

Information Technology tools for a transition economy*

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Although there are growing concerns regarding the eminent energy crisis followed by a discussion that is mostly focused on the development and use of new sources of energy, there is negligible mainstream attention given to the possibility that it may not be feasible to convert all of our energy supplies to renewables while still supplying a growing demand. This article discusses this possibility with its economic effects and how Information Technology may assist in the transition to a sustainable economy while still improving the welfare of the population. This transition may be catalyzed by the implementation of peer-to-peer social networking tools designed for the purpose of cultivating popular collective intelligence, facilitating the development of self-organizing, resilient local communities.

There is increasing evidence linking human activities to the disruption of Earth's ecological systems such as the effects of anthropogenic greenhouse gases to climate change [1]. A significant portion of greenhouse emissions originates from food production, transportation systems, and electricity generation, designed to sustain large urban areas - which for the first time in history holds more than half of the human population [2]. Among other problematic issues one can mention the destruction of natural ecosystems following urban development, extensive agricultural and farming strategies, overfishing, water contamination by human, feedstock animals, and industrial wastes. Nevertheless, there is still hope that humankind may undergo a transition to sustainable use of ecosystems [3].

Limited resources

At the root of this problem lies our society's dependency on non-renewable resources to maintain an ever expanding economic system. According to the Living Planet Report, issued every two years by the World Wildlife Fund [4], as of 1986, our civilization consumes more resources than natural systems can sustainably provide. On a historic perspective, one may notice that the apparent abundance of energy stored in fossil fuels along years of geological and biological activity modeled our society in such a way that it is now utterly dependent on this non-renewable, environmentally deleterious resource. Of the 5×10^{20} joules of energy consumed by humankind in 2005, 84% was obtained from the combustion of fossil fuels [5].

There are growing concerns regarding the emergent energy crisis. Although the discussion is mostly focused on the development and use of new sources of energy, negligible attention is given to the possibility that it may not be feasible to convert all of our energy supplies to renewables while still supplying a growing demand. The problem becomes even larger when raw materials are also put on the balance. Thus, as we recognize our technological and natural limitations and the dependence of the global economy on the environment, it becomes evident that a fundamental restructuring will inevitably take place in the economic system as we further advance beyond Earth's natural limits.

After careful observation, it is not difficult to realize that the recognition of environmental limitations leads to an inversion of the values as compared to those followed by the global economy during the last century. A transition to a sustainable state is inevitable. However, it may happen either by voluntary choice [6, 7], or we will be forced into a failed state following the aggressive depletion of natural resources [8]. In both cases we are faced by major changes, thus we should all get used to the idea. If we are to revert the situation and avoid the second scenario, it is desirable to encourage this transition before it is too late.

This change have major implications not only in industrial processes, which must be redesigned [9, 10], but also the transportation system and food production/distribution networks must be redesigned in order to achieve sustainability, avoiding the inevitable collapse following the systematic dependence on non-renewable resources. This is a modification that will finally revert to changes in the lifestyles of developed societies, which will move in the direction of simpler living standards. It also suggests that, on the average, people will work and live closer as compared to the trends observed during the last decades. In this scenario, local production of food and consumer goods are preferred over centralized mass production, since in the later situation, goods must travel large distances in order to reach the destination.

Indeed, the possibility of a collapse following the established economic system was recognized early in the 70's [11], although accounts of the impossibility of sustaining infinite growth in a finite planet can be dated back

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to the XIX century in the writings of Thomas Malthus and John Stuart Mill, even though their predictions were not entirely accurate. More recently, we have been observing a growing number of initiatives from every sector of the society that, by recognizing the paradox of infinite economic growth in a finite planet, focuses on raising awareness and taking action towards a balanced relationship between human activities and the natural environment. Contributions are arising from diverse areas, among them one can mention the emergence of new academic fields such as Ecological Economics, popular movements exemplified by the Transition Towns¹ initiative [12], and a large amount of literature being published on the subject[9, 10, 12].

However, the question remains: how to build a new functional economic system? A system based on existing or developing technologies that empowers local communities and reaches a large number of individuals in a timely manner; an economy that addresses the environmental constraints while still improving the welfare of the population?

An answer to this question may be in the people you know.

Six degrees of separation

During the last few years our understanding of networks skyrocketed. Similarities between links of proteins in a cell and the spread of contagious diseases have been clearly presented [13–15]. Notably, early studies on the network of human social interaction suggested that every person alive today is, on average, separated by six social links [16]. The existence of an average small number links separating any two nodes is a common feature of several networks found in nature; this is known as small world effect.

