THE DIGITAL GENIE PROJECT

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CONTEXT

The world as we knew it vanished on November 9th 1989, with the fall of the Berlin wall. The world we grew up with, a world that was defined by division and separation—whose side are you on, iron curtains, third worlds, etc.—was replaced by one that is defined by level of connection—can you access the flow of information, are you on the Net, who are your closest global partners, do we see the same news? In this new Global Society, as we create the global industrial, political, and legal overlays that remove trade barriers, open labor markets, and harmonize environmental objectives, we must assume an equal responsibility to all the people this global society includes—or should include! Of course this is an extremely complex problem, with many political, cultural, and societal elements well beyond the reach of the technical community. But we can do one critical thing—**we can provide the research and development needed to enable an inclusive information-technology-based foundation upon which these other debates can be held.** If you believe communication is a key to mutual understanding and shared governance, if you believe digital media can ever play a major role in education and literacy, then we have a real role to play. If you believe access to information can help families—not just in the United States or the developed world but every family anywhere on this planet—improve their family planning, the health and education of their children, and their ability to grow food and provide clean drinking water, then the IT research community has a clear responsibility to respond to this need, and to respond as soon as it can.

Many of you may have heard of the Grameen Bank, the micro-lending bank, established in Bangladesh by economics professor Muhammad Yunus a quarter century ago, to provide micro-loans to poor women (mainly) in rural villages. Today, Grameen Bank provides over 2.4million loans/year to poor villagers, with total capital of over $50M—with virtually no external support. Grameen Bank recently established Grameen Phone, a "for profit" subsidiary company that uses micro-loans to fund a "Phone Lady" in each village. The designated Phone Lady sells access to the cellular phone to villagers, at a rate sufficient to pay back the loan she received to buy the phone, pay the phone charges needed to maintain the network, and with enough left over to improve the quality of life for her family. Grameen Phone stands today as the largest cellular provider in the South East Asian subcontinent, with over 12,000 phones in service. The villagers feel personally empowered, being a part of a "global network"[1]. **Grameen Phone is not a charity, but is a very successful business, playing an important societal role, built using modern IT and a radical business model.** Independent studies over the past few years have shown that Grameen Families (the families of women who have received micro-credit loans to finance their home businesses) have fewer children and their children have a significantly higher literacy rate; the families are healthier, and more productive. More than 2.4 million lives transformed by micro-loans and what we would consider today relatively basic information technology. This is just one of many such ongoing stories that could be told about the transformation of poor communities across the globe using appropriate engineering and alternative ways of doing business.

Yunus and many others believe that by empowering the poor—the 4 billion people earning less than $1,500/year—through a combination of micro-credit or other innovative business models and appropriate information-technology-based systems, we can provide a global foundation to empower these people to improve their lives. In so doing, problems of population growth, political and economic exploitation, hunger and healthcare are also likely to be far more easily and efficiently addressed as well.

[1] The Phone Lady is even given the telephone numbers for the Prime Minister, the village's local member of parliament, the chief of police, and local doctor or medical service, to be used by the villagers "just in case!"

The key to this opportunity is a global digital information architecture that has the potential to deliver effectively digital content to every person on the planet.

Such an architecture would be used to deliver education and healthcare, make (very) small business more efficient, empower the poor and displaced by providing a permanent and self-manageable 'digital home' (digital money purse, personal records, etc.), and enable the many other opportunities yet to be thought of.

But even if we could provide such a digital architecture, what about the content? What would we deliver to these far reaches of the world? It was Pavel Curtis who once said: "People are the killer app of the Internet" and I'm sure he is right. Connecting people to people, throughout the world, is certainly the basis for any new idea or development in this new and connected environment we live in today. I am confident that once the reliable, robust and easy to use basic infrastructure is there, motivated people from throughout the world will find really good ways to use it[2].

In a recent visit to Berkeley, Muhammad Yunus said, "My ultimate goal is to see the day when every village has a Digital Genie—like Aladdin's Lamp—where a villager comes up to the Genie and asks a question, in whatever way she feels most comfortable, and the Genie finds and gives her the answer." How closely could we approximate that dream?

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There are many elements to such an objective and my hope is that this group and the broader the research community would work to flesh out the central requirements of such a project. A few of the key elements of such a research initiative might include:

Empowering Individuals

The Digital Genie project must be considered from a number of points of view, but the most important is from the perspective of the individual—the 'consumer'. That is, let us consider an architecture that truly puts the individual first for a change, rather than a business interest. This person might be one of us, or might be a disadvantaged student in the suburbs of Chicago, a newborn girl in Afghanistan, or a villager in Bangladesh. I suggest that this aspect of a global digital architecture is the least well explored today, presents the toughest technical challenges, and has the potential to have the most impact on a global scale. We need an architecture that provides an unencumbered ability to define a digital persona—a digital home—with *guaranteed*[3] access to ones personal information—one's digital state—anywhere, any time, and through a wide range of interfaces. It must be secure, private, portable, and insensitive to user error. It should be 'extortion-proof' and with assets inheritable upon death. It must be trustable by third parties (e.g. its use as an identity card). Most of all, it must be absolutely indestructible under any and all circumstances.

