." This type of emerging infrastructure aligns in important ways with human-centered computing (HCC) as articulated by Sebe [10]. As such, computing is seen to be moving from the desktop to mobile, nomadic, and other spaces and surfaces to form the infrastructure around human activity.

Ramnarine-Rieks et al. [12] describe wireless grid learning environments, designed to improve the process of interaction, negotiation, and collaboration in trusted spaces as, amenable to social interaction. McKnight, Treglia, and Kuehn [13] discuss wireless grids and the potential for personal infrastructure in the context of policy implications around an emergent open standard. The emergence of a tool such as the tablet device (e.g., iPad) for work, learning, and everyday use is said to be transformative [7]. Key features of the tablet-type tool include the affordances of: ease-of-use, mobile, personalized learning environments, collaboration, and sharing of content [7]. It is these types of features which wireless grids are designed to accommodate for varied purposes. As tools evolve in new contexts, enabling resource discovery, information sharing patterns and behaviors are influenced around security, privacy, and trust and in turn, the willingness to share, collaborate, and interact.

3.4. Workplaces of the future

In a technology-pervasive world, the notion of places of work, learning, and everyday life continue to blur. Looking at workplaces of the future for information professionals, Fidler [14] draws on research from the Institute for the Future, identifying work skills going forward to 2020. As if in anticipation of enriched renderings of ambient intelligence (AmI) with wireless grids, Fidler speaks of the need for enhanced interactions supported by skills such as: computational thinking, media literacies, cognitive load, boundary crossing, sense making, social intelligence, design mindset, and novel and adaptive thinking. Beginning with an articulation of the concept of enhanced social interactions, this section looks more closely at selected future work and learning skills. This review will allow insights to emerge into the need for, and relevance of, evolving notions of privacy enabled by ambient intelligence with wireless grids, aligned with 21st century ambient information society.

Regarding enhanced interactions, Kaptelinin and Nardi in *Acting With Technology* remind us that, "technologies that beckon are not merely carriers of information in systems, but potentially transformative artifacts capable of providing people with diverse new cognitive, emotional, social, aesthetic, and physical experiences." These authors point to "the flux of multiple activities typical of everyday settings and practices" characterizing

"complex real-life processes." From the perspective of *Activity Theory* for use with interaction design, Kaptelinin and Nardi speak in terms of "developing human beings who create meaning in their lives through acting with technology."

3.4.1. Computational thinking. The need for predictive analytics and learning analytics [7] align with notions of computational thinking articulated by Nicholas Christakis as "the era of computational social science" afforded by big data. The potential for gathering and analyzing data around human activity, in real time, holds unprecedented potential for ambient learning and ambient discovery, according to Nicole in a 2012 *Silicon Angle blog*, contributing to greater understanding about events, the world around us, and ourselves. In relation to business, computational thinking gives rise to ambient commerce based on "algorithms that can not only meet but anticipate our needs" according to Wohlsen in a 2013 *Wired* article. In view of the "proliferation of incredibly massive searchable datasets, the increasing use of predictive analytics in almost every domain of public and private life and the extent to which critical infrastructure has come to depend on information communication technologies (ICTs)", Hildebrandt et al. [15] call for a digital 'enlightenment discourse'. The discourse focuses on the affect of ICTs on individuals in terms of privacy, informational self-determination, contextual integrity, personal identity, and the networked self. Fidler [14] points to the design opportunities that data affords based on the leveraging of interactions and patterns to influence outcomes.

3.4.2. Media literacies. Building upon the core media literacy work, Arnone et al. [5] propose an extension of connections made with interest and engagement to encompass the three-part dynamic of curiosity-interest-engagement (CIE) as critical to each of the existing and other ambient and emergent learning skills. Core media literacy skills are: play, simulation, performance, appropriation, multi-tasking, distributed cognition, collective intelligence, judgment, transmedia navigation, networking, and negotiation. Media literacies are critical to new media ecologies afforded by technology-pervasive environments supporting multiple interpretations and perspectives.

