Emerging Patterns of Intersection and Segmentation when Computerization Movements Interact

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Abstract: Kling and Iacono introduced and investigated computerization movements, counter computerization movements, and computerization organizations in a series of papers starting in the late 1980's. Their analyses focus on characterizing structural properties, ideologies, and consequences of computerization movements and organizations. This paper starts from their foundations to investigate a set of three new computerization movements: open source software development, computer games, and grid computing. I focus attention on examining not only structural properties, ideologies, and consequences of these three computerization movements and associated organizations, but also on structural processes that characterize what happens when computerization movements come together, and consequences that emerge as a result of these intersecting movements. This focus on identifying emerging patterns of intersecting computerization movements, as well as the segmenting of these computerization movements is the principal contribution of this chapter.

Keywords: computerization movements, open source software, computer games, grid computing, patterns of intersection and segmentation.

INTRODUCTION

This chapter examines three established yet continually emerging worlds of computing. These are the worlds of open source software development [2002], computer games [Scacchi 2004], and grid computing. Each of these worlds can and has been subject to some of the analytic frameworks that emphasize either ethnographic, empirically grounded theory building or technological rationalization. However, in this chapter, it will be most effective to examine what happens as these computerization movements (CMs) collide or pass through each other in ways that might not be readily predicted from studies of each movement or computing sub-world onto itself. Subsequently, this study builds on the analytical frameworks of Rob Kling and colleagues over nearly 20 years of research in social analyses of CMs.

The chapter is organized as follows. The next section reviews CMs, social movements, and other related framings of collective action within the computing world. It is followed by an examination of three current CMs: open source software, computer games, and grid computing. Each movement is examined and compared to prior CMs. This reveals trends and structural patterns found in these current movements which differ from those examined in the studies by Kling and Iacono. In particular, attention is focused on how these three current movements intersect each other and the consequences that can result. This is followed by a discussion that presents some ways for how to further advance studies of CMs based on the topics covered in the chapter. A statement of conclusions close this chapter with recommendations for new research problems to be investigated related to emerging CMs and to the collective actions and social dynamics that animate their movement.

UNDERSTANDING COMPUTERIZATION MOVEMENTS

The analyses of Kling and Iacono [1988, 1994, Iacono and Kling 1996, 2001] and others in this volume build from a foundation of prior theoretical and empirical studies of CMs. Traditionally, these studies have drawn attention to structural patterns arising within a CM, ideological tenets and technological action frames [cf. Orlikowski and Gash 1994, Iacono and Kling 2001] that form the rhetorical core of the CM, and organizations that persist and are associated with advancing the CM. A closer look at the social movements literature reveals additional conceptual foundations that can expand and refine what can be examined when studying social movements, and by extension, when studying CMs and counter-CMs.

Kling and Iacono also drew on the analysis of Zald and colleagues [Zald and Berger1978, Useem and Zald 1982] to flesh out other properties of social movements that could help characterize computerization movements. For example, Zald and colleagues observed that *social movements can occur within organizations* as a participatory strategy for collective action that seeks to affect some organizational reform or major organizational transformation. Such movements may be based on affecting political change within an organization. Alternatively, *organizations may emerge whose purpose is to help guide or lead a movement* in affecting social change through organized collective action. Finally, such an organization may rely on focusing its efforts to mobilizing its movements around certain technologies either in support or opposition to the entrenched technologies of dominant institutions. Zald and colleagues identify these as *technology movements* or *technology counter movements*, depending on whether the organization guiding the social movement supports or opposes the existing technological order. The computerization movements characterized by Kling and Iacono employ these notions of the role of key organizations and technological movements and counter movements.

Many scholars have studied and theorized about social movements, which now also influence how we may view CMs. Gerlach [1971, 2001] and others [e.g., McAdam, McCarthy and Zald 1996, Snow, Soule, and Kriesi 2004] find that social movements are segmentary, polycentric, and networked (SPIN), therefore heterogeneous and cyclic. *Segmentary* means that movements are composed of many diverse groups that grow, divide, fuse, proliferate, contract, and die. *Polycentric* means social movements have multiple and sometimes competing leaders or centers of influence, and the persistence of such positions of authority may be short-lived. *Networked* means movements are integrated through multiple relationships among movement participants, the overlapping and joint activities they engage, shared communication media, ideals, and opponents. These networks may therefore be recognized as constituting social networks (including organizations), technological networks (including computing systems and networked information infrastructures), and mutually dependent socio-technical networks can all therefore exist within technological or CMs and counter-movements [cf. Scacchi 2005, Sproull and Kiesler 1992].

The structural characteristics of SPIN are useful additions to the Kling and Iacono framing that helps flesh out important other structural properties of CMs and counter-movements. For example, if CMs follow a SPIN cycle, then they must be segmentary rather than monolithic, polycentric rather than singular, and networked rather than hierarchical or fully decentralized and disconnected. This implies that no one advocate, group, or organization truly speaks for or leads all the participants associated with a CM. Similarly, it implies that conflicts exist within each movement, as do struggles to rest control from those currently in positions of movement leadership. Finally, ideological beliefs, values, and norms [cf. Elliott and Scacchi 2005] reinforce these structural characteristics when employed by movement participants to frame what are core problems, how they are to be addressed or resolved, and how work is to be divided and performed among participants [McAdam, McCarthy and Zald 1996, Snow, Soule, and Kriesi 2004]. However, there is no single rhetoric or master narrative that uniquely characterizes such heterogeneous and dynamically evolving social movements, though individual statements, authored works, proclamations appearing in the media, and the like are sometimes treated as defining or characterizing a social movement.