It is hypothesized by some researchers such as Barabási that the prevalence of small world networks in biological systems may reflect an evolutionary advantage of such an architecture. One possibility is that small-world networks are more robust to perturbations than other network architectures.

As a consequence of the small world effect, the number of people you can reach by taking a given number of steps in your social network increases exponentially with the number of steps you take [14]. Thus, following the small world effect and considering that any product or service, or any task involved in the assembly of products that are necessary for surviving on this planet can be performed by some person, one wonders why not use this existing social network as a blueprint of a new economic system?

In other words, why not rearrange the economic flow by coupling the production and distribution chain of goods and services to the social network of individuals who finally consumes products and services? This concept can be referred to as social-coupled economy or *peer economy*.

Peer economy

Peer economy is a concept for an economic system that is based on the simple premise that goods are always exchanged between individuals, or peers, in a process known as peer production [17]. It contrasts to the dominant globalized economy in the sense that in this case there is negligible connection between the production/distribution chain of goods and services and the social cycle of the individuals who consumes/uses them. Although peer production has already been recognized as a new form of production restricted to digital information such as free software [18, 19], usually released under the GNU general public license, and multimedia sharing, released under the Creative Commons license, there are no intrinsic factors preventing its adoption by other realms of the economic production system. [17].

Although there are several advantages of the dominant market model, such as the diversity of products found in a marketplace, the prevailing industrial economic model is very energy inefficient, results in social disruptions, and tends to neglect the environment. In the particular case of food, for instance, the dominant industrial model also tends to obscure the origin and impacts of the manufacturing processes. The consumer is allured with carefully designed packages while the nutritional value if its contents decreases, its ecological impacts and the working conditions of those who produce are ignored in favor of higher profits.

On the other hand, a peer economy can empower local economies by boosting the exchange of locally produced goods and services. Another advantage is that in a peer economy individuals can easily check the origin and processes involved in the production of their livelihood goods by following the social chain responsible for its acquisition. By reducing the need of large scale transportation, a local economy can be more energy efficient, thus relieving, and eventually abandoning, its dependence on fossil fuels. Also, the integration of the production chain to a social network will result in the fortification of the local economy, making it less vulnerable to the global economy, thus building a healthier community.

By developing technologies that facilitate a peer economy, we will stimulate the emergence and growth of sustainable, environmentally friendly communities within the existing society.

¹ The aim of the Transition Towns project is to equip communities for the dual challenges of climate change and peak oil — <http://www.transitiontowns.org/>.

Information Technology

At the same time that it is arguably the most innovative field of the last decade, Information Technology (IT) is certainly delivering only a fraction of its full potential for mass collaboration, in specific for large scale collaboration among popular masses. Collaboration groups on the network is indeed being recognized as a new kind of global collectivist society based on peer production [20]. Accordingly, existing communication technologies is indeed allowing a higher level of coordination between individuals and communities to take place. However, in the same way that one to two centuries passed between the invention of the press and the culmination of the scientific revolution and the Age of Enlightenment, the revolutionary potential of network communication for the masses is still in its incubation stages. It is waiting to trigger a phase transition in the way people interact and use its collective intelligence as soon as the correct tools that fosters popular collective intelligence are available for a wide audience.

This process is being delayed at some extent since the majority of leading IT tools are developed by corporate collective intelligence, which would be particularly threatened by the rise of a competing popular collective intelligence. The fact is that strategic and economic issues associated with social networking platforms makes it impractical for commercial service providers to develop and implement software that delivers the full potential of communication networks for the masses. Thus, it is expected that the real breakthrough of IT will most likely be based upon free software since it does not present this kind economic constraints [18, 19].

Social Networking

The Internet is loaded with a large number of social networking services that are not particularly designed for social or economic transformation. In particular, the available services inherently lacks the flexibility and robustness of small-world networks given the fact that these are all dependent on specific hubs that are not members of the community, namely the service providers themselves². When third parties mediates user communication, although this intermediary greatly simplifies the transmission of messages given its dedicated purposes, the scope of interactions between users and communities is inevitably limited as compared to direct peer-to-peer communication. In order to superficially address these

² Notice, also, that by connecting through commercial social networking services, users are always bounded to a third party service provided by legal agreement. A legal agreement with an intermediary is not necessary for people communicate, the purpose of language itself.

issues, commercial social networking software developers are joining efforts for the implementation of a standard that will relax some of the communications constraints related to users connected at different hubs, while still maintaining strategic control over the network [21]. Nevertheless, as far as the potential of network communication is concerned, server-based communication cannot overcome the trust potential of peer-to-peer direct communication.