3.4.3. Cognitive load management. Fidler [14] refers to rich environments filled with information streams and myraid devices.

3.4.4. Boundary crossing. With the increasing complexity of people, technology, and information interactions, the importance of working across disciplines becomes critical. Given the increasing complexity of emerging technologies, Yoo [16] calls for more integration between law, engineering, and computer science, where important connections between the "fields remains nascent and underdeveloped." Fidler [14] includes curiosity; lifelong learning; and multiple careers, aligned to longer lifespans, as integral to the transdisciplinary mindset. The importance of diversity in terms of "ages, skills, disciplines, and working and thinking styles" is highlighted by Fidler [14].

3.4.5. Sense making. Interdisciplinary in nature, sensemaking is employed in computer interaction research to support interactive sensemaking systems; in relation to places of work by Weick (*Sensmaking in Organizations*, 1995); and in critical thinking and decision making in the renegotiation of emerging people-technology relationships.

3.4.6. Social intelligence. Fidler [14] emphasizes social intelligence as important for collaborative environments. De Ruyter & Aarts [9] articulate social intelligence in relation to social interactions in AmI environments. Recognizing the importance of the social component, the AmI model is extended beyond the systems intelligence component to include social intelligence, incorporating socialized, empathic (representation of emotions), and conscious.

3.4.7. Novel and adaptive thinking. The creative and growth mindset, described in *Mindset* (2006) by Dweck, as able to adapt to new and unexpected situations in the moment (characteristics supported by AmI and wireless grid environments), is becoming more critical as a 21st century skill.

3.4.8. Design mindset. Computational power in technology-pervasive environments sets the stage for use of the design approach in workspaces and the concept of meta-design [1]. A key component of meta-design is underdesign, which "assumes that the meaning, functionality, and content of a system are not fully defined by designers and user-representatives alone at design time, but are socially constructed throughout the entire design, deployment, and use cycles of the system" [1]. Fischer argues that the underdesign concept in meta-design is an important underlying element for social creativity and cultures of participation [1].

3.5. Privacy

Zuckerberg is quoted by Kirkpatrick in *ReadWriteWeb*, January 2010 as saying that "if he were to create Facebook again today, user information would by default be public." Turkle, in an interview about her book, *Alone Together*, with Fleming and Strainchamps of ttbook.org in 2011 (Wisconsin), challenges Zuckerberg's claim that

"privacy is no longer a relevant social norm" and poses the questions: "what is intimacy without privacy and what is democracy without privacy." Xu [17] reframes privacy for 2.0 environments in the context of online social networking (OSNs) where "highly dynamic social interactions with rich data exchange" occurs. Noting a range of conceptualizations of privacy and the view by Solove that the privacy concept is in a state of disarray, Xu uses a multiple lens approach in an attempt to develop an integrated and common understanding of privacy and a proposed theoretical framework identifying research issues.

Monteleone [18] elucidates a new comprehensive legal-technical framework for privacy in ambient intelligence environments, incorporating mutually informing legal-technical concepts such as cognitive technology and Hildebrandt's notion of ambient law, "an intelligent interplay between technological design and legal resolution." Hildebrandt, O'Hara, and Waidner [15] argue that, "privacy plays several important roles, protecting the autonomy of individuals and governing their relationships with institutions, communities and society as a whole." Devine [19] envisions a taxonomy of privacy and 'negotiated levels of privacy' such as monitored "me", quantified self, and non-quantified self, in a learning context. Hildebrandt et al. note that: "It is becoming increasingly hard to track what knowledge is mined from the proliferation of networked data, how such knowledge will map onto individuals' identities, and what consequences will follow from these matches" [15]. Bain Company and Marc Davis, in collaboration with the World Economic Forum (WEF) initiative to rethink personal data, developed concepts for categorizing personal data as: volunteered (declared interests, preferences); observed (browser history, location); and inferred (credit score, future consumption). The Bain & Company personal data framework encompasses the regulatory environment and communication standards and is presented by Hildebrandt et al. as: *Personal data ecosystem: A complex web from data creation to data consumption*. It is worth noting that location data is categorized as observed and does not show up in the volunteered space.