Kling and Gerson [1977, 1978] also introduced the concept of "computing world" as another way to characterize how collective action within the social world of computing is organized and articulated. The computing world combines Strauss' [1978] social world perspective and Zald's technological movements [cf. Zald and Berger 1978, Useem and Zald 1982], while a given sub-world of computing or occupational community [cf. Gerson 1983, Elliott and Scacchi 2005] is centered around work with distinct kinds of computing systems or technologies. These papers add an interesting new dimension to that of CMs in that they propose to ground and focus on characterizing movement dynamics within the computing world as being driven in part by *technological innovation practices and processes* [Kling and Gerson 1977, Scacchi 1981, Kling and Scacchi 1982]. Broader patterns of technological innovation, resource transactions, computing work trajectories and occupational careers within and across organizations help articulate patterns of *segmentation and intersection* within the computing world and sub-worlds [Kling and Gerson 1978, Gerson 1983]. The patterns of intersection within the computing world and sub-worlds reiterate Strauss' foundational notions while segmentation patterns correspond to the SPIN cycle reported by Gerlach and others. Technological innovation, segmentation, and intersection thus introduce a set of *dynamics that animate and provide a motive force to CMs*.

Collectively, these studies reveal a sustained intellectual focus of computing, computing world, and CMs as a complex socio-technical regime of organizational and technological resources arrayed through recurring patterns of negotiation, reallocation, and control that simultaneously enable and constrain what people can accomplish in their work with computing. But computing and computerization continues to evolve and new regimes and movements are emerging which may or may not change the landscape of analytical framings that have appeared, and thus merit study and reapplication so as to re-establish their relevancy and theoretical validity.

Three Emerging Computerization Movements

The CM studies of Kling and Iacono examine initially five movements; urban information systems, artificial intelligence, personal computing, office automation, and computer-based education [Kling and Iacono 1988]. They later added two additional CMs, for virtual reality and computer supported cooperative work (CSCW). For the most part, all of these CMs, with the exception of CSCW have mostly receded in their prominence or aggressive promotion. Why and how these CMs have faded is an open question beyond the scope of this chapter. However, it is fair to say that it may be explained in part by reference to the comparative success or failure of these early CMs to facilitate the broad diffusion of computing innovations that are often the focus of each respective CM [cf. Rogers 1995]. However, none of the studies by Kling and Iacono examined the dynamics that drove these movements, nor whether any of these CMs drove into one another and to what consequence. This is the point of departure in the remainder of the study presented here.

Specifically, it is now possible to examine a new set of CMs, not only in terms of their structural properties and ideological foci as found in previous CM studies, but also to some of their dynamics, including attention to where and how different CMs may intersect each other, and to what ends. Accordingly, three CMs now in the limelight can be examined and compared, both as separate movements, and as intersecting or overlapping movements. The three CMs for study are those focused on open source software development, networked computer games, and grid computing.

Open Source Software

Structural patterns of the OSS movement

The OSS movement [cf. Elliott 2006, West and Dedrick 2006] is populated with thousands of OSS development projects, each with its own Web site. Whether the OSS movement is better recognized as a countermovement to the proprietary or closed source world of commercial software development is unclear. For example, executives from proprietary software firms have asserted that (a) OSS is a national security threat to the U.S. [O'Dowd 2004], or (b) that OSS (specifically that covered by the GNU Public License or "GPL") is a cancer that attaches itself to intellectual property [Greene 2001]. However, other business sources seem to clearly disagree with such characterizations and see OSS as an area for strategic investment [Gomes 2001]. Nonetheless, more than 120K projects are registered at OSS portals like SourceForge.org, as seen in Exhibit 1, while other OSS portals like Freshment.org, and Savannah.org, and Tigris.org contain thousands more.

The vast majority of these OSS projects at SourceForge appear to be inactive, with less than 2 contributing developers. However, at least a few thousand OSS projects seem to garner most of the attention and community participation, but no one project defines or leads the movement. The Linux Kernel project is perhaps the most widely known, with its celebrity leaders, like Linus Torvalds. It is also the most studied OSS project. However, there is no basis to indicate that how things work in this project prescribe or predict what might be found in other successful OSS projects. Thus, the OSS movement is segmented about the boundaries of each OSS project, though some of the larger project communities have emerged as a result of smaller OSS projects coming together. Finally, a small set of empirical studies [cf. Hars and Ou 2002, Koch 2005] that upwards of 2/3 OSS developers contributes to two or more OSS projects, and perhaps as many as 5% contribute to 10 or more OSS projects. The density and interconnectedness of this social networking characterizes the membership of the OSS movement, but at the same time, the multiplicity of projects reflects is segmentation.