Connecting People

We might consider an international and all-inclusive human analog to the digital library project, where instead of books we architect and develop the infrastructure needed to index and search for people: teachers, volunteers, experts, historical data, lost family members, adoptive parents, and mentors, to name a few. A villager with a medical problem might as the Digital Genie in her village for assistance, might be connected to an available medic in the area that speaks her language, who might as for help and is connected to a specialist in New York. Perhaps he is 'volunteering' on the network for a few hours a week. A prescription is issued, the local doctor has perhaps learned something new, and the patient has

[2] And probably a few really bad ones—another interesting aspect of the research in terms of how to 'manage' the downside. In the end, some *de facto* standard global architecture is sure to emerge. But by getting ahead of the curve, the research community has an opportunity to influence the characteristics of such an architecture (e.g. central persona management or distributed, portable, private, secure?) and hopefully lead to a more 'democratic' alternative.

[3] It must be truly guaranteed—through natural disaster, civil war,

received the best medical care available. And the specialist in New York develops a growing appreciation for problems developing beyond the confines of a New York practice. Everyone involved benefits.

How should we architect such a system? What are the best approaches to data management infrastructure, authentication, storage and retrieval? How do these integrate into personal calendars, personal priorities and objectives? Perhaps the specialist is looking for examples of specific forms of disease with specific symptoms for a research project. What about user interface? Language translation services? What sort of services should be provided to 'police' such a system? What sort of requirements does such a system place on underlying hardware and communication technologies? What sustainable bandwidths are required, under what scenarios, to make such a system work?

Even the basic infrastructure needed to connect people effectively presents a major research challenge—the two-way video Mothers' Day call of 2020 will require orders of magnitude more digital infrastructure than we have provisioned today. Can we do it? How will we do it?

Societal-Scale Architectural Foundations

Such a global, personal capability will require major rethinking of our underlying storage, communication, and computational infrastructure. Affordability, reliability, robustness under the very worst kinds of failure, cost-effective maintenance that requires little or no local human knowledge or intervention, extreme scaleability[4] with evolvable organization and interfaces, reliability in the face of intermittent connectivity at all levels, a 'grid-like' computational foundation. Security and privacy must be at the heart of the project from its outset.

The architecture must be attack resistant and attack tolerant, must support heterogeneity, and is likely to require extreme redundancy. What sort of human interfaces are required and can their evolution be accommodated from the outset? Is a kiosk-like style preferred to a personal, portable form factor? How should the network be connected—fiber, copper, wireless; satellite-delivered, terrestrial? What sort of latency levels are tolerable for what applications and can they realistically be achieved on a global scale? If not, what other organizations make sense? What bandwidths are required and can they be sustained reliably?

These questions, and many more, lie at the heart of such a societal-scale system architecture—an architecture we need here in the United States for our own personal, commercial, and national security purposes, as well as for the globe.

SUMMARY

I have outlined just a few of the many challenges such a project would encompass—in fact, many of the other proposals presented at this workshop would be important elements of such a national initiative. However, the Digital Genie project represents an organizing objective—a 'Moon Shot'—that can be used to coordinate, integrate, and eventually test the resulting research in almost every area critical to digital systems architecture. In a global society, everyone is a member of our global family, whether we like it or not. But in today's world of conflict and terror, it is the disenfranchised, the powerless, the displaced and the poor that represent the greatest threat to our freedom and our way of life. Even our national security demands that we work to make this an inclusive world, where there is a digital place for every person willing to participate—the Digital Genie Project represents an opportunity to turn such a dream into a reality. The key to this is the development of a global architecture that puts the individual first.

[4] With 22 births and 9 deaths per 1000 people per year in 2001, the system would have to accommodate more that 200 million changes per year, or about 500,000 'people transactions' per day.

BIOGRAPHY:

Richard Newton is currently Dean of the College of Engineering and the Roy W. Carlson Professor of Engineering at the University of California, Berkeley. He has been a Professor in the Department of Electrical Engineering and Computer Sciences since 1979, where he has been actively involved as a teacher and researcher in the areas of design technology, electronic system architecture, and integrated circuit design. Over the past twenty years, he has received a number of Best Paper awards for his research and he was selected in 1987 as the national recipient of the C. Holmes McDonald Outstanding Young Professor Award of the Eta-Kappa-Nu Engineering Honor Society in recognition of his teaching.

He is the director of the MARCO/DARPA Gigascale Silicon Research Center (GSRC) for Design and Test. The GSRC coordinates the research of more than thirty faculty, eighty graduate students, a dozen postdoctoral researchers, and many industrial collaborators to tackle some of the design and test problems for integrated silicon systems that will face designers 6-12 years from now.

In addition to his academic role, Professor Newton has helped to found a number of design technology companies, including SDA Systems (now Cadence Design Systems), Simplex Solutions, Crossbow, and Synopsys, where he has rejoined the Board of Directors. Since 1997, he has also been a member of the Technical Advisory Board of the Microsoft Research Laboratories.

He is also a Venture Partner with the Mayfield Fund, a high-technology venture capital partnership, where he has contributed to both the evaluation and early-stage development of over two dozen new companies, including Silicon Light Machines, now a part of Cypress Semiconductor, where he was the acting President and CEO during 1994 and 1995.

He is a member of the ACM and a Fellow of the IEEE.