Cavoukian [2] developed the Privacy by Design (PbD) concept consisting of seven foundational principles, "ensuring privacy and gaining personal control over one's information and, for organizations." Cavoukian's approach is proactive rather than reactive where privacy is the default setting and is embedded into the design of systems and practices. Cavoukian maintains it is possible to have privacy and security, with end-to-end integrity, respect for the user, and visibility and transparency. To accommodate existing and legacy systems, Cavoukian and Popa [2] evolved the PbD framework to form the Privacy by ReDesign (Pb^RD) framework [2]. Not simply a retrofit, Pb^RD is intended for "any organization that wants to improve its privacy posture" using a 3 Rs framework to – Rethink, Redesign, and Revive.

As if in response to Thompson and Kaarst-Brown's [3] research agenda challenge where nine dilemmas associated with sensitive information are identified, Cavoukian claims that PbD "should be applied with special vigour to sensitive data" and that "the strength of privacy measures tends to be commensurate with the sensitivity of the data" [2]. Cavoukian claims it is possible to achieve privacy and surveillance, utilizing privacy-protective techniques such as homomorphic encryption [2] based on the PbD framework [2] and its support for creativity and innovation. Xu's theoretical framework for reframing privacy, proposes trust and information sensitivity as rational factors "to be considered as important determinants of information withholding and information disclosure" [17]. Privacy is not a stable and universally understood concept as noted by Dourish and Bell in their 2011 book, but rather, highly dependent upon other factors including context, culture, situations, technologies, and manifestations. In "rethinking privacy", Dourish and Bell propose a movement "beyond privacy" where privacy and security be understood as social products. This approach seeks "to support the human social and cultural practices through which the whole complex of phenomena – privacy, security, risk, danger, secrecy, trust, identity, morality, and power – are managed and sustained."

Arguing that "privacy cannot be assured solely by compliance with regulatory frameworks", Cavoukian and Reed [2] propose the concept of Big Privacy. Using a more dynamic approach to addressing the trust and privacy challenges of Big Data environments, privacy must also accommodate a personal data ecosystem (PDE) [2]. Big Privacy is defined as "the application of the 7 principles of Privacy by Design, not only to individual organizations, applications, or contexts, but to entire networks, value chains, and ecosystems, especially those that produce and use Big Data" [2]. Further, the goal of Big Privacy is "the systematic protection of personal data and radical personal control over how it is collected and used." Radical control refers to "an embodiment of informational self-determination." Cavoukian and Reed emphasize that in an information and communications technologies (ICTs) context, "privacy does not equal secrecy of personal data, it equates to individual control of one's data." As such, "privacy is not about keeping information secret (hiding information)", it is instead "about having a right to 'informational self-determination'" [2]. Cavoukian continues to extend the PbD framework, partnering with business to apply the PbD principles to the BYOD (Bring Your Own Device) movement and associated technology

options (e.g., xYOD, HYOD, CYOD) as a "privacy-aware mobility strategy" [2].

3.6. Summary of the literature

In summary, Table 1 provides an overview of several key points emerging as a take-away from this review of the literature across the domains of 21st century social sciences (21st CSS), ambient intelligence (AmI), wireless grids (WGs), workplaces of the future (WPotF), and Privacy. In the form of a matrix for technology-pervasive environments, Table 1 is intended to illustrate the complex interweaving of elements, characteristic of, and integral to, socio-technical interactions.