Ideological tenets of the OSS movement

The OSS movement arose in the 1990's [DiBona, *et al*., 1999] from the smaller, more fervent "free software" movement [Gay 2003] started in the mid 1980's. The free software movement [Elliott and Scacchi 2005] was initiated by Richard M. Stallman [Gay 2003], and its members identify their affiliation and commitment by openly developing and sharing their software following the digital civil liberties expressed in the GPL. The GPL is a license agreement that promotes and protects software source code using the GPL copyright to always be available

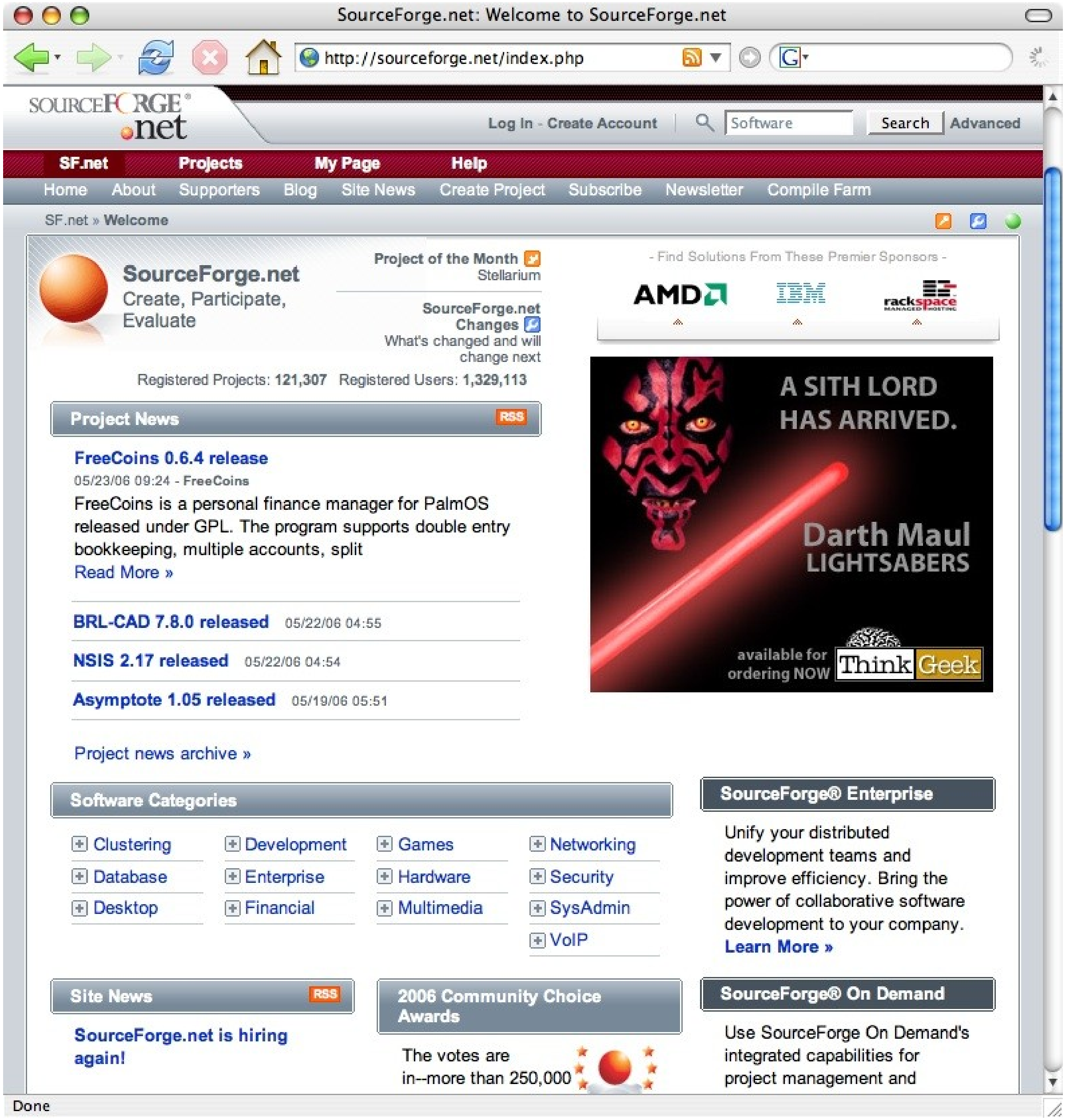

Exhibit 1. Home page of the SourceForge.net OSS Web portal, indicating more than 120K registered projects, and more than 1.3M registered users (source: **http://sourceforge.net/**, visited 7 June 2006).

(always assuring a "copy left"), that the code is open for study, modification, and redistribution, with these rights preserved indefinitely. Furthermore, any software system that incorporates or integrates free software covered by the GPL, is asserted henceforth to also be treated as free software. This so-called "viral" nature of the GPL is seen by some to be an "anti-business" position, which is the most commonly cited reason for why other projects have since chose to identify them as open source software [Fink 2003]. However, new/pre-existing software that does not integrate GPL source code is not infected by the GPL, even if both kinds of software co-exist on the same computer or operating system, or that access one another through open or standards-based application program interfaces.

Surveys of OSS projects reveal that about 50% or more of all OSS projects (including the Linux Kernel project) employ the GPL, even though there are only a few thousand of self-declared free software projects. OSS projects, like the Apache Web server, KDE user interface package, Mozilla/Firefox Web browser, have chosen to not use the GPL, but to use a less restrictive, open source license. In simple terms, free software is always open source, but open source software is not always free software. So the free software movement has emerged or has been subsumed as a sub-world within the larger OSS movement. Subsequently, OSS licenses have become the hallmark carrier of the ideological beliefs that helps distinguish members of the free software movement, from those who share free software beliefs but prefer to be seen as open source or business-friendly developers. It also distinguishes those who identify themselves as OSS developers, but not practitioners or affiliates of the free software sub-world.