Social networking services available on the web are based upon proprietary software which have the ultimate purpose of advertisement driven profit which implicitly demands tracking user activities. On the other hand, in order to allow people's collective intelligence to fully develop by means of their self-organized social networks, communication in social networking software must be independent of intrinsic intermediaries, free of external influence³. Otherwise the software platform will not be trusted as a medium for carrying out candor business negotiations and private conversations, for instance, being, thus, fundamentally flawed.

In order to overcome these limitations, it is desirable to develop free and open source information technology tools that encourage large scale, dynamic social interactions and stimulates popular collective intelligence. This open approach has the potential to facilitate the emergence of peer economic systems.

Social Cloud

Following the previous analysis of social networks and the underdeveloped potential of Information Technology, a new concept for designing social networking services is suggested. In this novel concept the networking services are not provided by centralized servers, but by nodes of the network forming a cloud of computers owned by individuals who joins the network. In analogy to cloud computing, where computer services are provided by an interconnected network of computational servers, the concept presented here is called *Social Cloud* since the services are provided and maintained by a social network; i.e. cloud computing owned and maintained by a social network.

The basic idea is very similar to P2P file sharing, but in addition to files, people will also exchange ideas, products, and services in the physical world. You may think of the *Social Cloud* concept as a blend of an auction website and a social networking website hosted at a cloud computing environment, which on its turn is running in a peer-to-peer network. A simple implementation of this concept in an exchange market, for instance, would involve a simple comparison of lists of products and ser-

³ Marketing is an example of external influence since it distracts the attention of the user - it is carefully engineered for this purpose.

vices offered or requested by members of the community. As lists are compared to lists of other peers connected to the network, there is increasing probability of positive matches as the search advances further in the social network of each individual. Once the number of matches and closed deals reaches a threshold, a transition may happen making people more reliant on the *Social Cloud* than on the market economy.

When someone goes “shopping” in a *Social Cloud* network, this person will be implicitly browsing his/her social network. Payments will be made using a local currency or a time-based currency⁴ instead of the official national currency. This scheme may catalyze the adoption of local currencies and stimulate the emergence of resilient local economies that are not fundamentally dependent on the global economy. More than that, dynamic interactions results in high degree of network flexibility, allowing communities to test different metrics as measurement of their progress. Thus a community may consensually choose their own prosperity indicators, conveniently replacing GDP. Also, reliability can be enhanced by reputation building based on peer evaluation.

Examples:

1) In a rural community, farmer John has a tractor that is available for rent. 20 km away, another farmer, Carl, is planning to do some heavy work on his property. John does not know Carl on a first name basis, but both are friends of a third farmer. In normal circumstances, John will not tell all his friends about all products and services that he can deliver, nor Carl about all his needs. However, if John and Carl decide to share this information with a mutual acquaintance by joining a *Social Cloud* network it will be straightforward to match and indicate the mutual interest of John and Carl.

2) A group of individuals are organizing a transition town initiative at an urban neighborhood. They have established a social cloud network that is already being used for a exchange marketplace, a for managing a decentralized Time Bank and local currency, and for organizing group activities. However, this community is also interested in the acquisition of organic vegetables and are looking for a trusted local supplier. At a farmer’s market, one member of the transition town initiative establishes a social cloud connection to Carl, the farmer that has rented a tractor from John and is starting to produce organic vegetables at his property. Once established, a single link between the Transition Town initiative and the rural community may result in rich interactions between members of both communities, resulting in the establishment of a supply chain of goods and services.

Below, some technical aspects for the implementation of a Social Cloud network based on existing or develop-

ing technologies are presented. The basic network functionality based on peers and groups of peers arranged in communities is also discussed. This is followed by a description of the software interface based on plug-ins that provide advanced functionality to the basic social networking layer. Some examples of how peers and communities can interact forming a complex web of relationships are also presented in order to illustrate the concept. The last section describes the hardware for running the Social Network client and its possible implementation for communities with limited economic resources.

THE NETWORK

The implementation of a Social Cloud peer-to-peer network can be divided into four layers: *i*) the basic networking infrastructure *ii*) a kernel social networking engine, *iii*) plug-ins to provide a modular addition of features, and *iv*) user generated content.