Table 1: Technology-Pervasive Interactive Spaces

	21stCSS	AmI	WGs	WPotF	Privacy
Adaptive	x	x	x	x	x
Analytics	x	x	x	x	x
Collaborative	x	x	x	x	x
Dynamic	x	x	x	x	x
Fluid	x	x	x	x	x
Learning	x	x	x	x	x
Participative	x	x	x	x	x
Personalized	x	x	x	x	x
Sharing	x	x	x	x	x
Social	x	x	x	x	x
Trust	x	x	x	x	x

The key elements fundamental to socio-technical interactions include: adaptive, analytics, collaborative, dynamic, fluid, learning, participative, personalized, sharing, social, and trust. The nature and extent to which these elements are enabled, fostered, and supported, contributes to the viability and efficacy of technology-pervasive environments.

With this review of the literature and theoretical background, an outline of the methodology used for this research paper is presented in section 4.

4. Methodology

This paper is based on research conducted through the Wireless Grid Innovation Testbed (WiGiT) Lab at the School of Information Studies, Syracuse University. WeJay social radio, the first aware-enabled wireless grid edgeware application to emerge from the WiGiT Lab is used in beta form for this study. The research process, data collection methods, and analysis techniques are described below.

4.1. Process

Using a case study approach, the contemporary issue of privacy in aware-enabled wireless grid environments was investigated based on use experience with WeJay. As a virtual distributed testbed space with diverse membership extending to other universities, businesses, and work environments, members were invited to participate in the study, as were iSchool students and faculty. The experimental design for the study used an unstructured approach with minimal guidance, supports, and influences to maximize real world experience and emergent and adaptive behaviors. Participants were instructed to: download and install the WeJay application; create a radio station; develop a radio show with their choice of content; host or cohost the show with one or more individuals; and live-stream the show for shared listening within WeJay, with Facebook friends, and with others who wished to tune-in to the Weheartradio broadcast over the Internet. In instances where participants were unable to download or install the application, two brief videos were made available to enable exposure to WeJay. The beta trial extended over a four month period and participants described their use experience in one or more ways, through: interviews, focus groups, and an online survey.

4.2. Data sources

Multiple methods of quantitative and qualitative data collection were used to gather use experience information from participants. Activity data based on actual tool use contributed to quantitative data. Pre-tested protocols were used to conduct interviews (n=22) and focus groups (n=6), yielding qualitative data. Based on interview and focus group data, a survey instrument with closed and open-ended questions was developed, tested, and administered (n=20), generating both quantitative and qualitative data.

4.3. Data analysis techniques

Quantitative data was analyzed through the use of descriptive statistics in keeping with a small sample size (n=34). Qualitative data was analyzed inductively and deductively using content analysis and explanation building, a form of pattern matching. Text segments (1000) were coded with the assistance of a second coder, achieving an inter-coder reliability of 91%-94%. Triangulation for rigor occurred in a number of ways, including: data, methodological, and investigator. An analysis of data, together with findings, is provided in section 5.

5. Analysis and findings

A key feature of the WeJay aware-enabled edgeware application which emerged as critical for users is the social interaction dimension. Findings from this research identify the need for enhanced awareness capabilities (e.g., presence, location,

resource and other types of awareness), in support of social interactions for complex technology-pervasive environments for learning, work, and everyday spaces. Participants reported that 'openness' around content creation and sharing would contribute significantly to the social, learning, and information interaction dimensions of WeJay. In support of computational and novel/adaptive thinking, the "need to combine and leverage information streams from wireless technology and social networks to create new applications" was identified. Further, this research confirms the complexity, importance of, and need for, improvements in the *interaction dynamic*, which can be described as: a) person to tool interaction; b) person(s) to person(s) interaction within the distributed, tool-mediated environment; and c) system to system interaction supporting heterogeneous device, platform, and network interactions.