Organizations of the OSS movement

A variety of organizations, enterprises, and foundations participate in encouraging the advancement and success of OSS [Weber 2004]. Non-profit foundations have become one of the most prominent organizational forms founded to protect the common property rights of OSS projects. The Open Source Initiative (www.opensource.org) is one such foundation that seeks to maintain the definition of what "open source software" is, and what software licenses satisfy such a definition. OSI presents its definition of OSS in a manner that is considered business friendly [Fink 2003], as opposed to "free software" which is cast by its advocates as a social movement that expresses civil liberties through software (e.g., source code as a form of free speech) [Gay 2003]. The OSI's Bruce Perens who advocates that OSS is an viable economic and innovative alternative to proprietary software, often is juxtaposed or compared to the FSF's Richard M. Stallman, who seeks to "put back the *free* in free enterprise" [Gay 2003]. Beyond this, a sign of success of the largest OSS projects is the establishment of a non-profit foundation or a not-for-profit consortium that serve as the organizational locus and legal entity that can engage in contracts and intellectual property rights agreements that benefit the project. A small but growing number of corporations in the IT, Financial Services, and other industries have taken on sponsorship of OSS projects, either as an external competitive strategy (e.g., IBM's Eclipse project and SUN's NetBeans project compete against Microsoft .NET products) or internal cost-reduction strategy [West and O'Mahony 2005].

Computer games

Structural patterns of the Computer Games movement

Computer games[1] have become a pervasive element of popular culture. More than 100 million computers have been sold for computer gaming applications, and every PC, PDA, and cell phone now comes with computer games installed [King 2002]. More than 600M users have played computer games over the Internet at one time, while hundreds of thousands of users play networked multi-player games per day, as indicated in Exhibit 2. Furthermore, the currently most popular networked games like *Half-Life: Counter-Strike* and *World of Warcraft* have millions of online players, while the most popular single player games (or game-based synthetic worlds) like *The Sims* have tens of millions of players[2]. Computer games are, safe to say, a global entertainment technology, and one that increasingly defines the leading edge of personal computing technology.[3] However, computer game technology in general, and computer games in particular has little presence or advocacy within academia, or within computer science research laboratories. This stands in contrast to other CMs like Artificial Intelligence or Personal Computing, when they first appeared, which clearly had a base of support within the academic and research communities. Similarly, it is somewhat challenging to find whether avid computer game players or game developers identify themselves as part of either a revolutionary or reform movement, rather than people who enjoy using computers to play games and have fun. If anything, this makes it seem that if there is a computer game movement, it might be one that seeks to reform the vision of computers as simply instrumental devices that support administrative or technical work tasks, to one where computers can be treated as hedonistic

[1] Historically, many authors identify computer games as "video games" as if to suggest their significance stems from their video/visual display, rather than from their basis as a computer or computing system.
[2] It is also worth noting that parlor games like Solitaire, Minesweeper, and Pinball may be even more pervasively deployed, being found on hundreds of millions of personal computers and related devices.
[3] This can be seen in that the most expensive PCs are those configured for high-performance computer gaming.

Exhibit 2. Some descriptive statistics characterizing Internet-based use of multi-player computer games, indicating more than 22.5M active game players (Source: http://www/csports.net, visited 7 June 2006).

devices that support fun, playful competition, and sustained periods of immersive fantasy and use. The Computer Games movement might then appear to be one focused on diffused cultural and technological change, rather than sharply targeting organizational or institutional change. But a closer look may reveal more than this.

Ideological tenets of the Computer Games movement

As elements of popular culture, computer games would not seem to constitute a social movement any more than some other personal technology (transistor radios, pocket calculators, or portable music players). Further, the popular press associated with computer games, periodicals like *PC Gamer*, *Electronic Gaming World*, and dozens of other similar titles, or even trade titles like *Game Developer* do not seem to convey that computer games are in some way a social force or mechanism for social change; instead computer games are about fun andplay, and something entertaining to play for those who have grown up in the modern computer age. Furthermore, the technology, design, and development practices of commercial game developers seem more strongly aligned (or gender biased) to the interests of young male adults [Cassell and Jenkins 1999], and such interests would not typically be recognized as a basis for a social movement. However, there is growing interest from humanists and business pundits who are beginning to articulate a vision that computer games have the potential to be part of a dramatic transformation of culture, entertainment, and online social interaction. For example, Prensky [2001], as well as Beck and Wade [2004], see computer games as a precursor for a new generation of business computing applications that will transform how modern businesses operate. Prensky [2001] and Gee [2003] see similar transformations arising within the institution of education, in that computer games also appear to operate as immersive learning and persistent socialization environments. Gee [2003], and also Wolf and Perron [2004], see computer games emerging as a new cultural medium, much like radio, television, and cinema, which may transform the language, experience, and venues for communication, learning and social action. Such game-based computing environments or media may therefore represent a new force giving rise to educational reform, as well as to new ways and means for learning on the job or on demand. So it appears that the ideological basis for a social movement centered about computer games is emerging from outside of its industrial centers of development, and from academic interests not typically associated with promoting information technology.