Infrastructure

The basic networking infrastructure refers to the basic hardware responsible for network communication. The existing Internet hardware based on the standard TCP/IP protocol is perfectly suitable for the task of supporting *Social Cloud* networks. Alternatively, it is also possible to grow *Social Cloud* networks on decentralized systems such as a mesh networking wireless topology, which can be particularly useful for isolated communities. However, as the network expands and communities start to join local *Social Cloud* networks, it will be possible to migrate *Social Cloud* services from the standard Internet to mesh networking, making it independent of commercial or governmental networking services.

Kernel

A kernel, running on top of the basic infrastructure, is responsible for managing the social network, information flow, and a MySQL database where network information is stored. The kernel also provides the interface on which plug-ins can access database and network information. This kernel will provide the basic interface on which the network topology will be build according to users’ social networks, forming the *Social Cloud*. It will result in the establishment of communities. Data will flow in peer-to-peer, peer-to-group, and group-to-group schemes - see Fig. 1.

This kernel consists of a mixture of *i*) existing P2P file-sharing software networks based on distributed hash tables and *ii*) social networking software, resulting in a decentralized, scalable, and fault tolerant network once it grows with a sufficient number of nodes. It can be

⁴ This concept is known as time banking.

inspired or based on existing projects such as GNUNet [22] and Freenet [23].

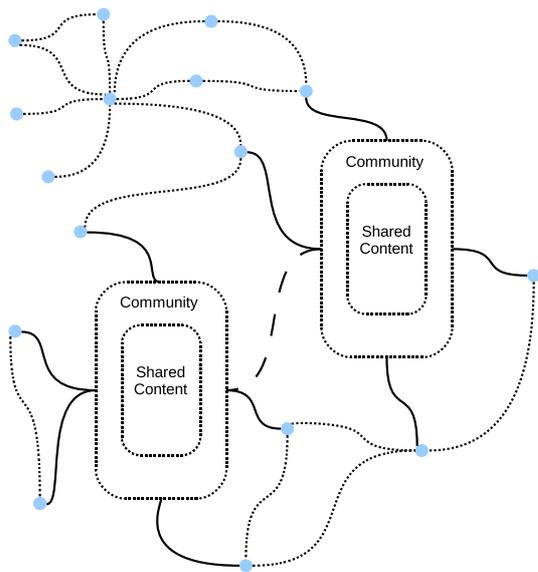


FIG. 1: Schematics of a Social Cloud network, showing the connection between peers and communities. Shared information can be arbitrarily accessible to peers not directly connected to a given peer or community.

For enhanced security and privacy, networks can be constructed using the Friend-to-Friend (F2F) network topology [24]. In friendship and community based P2P network, peers can be securely identified by cryptographic keys, allowing private and secure communication between trusted parties upon mutual agreement. Cryptographic keys can also be generated for community content, where groups of users can securely create and edit shared content for the development of complex projects.

Plug-ins

Plug-ins, running on top of the social networking kernel, are responsible for advanced functionality of the *Social Cloud* network by allowing a modular addition of features. Plug-ins will serve specific purposes such as managing an exchange marketplace where peers may post offers or requests for goods and services. Another plug-in may track and verify user reputation by checking with other peers about evaluations of past negotiations. Other possible plug-ins include the management of a local currency, time banking, instant messaging/e-mail client, cluster for parallel computing/distributed computation, video and voice streaming, wiki-wiki, blogs, distant learning tools, software for source code management, and other advanced project management tools.

Content

Content falls under two basic categories:

1. *Individual Content*: Each user can store content in a profile that can be synchronized to peers selected according to attributed categories. Synchronized peers will serve as web caches / relays, distributing the information while the primary user remains off-line. Hierarchical category levels of information will allow each user to select the desirable range of information flow for each posted content in order to control the distribution of sensitive information only for trusted partners. Some possible categories include public, business, family, friends, friends of friends.
2. *Community content*: can range from simple shared text documents (blogs or wiki-wiki documents), or a virtual market provided by a cooperative of workers. Communities allows the coordination of large projects with each associate/subscriber caching community information, relaying group content. Some suggested subcategories include public, members, friends of members.

Communities will be built upon the generation of public and shared keys in order to control what information will be public and what will be restricted to its members. Once a new member is accepted into the community, he/she will receive appropriate keys granting access and participation in the group's activities.

In this peer-to-peer social network, the public and shared contents of users and communities must be kept synchronized by appropriate protocols. Each user will allocate some space in his or her own hard drive for relaying the content of other users while some others are off-line.