Some participants understood WeJay to be supportive of private networks and expected privacy and security issues to be addressed by the product. Regarding existing social media platforms such as Facebook, some participants placed an emphasis on learning to use the application first, and then taking care of privacy settings. One participant claimed to avoid social media spaces because of surveillance concerns. Upon deeper probing it was found that this individual does use social media, discerningly, deriving considerable benefit and enjoyment. While participants called for greater awareness features for more dynamic and smarter (ambient) renderings of recommendations, connections, and sharing, concern was expressed about whether this would be 'creepy' or 'scarily accurate'. Delineations were made between types of awareness such as that pertaining to personal interests versus physical location information. Table 2 identifies levels of concern for privacy and security among survey respondents (n=20), based on a 5-point scale.

Table 2: Privacy and security concern

(n=20)	Non Issue	No Concern	Neutral	Concern	High Concern
Privacy	5%	45%	25%	15%	10%
Security	5%	50%	15%	10%	20%

Because some participants expected and trusted the product authority to take care of privacy and security issues, the percentages for 'no concern' for privacy and security appear high at 45% and 50%, respectively. There is considerable neutrality for privacy at 25%, however, greater concern is expressed for privacy than security at 15% and 10% respectively. At the high concern level, 10% emerges for privacy and 20% for security.

70% of survey respondents perceived WeJay to be a social space while 75% perceived wireless grids as enabling ambient intelligence. As a pre-standards beta tool, WeJay offered an environment for participants characterized by underdesign. When asked about whether they felt creative, in control, autonomy, and innovative during their use experience, survey respondents (n=20) show a persistently high level of agreement as shown in Table 3, particularly for innovativeness (85%, 35%), creativity (50%, 40%), control (35%, 25%), and autonomy (45%, 15%).

Table 3: Autonomy-control-creative-innovative

(n=20)	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree
Creative	10%	0%	50%	40%
In Control	5%	35%	35%	25%
Autonomy	5%	35%	45%	15%
Innovative	5%	25%	85%	35%

The interaction dynamic will now be discussed in relation to rich, smart environments for technology, people, and information in conceptualizing notions of ambient privacy and 21st century information society.

6. Conceptualizing ambient privacy

In conceptualizing privacy for information spaces in the 21st century, this paper proposes an ambient privacy interaction dynamic. Wireless grids with ambient intelligence (AmI) hold the potential to support complex, smart, personalized, private, and dynamic interactions. Interactions and relationships are predicated upon the nature and extent of the affordances and constraints in technology-pervasive environments, forming a balanced people, technology, and information dynamic. Drawing on the theoretical perspective presented in this document and participant use experience, a complex interaction dynamic emerges as depicted in Fig. 1.

With Cavoukian's notion of a 'privacy-aware mobility strategy', we begin to see the emergence of the concept of ambient privacy or smart privacy within dynamic technology-people-information interactions. The ambient privacy interaction dynamic is enabled by aware wireless grid environments that foster and enable autonomy, control, creativity, and innovativeness.

Within this evolving and emerging space, an information landscape is taking shape, based on the relationships and interactions within the following dynamic: technology and people; people with each other; and technology to technology. The potential for this information landscape to become smart, as in ambient, is based on multi-level relationships and interactions, as conceptualized in Fig. 1 and described below.

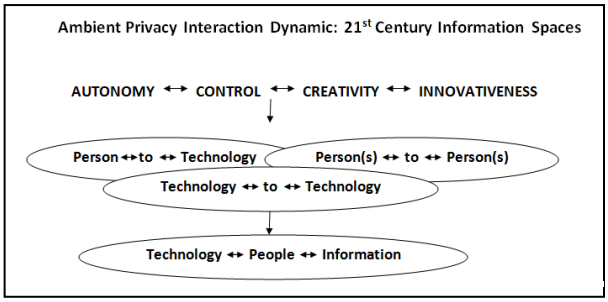

Figure 1. Ambient Privacy Interaction Dynamic

6.0.1. Person-to-technology interaction. Refers to the relationships enabled and supported by the tool environment.

6.0.1. Person(s)-to-person(s) interaction. Refers to the relationships between people, supported within the distributed, tool-mediated environment.