Organizations of the Computer Games movement

The computer game industry already generates larger annual revenues (about $10B in 2004) than the feature film industry (less than $9B in 2004), and computer games (software) are often the leading edge embodiments of game consoles and personal gaming computers (hardware). Large corporations like Electronic Arts, Microsoft, Sony, and Nintendo indicate the international basis of this technology, and countries like Korea probably have the highest per capita penetration of computer games with broadband network connectivity. Small game design studios like Id Software, Epic Games, BioWare, Valve Software, and Sony Online Entertainment in the U.S., and NC Soft in Korea are responsible for much of the software technology and "game engines" that are the core of computer games. In contrast, popular game titles marketed in retail venues like Best Buy, Circuit City, Amazon.com and WalMart in the U.S., are distributed by large firms like Electronic Arts, Ubisoft, Atari, THQ, Microsoft, and others that effectively control the retail channels for computer games, and thus what games become widely available on a regional, national, or international basis. Furthermore, other large IT companies like IBM, SUN, Dell, and HP are all now shipping both personal computers and clustered server systems that are preconfigured and packaged to support computer games or game-centered businesses (e.g., online networked game play service providers) for sale to individual or corporate buyers.

Mid-size semiconductor manufacturing firms like NVidia and ATI now dominate the market for devices specialized to support computer game graphics (graphics processing units, GPUs), while these GPUs now represent the most complex digital processors in the computer industry. Small, boutique personal computer vendors like Alienware, Voodoo, Falcon, and others have emerged and thrive on selling highly custom personal computers that are configured and optimized (including "overclocked" CPUs and GPUs). Elsewhere, as a small but growing number of massively multiplayer online games (MMOG) and online role-playing games (MMORPG) like *Everquest, Ultima Outline, World of Warcraft (WoW),* and *Second Life*. In the case of the first three of these MMORPG, their parent companies have realized many millions of dollars of revenues not only from sale of the games, but also from pay-to-play online subscriptions from players who subscribe on a monthly basis. In the case of *WoW*, the most popular subscription-based MMORPG in the U.S. and other parts of the world, more than 6M players pay between $11-15/month to play the game and participate in the online experience and community of *WoW*. Furthermore, these MMORPG have emerged on the international scene offering not only persistent (24/7) online game play worlds, but also real-world economic systems that are generating income and wealth comparable in gross domestic products terms to developed nations (the virtual game world of *Norrath* associated with the MMORPG *Everquest*, now boasts of a GDP monetized in U.S. dollars at approximately $2,600/year, placing its economy ahead of the nation of China, and just behind that of Russia [cf. Castronova 2005]).[4]

Next, the U.S. Department of Defense is now investing heavily into the development and distribution of computer games as interactive media and educational technologies for conveying the modern military (combat) experience, as well as for training troops in small team tactical warfare. The game, *America's Army*, which is available for free download from the Web, has become the most widely distributed networked computer game in history, with more than 20 million copies in circulation, and nearly 6 million users registered on its associated Web portal, who play on one or more of the 40K AA servers accessible over the Internet. However, it is difficult to find examples in other government agencies involved in funding research and development (e.g., NSF, NASA, DoE, NIH) that are investing in computer games or game-based applications.

Finally, there are a yet unaccounted number of Web portals or Web sites supported by game players. These are generally "virtual organizations" [DeSanctis and Monge 1999, Kiesler, *et al*., 2006, Tuecke, Foster, Kesselman 2001] whose primary organizational or teamwork form is based on the use of electronic communication systems and media like Email, Web sites, discussion forums, Weblogs (blogs), and others. However, the game related virtual organizations are generally not going concerns organized for financial gain or capital growth, but instead are organized as online venues for social interaction, community and clan interaction around favorite games. Game development companies appreciate the economic and market development value of these online communities, and sometimes actively sponsor or host them on their corporate Web servers [cf. Kim 2000]. Three types of virtual organizations for games include fan sites, clan sites, and tournament sites. *Fan sites* attract and organize the efforts of

[4] The market for producing and selling in-game resources, assets, or high-rank game characters can be seen, for example, in postings found on EBay.com, where top-price items for games like Everquest or WoW range from hundreds to thousands of U.S. dollars, even though the end-user license agreements associated with these games may restrict or prohibit such unauthorized trade of copyrighted game properties.

game players who want to share their game play experiences, results, or creations (e.g., game-related artworks) with other like-minded enthusiasts. *Clan sites* draw the attention of avid or hard-core game players who want to be identified with a group of like-minded, accomplished players or game modders [Cleveland 2001] in order to advance their game play or game development skills. Player-based clans seek to be able to subsequently engage in team-oriented (clan versus clan) play within multi-player games. Such multi-team engagements, as well as advanced player versus player engagements, are facilitated through *tournament sites*, which seek to elicit top-tier game players in professional or near-professional levels of game play. The most popular networked, multi-player games often have hundreds of fan and clan sites that identify themselves with a particular game, or set of related games, while tournament sites are often associated with either a specific game or game vendor (QuakeCon.org for games from Id Software, BlizzCon.com for games from Blizzard Entertainment), or for regional, national, or international game play events,[5] and thus also bring along corporate sponsors to finance the event, and to showcase their products to game players.

Grid Computing

Structural patterns of the Grid Computing movement

Compared to the other two CMs discussed here, grid computing is a CM whose activities and promoters are much more like the CMs examined in Kling and Iacono's studies. The advocates of Grid Computing envision a new order for how large-scale enterprise computing should be structured in terms of hardware, software, and networking. Grid computing is envisioned to be based on loosely-coupled/distributed computer clusters and shared storage systems (hardware), grid-based middleware services and remote application services (software), and high throughput data networking [Foster 2002, Johnson, *et al.,* 2004]. An enterprise that plans to adopt grid computing is one that must plan to make a major investment in new computing technologies and development services. Ironically, the major reason most commonly cited for such investment is cost reduction and resource flexibility, which are to be realized through migration from monolithic legacy system applications, to loosely-coupled and incrementally reconfigured applications that are composed from "best of breed" applications services. So grid computing is supposed to realize its benefits through offering an enterprise a new, agile computing

[5] The *World Cyber Games* (based in Korea) is an example of an international league of national game teams made up of game play enthusiasts who play for cash prizes (up to $50,000 winner per game, per event), gaming equipment, and product endorsements.

application environment, one that might be adapted to meet the ebb and flow of business cycles [Johnson, *et al*., 2004]. In this way, application services can scale up to meet growth demands, or can scale down to shrinking demands. However, all of these capabilities are mostly yet to be demonstrated in real-world business settings where agility or adaptability is critical to an enterprise's operations or success.