Some examples of communities: a cooperative of workers, a group of students, ecovillages, transition towns, groups of consumers with mutual interest. Formal connections can be established between communities, allowing collaborative interaction between a cooperative of organic farmers and a group of consumers interested in organic products. In order to maintain a large community it is desirable to have different levels of memberships. Community creators can grant different levels of memberships such as Owner, Editor, Member - each category having its own set of permissions.

Similar to RSS feeds, users can also subscribe to public content of communities or peers. In this way the subscriber may also relay its content to others.

Another potentiality of communities regards its ability to issue certification to goods and services offered by individuals or even other communities. In this context, offerings can be certified, approved, or audited by a trusted group. This allied to reputation obtained by on-line voting and peer evaluation, can provide a reliable metric for

enhancing trustfulness of products and services offered within the network.

SYNCHRONIZATION

Some good practices will have to be carried in order to keep the network running. Synchronization problems can be reduced by increasing connectivity times or a common daily synchronization period at an agreed time each day for a local community. For geographically sparse communities lacking a long distance communication link, synchronization parties can be regularly scheduled in order to maintain service functionality.

P2P networks also presents high flexibility and can provide a higher level of privacy as compared to standard, server based social networks as each user can authoritatively select who will have access to each information.

On the other hand, a loose implementation of the Social Cloud protocol will facilitate the conception of crawling bots that can harvest information in the network for data mining and monitoring, raising serious privacy concerns. Consequently, it is advised to build a protocol based on strong encryption and careful information sharing between peers - categorized information sharing. Encryption layers similar to Freenet can be implemented in order to prevent privacy attacks [23].

With a mesh networking topology, the social cloud protocol can run in isolated communities independent of commercial and governmental network providers. It allows advanced digital communications in case of accidental (or otherwise) unavailability of central digital backbones.

HARDWARE

The social cloud network can run on any platform capable of network communication. With the increasing availability of wireless networking devices, the connection of multiple devices with minimal changes in the basic infrastructure becomes possible, simplifying the expansion of the network. Indeed, almost any hardware with network capabilities can may integrate a *Social Cloud* network if it was not locked by its manufacturer.

By developing the software for lower cost hardware, such as mobile phones, Pocket PCs, Palmtops, or the \$100.00 laptop (One laptop per child XO-1 sublaptop computer), communities with limited resources will be able to make use of social cloud networking. In this scenario, by children with access to XO-1 computers may have the ability to build powerful *Social Cloud* networks, with the possibility of helping in reshaping the economy the community in which they are inserted. This is one issue that must be carefully analyzed. Another possibility is providing low cost networking devices for each household.

Low cost mobile devices can also work as surveying and publishing probes, expanding the broadcasting range of the network by connecting to other peers while moving outside of its primary location. Synchronization is maintained when the user is back to his primary location and the mobile device connects to his main computer.

In this sense it is urged for hardware manufactures to open their architecture in order to allow the utilization of discarded equipment for applications other than the primary designed purpose. Nowadays, equipment with wireless communication capabilities, in perfect usable conditions are being unnecessarily dumped into the environment for being outdated, while it could be used for other purposes such as running basic mesh communication services. This kind of locking policy is not viable in a planet with limited resources and should be condemned.

How to become part of the solution?

- Share the idea;
 - Join the discussion group at www.socialcloud.net and contribute with your expertise;
 - If you are a software developer, volunteer at the project development team;
 - Start building a community and once the software is released adopt it for extending community interaction.
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CONCLUSIONS

This article discusses some of the limitations of the current economic system, in particular its dependence on non-renewable resources to sustain infinite growth. As resources approach depletion an inevitable collapse will take place and a transition to a sustainable economy is the only alternative to maintain a resilient human society.

In this scenario, the role of information technology tools in a transition economy is presented with emphasis on a new concept for building social networking services. This new concept, the *Social Cloud* can be summarized as cloud computing running in a peer-to-peer social network. It may help increasing the level of self-organizing coordination and collaboration both within a community and between communities. With proper hardware, it may also bring network communication for the masses and waking up their collective intelligence, triggering a social and economic revolution.

It is also suggested that the proper implementation of the *Social Cloud* concept using free and open source software allied to suitable networking hardware will catalyze the formation of resilient local economies by linking the production chain to the social network of each community, facilitating the emergence of a peer economy. This alternative economy have the potential to depend on less resources as compared to the traditional economic system, helping to revert the current state of humankind

and achieving sustainability in a timely manner by extending the quality and efficiency of human interactions. It may have the potential to allow local communities to

fortify its social links and boost its economy by increasing the level of collaboration and resource-sharing, in an over-populated, finite planet.

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