6.0.1. Technology-to-technology interaction. Refers to the connectivity and compatibility supported among and across heterogeneous devices, platforms, and networks.

6.0.1. Technology-people-information interaction. Refers to the flow of information enabled, based on the composite of the: person-to-technology; person-to-person; technology-to-technology interactions.

The emerging ambient privacy framework for 21st century information society conceptualized in this paper is intended to illustrate the presence, interactivity, and awareness, characterizing the technology-people-information dynamic. An ambient information society emerges from a coalescence of the technology-people-information dynamic, forming an ambient privacy landscape enabled by environments designed to support autonomy, control, creativity, and innovation. It is in technology-pervasive environments where autonomy, control, creativity, and innovativeness are fostered and supported that the key elements fundamental to socio-technical interactions, identified in Table 1 (adaptive, analytics, collaborative, dynamic, fluid, learning, participative, personalized, sharing, social, and trust), have an improved likelihood for viability and efficacy.

The importance placed on improved awareness, autonomy, and control by participants in this study, as being supportive of creativity and innovation, relates to privacy and personalized networks in terms of informational self-determination [2], [15]. This ambient privacy landscape draws upon human-centered computing (HCC) in realizing relationships supportive of increasing levels of trusted socializing and smartness underlying the interaction dynamic. In this ecosystem, human intelligence and social interactions contribute to intelligent systems and smart environments and are in turn, supported and enhanced through these interactions.

6.1. Ambient privacy framework for research

Combining ambient intelligence (AmI) with wireless grids, this paper contends that technology-pervasive environments, when enabled and **supported by the ambient privacy interaction** dynamic, align more fully to a realization of enhanced human potential. Fig. 2 graphically elucidates an emerging 21st century framework for ambient privacy.

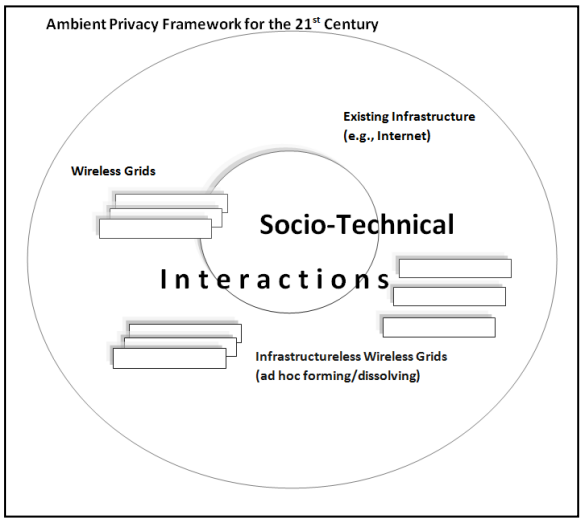

Figure 2. Ambient Privacy Framework

The outer circle depicts the larger world of information. Within this framework, the inner circle illustrates the existing and contained space for information and socio-technical interactions. The Internet is used as an example of this type of existing infrastructure. Connecting to, overlapping with, and complementing this existing information landscape and infrastructure are wireless grids, to the left of the inner circle. However, as shown in the lower part of the diagram, wireless grids also operate independent of existing infrastructure and are said to be infrastructureless [20]. As such, a glimpse is revealed of the dynamic (ad hoc) forming and dissolving of social interactions in information landscapes, supported by the ambient privacy interaction dynamic in wireless grid environments. McKnight described this scenario in a 2007 NSF/OECD workshop paper as, "the dynamic inter-operation, integration, and dis-integration of networks, applications, and users, in real time."

The ambient privacy framework for 21st century aware-enabled wireless grid edgeware environments is concerned with enhanced human potential and is formulated from a human-centered computing (HCC) perspective. Although existing infrastructures

such as the Internet may appear to be ubiquitous and evenly distributed, in an interview with *The Atlantic Monthly* (November 2012), Bell maintains that "the Internet is not a seamless, global technology," arguing that: "Different places in the world have different regulations and different infrastructures" contributing to varying experiences. Wireless grids can be seen as complementing and extending existing infrastructures. In the context of existing infrastructure limitations and constraints, the potential of aware-enabled wireless grids, supportive of ambient privacy, give rise to opportunities for the formulation of an agenda for 21st century research and practice.