Ideological tenets of the Grid Computing movement

Perhaps the most common message associated with Grid Computing is that it represents the future of enterprise computing [Foster and Kesselman 2003]. Grid Computing is not in general advocated as personal or small group technology; instead, it is intended primarily for large enterprises with large IT budgets or investments. For many years, computing grids remained the playthings of researchers, but by 2005, they were said to have finally come of age [Worthington 2005]. The key to grid computing is said to be focused on "federating" existing computing resources, thereby breaking down the technological boundaries that make enterprise computing more expensive and less reliable than it should be [Foster and Kesselman 2003, Worthington 2005]. Similarly, Grid Computing is about enabling the configuration and reconfiguration of virtual organizations [Tuecke, Foster, Kesselman 2001], whereby it becomes possible to configure computing grids that transcend the boundaries of the (physical) organizations where they reside. However, such a capability seems to ignore the long legacy of research into organizations and organization science [e.g., DeSanctis and Monge 1999, Kiesler, *et al*., 2006], let alone the politics of organizations, organizational computing, resource fiefdoms, or even science data wars [Hunter 2003].

Organizations of the Grid Computing movement

Compared to the other two CMs discussed here, the grid computing movement appears to be smaller in terms of the number of participating organizations, but those that do tend to be primarily large enterprises, consortia, or research laboratories. Grid Computing is an emerging commercial marketplace in the IT industry, so all the major IT firms like IBM, SUN, Microsoft, HP, Oracle, and others are creating hardware-software-networking product lines that embrace Grid Computing (or "Web services") technologies. The GRID Forum (www.gridforum.org) is a trade association interested in promoting grid technologies for scientific and commercial computing applications, as well as hosting conferences and trade shows to help promote the commercialization and standardization of these technologies. Finally, most government agencies involved in funding research and development in the U.S., Europe, and beyond, are all investing in R&D projects that seek to stimulate the deployment, growth, and standardization of grid computing technologies, especially in support of large science laboratories or major science research projects (e.g., in areas like genomics, high energy physics, astrophysics, computational chemistry, and others). However, the large IT consultancies like Accenture, EDS, PriceWaterhouse Coopers, and others are yet to provide large-scale service offerings based on grid computing platforms or technologies, compared to their (highly profitable) service offerings based on software technologies like enterprise resource planning (ERP), or customer relationship management (CRM) systems.

INTERSECTING COMPUTERIZATION MOVEMENTS

Just as people at work participate in multiple social worlds, they might also participate in multiple computing sub-worlds, and thus in multiple CMs, as these computing worlds intersect and segment [cf. Kazmer and Haythornwaite 2001]. This section explores and characterizes the structural patterns and dynamic processes that arise when otherwise independent CMs intersect one another, as well as the segments that may form and persist as a result of the intersection.

OSS and Computer Games

The world of OSS and computer games is an active area of engagement and collective action [Scacchi 2004]. These two independent CMs clearly intersect each other. Similarly, there are well established and easy to identify segments within these intersecting movements in the form of OSS-based Computer Games projects found on the Web. For example, on the SourceForge.net Web portal, there are over 13,000 self-declared OSS-based Computer Games projects, out of the 120K OSS projects, as seen in Exhibit 3.