6.2. Research agenda for an ambient privacy society

Study findings and insights, reinforced by the literature review in section 3, contribute to the need for further study and exploration of the ambient privacy concept. An agenda to guide future ambient privacy research and practice, focusing on six key areas, is proposed.

6.2.1. Ambient privacy. Continued research is required into the concept of ambient privacy; the ambient privacy interaction dynamic; and the ambient privacy framework in support of 21st century information society to learn more about viability, potentials, and impacts for work, learning, and everyday life. Further exploration of the 'informational self-determination' concept is also required in relation to aware-enabled wireless grid types of environments that foster and support autonomy, control, creativity, adaptability, and innovativeness.

6.2.2. Socio-technical interactions. Characteristics integral to socio-technical interactions and relationships in technology-pervasive spaces, identified in Table 1, are not exhaustive and invite further examination and development.

6.2.3. Computational thinking. Research is needed into the computational thinking dimension of aware-enabled wireless grid environments, as part of ambient privacy and the digital enlightenment discourse initiative [15].

6.2.4. Design & underdesign mindset. This paper calls for continued exploration and development of the underdesign and design mindset approach, in formal and informal aware-enabled wireless grid environments in support of ambient privacy and security.

6.2.5. Boundary crossing. This work proposes use of a transdisciplinary approach and perspective in ambient privacy research and practice, involving the complex technologies of aware-enabled wireless grids. As such, this would serve to contribute to integrated work across the domains of engineering, law, computing science, education, business, design, information science, etc.

6.2.6. Information sensitivity. Further research is needed into understandings of sensitive information in the context of ambient privacy in particular and technology-pervasive environments, more generally.

7. Challenges and mitigations

The early stage pre-standards state of the wireless grids tool is simultaneously a limitation and strength of this study. This first use opportunity with individuals having diverse interests, skills, experience, age ranges, and places of work and study contributes valuable insights into emerging and next generation technologies in relation to social interactions in aware environments. Actual use experience was complemented by imagined use potentials and interpretations supportive of creativity and innovation in underdesign environments. While tool readiness limited the sample size, findings draw upon the use of multiple methods of inquiry supported by multiple types of triangulation.

8. Contributions and conclusions

This study utilizes the emerging technologies of ambient intelligence with next generation wireless grids to explore and develop the ambient privacy concept, in socio-technical interactions in technology-pervasive environments. Investigation of the interactivities afforded by aware-enabled environments, in evolving network configurations, confirms a growing interest in engaging with discussions, research, and practice to influence current experiences and future visions of smart technologies. Several key contributions emerge from this research.

8.0.1. First. The ambient privacy concept is developed, building on Cavoukian's [2] notion of a privacy-aware mobility strategy.

8.0.2. Second. An ambient privacy interaction dynamic is advanced, enabled by aware wireless grid environments, which foster autonomy, control, creativity, and innovation.

8.0.3. Third. An emerging ambient privacy framework for a 21st century ambient information society is presented, based on: a) human-centered, socio-technical interactions and relationships within existing infrastructures such as the Internet, and; b) a complementary and extended dynamic (ad hoc),

intelligent connectivity, using evolving forms of wireless grid infrastructure and infrastructureless networking.

8.0.4. Fourth. An ambient privacy agenda is developed with recommendations for research and practice, focusing on ambient privacy; socio-technical interactions; computational thinking; a design and underdesign mindset; boundary crossing; and information sensitivity.

Using the underdesign concept, this study contributes insight into the potential for collaboratively designing smarter privacy, as in, ambient privacy, in support of technology-people-information interactions and practices, aligned to smart and healthy societies for the 21st century.

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