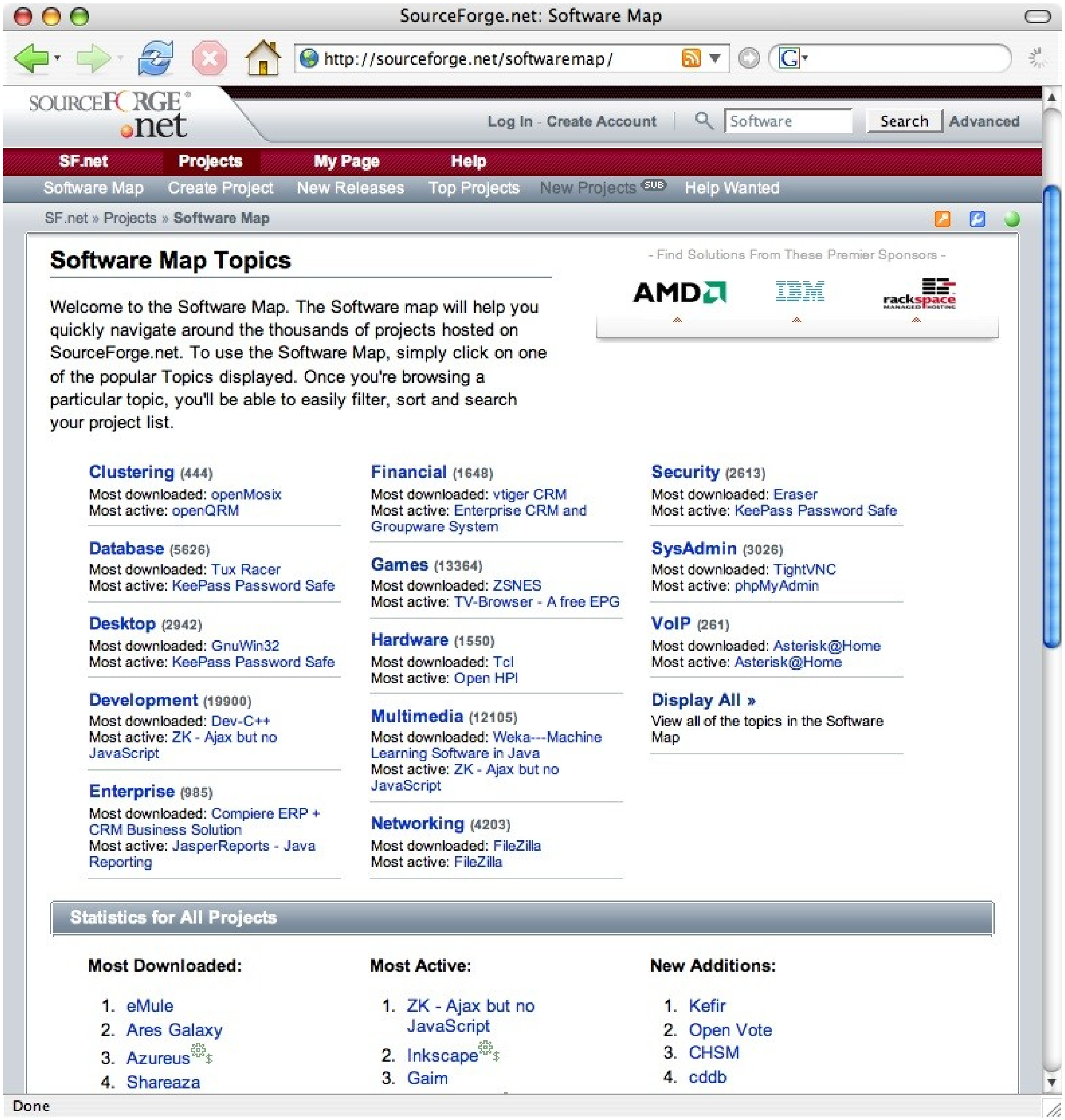

Exhibit 3. Screen display from SourceForge.net indicating the "Games" OSS project category includes more than 13,000 projects, second only to "Development" (source: http://sourceforge.net/softwaremap/, 7 June 2006).

However, this sub-world is the second largest community of interest in OSS within SourceForge, representing just over 10% of the total of OSS projects at that portal. Nonetheless, the existence of on the order of 13,000 OSS computer game development projects points to the emergence of a computing world that apparently conflates the fun and play of computer games, with the community participation and technical development work of OSS development. Said differently, if working as an OSS developer for personal enrichment, then developing and playing computer games should be fun. It might also be a provocative and non-traditional way to learn about computer science, software development, and computer game design [cf. Prensky 2001, Gee 2003], well outside of established educational institutions. But whether it leads to a productive professional career as a commercial software developer or business venture is unclear. However, it can in fact provide an entry into the computer game industry, as OSS-based computer game development, through demonstration of "game modding" [Cleveland 2001] or innovative game design experience [Scacchi 2004, Game Developer 2006].This intersecting movement is highly active compared to those that follow. It appears that this sub-world could emerge into its own separate CM, with its own innovation practices, ideological beliefs, and internal segmentation and intersection with other independent CMs. These are described in a related study [Scacchi 2004].

OSS and Grid Computing

OSS and Grid Computing, most often referred to as "open grid services", are intersecting CMs at a scale smaller that OSS and Computer Games, but larger than Computer Games and Grid Computing. It appears that this sub-world will not emerge into a distinct CM, but instead will more likely be assimilated back into the world of Grid Computing. Reasons for why this may occur include the following. First, the software core of Grid Computing is the middleware technology called *Globus* [Foster and Kesselman 2003]. Globus has been and still remains as OSS, as indicated in Exhibit 4. The choice to open source Globus was tied to the desire to have an open standard for defining and integrating grid services (aka, Web services), as well as integrating with both new and pre-existing open data communication protocols. Similarly, the nascent effort to establish ad hoc "flash mob computing" services (cf. www.flashmobcomputing.org), which entail the rapid assembly of supercomputing clusters from networked and participant-contributed PCs, seems to have failed to emerge as a

Exhibit 4. Background information on the OSS Globus Toolkit for building computing grid applications (source: http://www.globus.org/toolkit/ visited 7 June 2006).

sustainable grid-like computing infrastructure, even though many OSS technologies have been marshaled and configured to demonstrate the potential.

Computer Games and Grid Computing

Computer Games and Grid Computing are intersecting CMs at the scale smaller than the preceding two. But traces of their intersection and emerging persistent segments that span and relate the two can be found and examined [Levine and Wirt 2003]. Similarly, the Sony Corporation has announced that its PlayStation3 computer game console[6] is designed to be hardware, software, and network compatible with grid computing [cf. Worthington 2005]. Other companies like Emergent Game Technologies and IBM have also announced interest in offering grid-based middleware services that support continuously scalable MMOG infrastructure [cf. Deen, *et al*., 2006]. Study of this segment reveals a narrow set of recurring practices and innovation processes that appear to limit the near-term growth into a separate CM. It appears that this sub-world may emerge into a distinct CM that will more likely be assimilated back into the world of Computer Games. Reasons for why this may occur arise from recognition that the market for grid computing remains uncertain outside of scientific research applications, while the revenues generated by the computer game industry already exceed $10B/year. Furthermore, the emergence of the MMOG-based persistent online worlds and external economic systems point to plausible opportunities for marketing and deploying computer game-oriented grid systems to national or international game service providers. At the same time, computer game grid represent a new arena for technical innovation by game developers, as well as an arena for new kinds of computer game play experiences for end-users that may conflate having fun with making money (or not!). Finally, it may represent a bundling of technologies that governmental agencies that fund advance educational research (e.g., NSF) may find to be an applying venue for exploring new concepts in large-scale game-based learning environments. Such applications may find interest more within the computer science research community, rather than in education or humanities programs which are helping to motivate the opportunity.

[6] Sony has already sold more than 100,000,000 PlayStation1 and PlayStation2 computer game consoles worldwide.

OSS, Computer Games, and Grid Computing

This is the smallest and least populated sub-world of computing that spans each of the three computerization movements. The fact that there are any identifiable and persisting activities within this segment is noteworthy and significant, since they must interlink three otherwise independent computerization movements. In 2005, there were no established projects or corporate ventures in this arena, though the idea of their existence seems to be in circulation. But recently (Spring 2006) IBM [Deen, *et. al*., 2006] announced an internal R&D effort that seeks to support the development of MMOGs that run of grid technologies using OSS game engines. Whether this community can emerge, survive, and achieve the critical mass of social networking that can precipitate reinforcing network externalities is an open question. However, examining how participants in this segment can or might interact collectively, and whether there is a common overlapping ideology is of interest. For example, there are many large-scale "LAN parties" where computer game players congregate (i.e., move to a common location) to build truly large-scale local area networks and interconnected game servers to play both commercial games and OSS game mods, and then disappear all in a matter of days, much like when the circus comes into a town. Exhibit 5 portrays such an example from QuakeCon, one of the largest annual gaming enclaves and social event, formed about a large-scale LAN-based computing environment similar in capability to a flash mob computing cluster. Subsequently, this nascent sub-world of computerization that intersects OSS, computer games, and grid computing is perhaps most interesting as a boundary case whose future or continuing emergence is unclear, as is it's status as a viable CM. Said differently, it may represent a case where the conditions needed to support the emergence of a CM are partially articulated, but whose longer-term success or demise is unclear. This sub-world thus represents an interesting boundary case for further study, so as to determine whether it will in fact emerge as a sustained computerization sub-movement, or whether it lacks some critical structural, ideological, or organizational component to sustain its emergence.

DISCUSSION and CONCLUSIONS

This chapter examines computerization movements surrounding open source software, computer games, and grid computing, none of which had yet been subjected to critical analysis prior to the studies found in this volume. It also adopted an updated perspective on CMs in

Exhibit 5. Overview of a large, informal computing grid for playing commercial computer games and open source game mods, found at the QuakeCon 2005 LAN Party. (Source: http://www.quakecon.org/gallery_byoc.php, visited 7 June 2006).

terms that seek to reveal the segmented, polycentric, and networked dimensions of the social worlds and sub-worlds that constitute these movements. In doing so, it became possible not only to examine each of these CMs on their own, but also to explore whether and how these movements might intersect one another, and thus manifest inter-movement conditions and dynamics. This kind of analysis was suggested by early works of Kling and Gerson [1977, 1978] more than 25 years ago, but this analysis strategy still proves viable, as well as a source of new insights into how CMs are animated and evolve. Perhaps this is due to the growing maturity and ubiquity of computing technology and culture, as well as to our ability to critically examine them more closely.

This analysis also helps reveal that CMs and computing worlds are more diverse and more complexly structured than perhaps may have been seen in prior studies. Also, the outcome of the intersection of different CMs is not uniform, and does not necessarily give rise to a new, persistent sub-world of computing, though new sub-worlds do arise, as appears to be the case of the world of open source software for computer games. In fact, just the opposite can happen—one computing sub-world can effectively subsume the intersection of another computing sub-world, resulting in the two former sub-worlds being assimilated back into the dominant computing sub-world. This appears to be the situation resulting from the intersection of the sub-world of OSS and grid computing, as well as grid computing and computer games. Finally, the nascent intersection of these three CMs points to a fledging sub-world whose sustained existence is sufficiently unclear and ill-defined to determine whether any of the three CMs will likely assimilate it. Subsequently, this homeless sub-world perhaps becomes most interesting from a critical perspective because of how it helps reveal and deconstruct the boundary conditions that arise as computing worlds and marginal social movements intersect one another.

Established groups within a CM can and often will fragment, resulting in either new groups with different members and allies, or in the departure of the disenfranchised. Consequently, CMs are probably more heterogeneous rather than homogeneous, though collective action still emerges, and shared beliefs or ideologies are expressed and renewed through communication media shared within a given movement. This revised perspective seeks to avoid or mitigate assumptions that all participants who are identified or associated with some CM or countermovement myopically subscribe to some master narrative of ideological beliefs or uncritically agree to follow prescribed courses of collective action without reflection, disagreement, consternation, or conflict. Thus, CMs must be examined in ways that highlight their heterogeneity, their segmented social worlds, and the socio-technical interaction networks that enable these segments to collective act toward partially articulated and often conflicting goals.

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