Professional Development Topic 5: Brave New Worlds

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Co-operative Computing

- Co-operation was once normal
  - Intellectual Property Rights
  - Co-operation requires Trust
- Free Software and Open Source
  - Free Software Foundation
    - Copyleft
    - GNU
  - Open Source Initiative
    - Open Source Definition
  - Linux
- Peer-to-Peer
  - Antithesis of Client/Server
  - From Usenet to Napster

Sharing

- Prior to the 1980's source code was always made available - even for proprietary systems
- Copyright and Patent Law should have protected Intellectual Property Rights and fostered the dissemination of information
- Trust broke down and binary-only releases have now become the norm for proprietary systems
- The sharing ethic of the pre-1980's has endured in a few places and seems to be taking off again
- Trust is essential for any form of co-operation

Free Software and Open Source

- What does “free” mean?
  - “Free as in Freedom not Free as in Beer” (Richard M Stallman)
  - Copyleft
- Free Software Foundation
  - Founded by Stallman
  - GNU Project and GPL
- Open Source Initiative
  - Need to end confusion over the word “free”

Free Software Foundation

- Richard M Stallman (RMS)
- MIT, 1984
- Holds software freedom as a political philosophy
- GNU - GNU’s Not Unix
  - Mach microkernel
  - GNU HURD servers (unfinished)
- GNU/Linux
  - Kernel covered by GPL
- Debian, Red Hat, SUSE, etc.

Open Source Initiative

- GNU General Public Licence
  - The starting point
- Debian Social Contract
  - Debian GNU/Linux licence
- Netscape
  - First opening up of a commercial product (Apple, IBM, Sun followed)
- Open Source Definition
  - Defines what a licence needs in order to be Open Source
- Microsoft Hallowe'en Documents

What does free mean?

- Public domain [unlicensed]
  - No restrictions whatsoever
- Free of charge [gratis]
  - Freeware (NOT free software)
  - Shareware (free for a limited time)
- Free to use [licensed]
  - FSF
    - No cashing in on work of others
    - No integration in proprietary packages
    - Examples: bash, c library, emacs, gcc, gnu/linux
  - OSI
    - Freedom to access/modify source code
    - Permits selling the freely-released work of others
    - Examples: apache, bsd, netscape, X windows

"Copyleft"

- Gives permission to
  - run
  - copy
  - modify
  - distribute modified versions of
- a program
- So source must be made available

- Does not allow
  - adding extra restrictions of your own
  - taking the program or modifications to it private
- So combination with non-copylefted works is non-trivial

Licences

- Free Software and Open Source licences give away rights (and disclaim liabilities) –

- GNU General Public Licence (GPL) forbids mixing GNU software with non-free software
  - GNU Lesser GPL (LGPL) relaxes this for software libraries
- OS licences confer a right to use modifications of the original source in non-open applications
  - Apache, BSD, Mozilla, X Windows
- Open Source Definition explicitly states that selling-on as part of an aggregate must be permitted under an OSD licence [cf. GPL?]

Linux

- Linus Torvalds
  - Helsinki student, 1991
  - Tanenbaum's Minix
- Open Source success story
  - Troll Tech's Qt opened for KDE; Sun opened Solaris; Apple's Darwin
- Linux kernel
  - Macrokernel
  - Cathedral style development; Strict control by Torvalds
  - Covered by GPL (GNU/Linux)
- Linux tools and applications
  - Modules
  - Bazaar style development; Evolutionary control
  - Not covered by GPL in order to include commercial vendors

Peer-to-Peer

- Antithesis of Client/Server
  - Direct person-to-person (P-P) or application-to-application (A-A)
  - Very fluid membership
  - 100,000 TeraHz, 2 million Terabytes
- Yesterday (from 1979)
  - Usenet for exchange of newsgroups
  - UUCP across Arpanet/Janet/…
  - New sites simply hooked on
  - A "backbone" of sites emerged
- Today
  - Usenet is still there
    - NNTP (TCP/IP based)
  - Increasing number of P2P projects
- Tomorrow?

Peer-to-Peer Definition

- Variable connectivity of nodes
  - Home PCs dialling up via a modem are nodes in the system
    - Note that they aren't always there and don't have DNS entries
- Transient node network addresses
  - Nodes lack permanent IP addresses
    - IP addresses dynamically allocated by ISPs
    - Protocol based addressing can be provided by some central authority
- All nodes have a degree of autonomy
  - PCs can publish (not simply author)
    - "Cornucopia of the Commons" - Variety
    - "Tragedy of the Commons" - Freeloading
  - Trust and Accountability

Peer-to-Peer Examples

- Freenet
  - File exchange (Ian Clarke, Edinburgh Uni)
- Gnutella
  - File exchange (Open Source)
- Jabber
  - Instant Messaging - XML
- Napster
  - MP3 music distribution
- Publius
  - Censorship avoidance - not pure P2P
- Red Rover
  - Censorship avoidance - e-mail
- SETI
  - Search for Extra Terrestrial Intelligence
- .NET
  - Microsoft's foray into P2P - XML; SOAP

The Napster Story

- Napster is probably the most (in)famous P2P system
  - A simple definition based on “no central control” would exclude Napster
- Napster’s history

1990s	All sorts of legal wrangling over the copyright violations to which Napster was giving succour One band even threatened to take their fans to court if they used it
2000	Recording Industry Association of America (RIAA) starts legal proceedings against Napster which effectively close it down
2001	Napster starts signing agreements with copyright holders
2002	Roxio Inc. buy Napster for $5m
2003	Napster 2.0 launch (fully legal)
2004	Napster signs deal with UK AIM - Association of Independent Music

eLife

- Emerging Technologies
- Technological Paradigms
- Societal Paradigms
- Obstacles

Emerging Technologies

- Embedded Systems
- System Level Integration (SLI)
- MicroElectroMechanical Systems (MEMS)
- Semantic Web
- Obstacles

Embedded Systems

- Embedded systems are not general purpose, they are designed to perform specific functions
- They are typically a hardware device with a software component
- Their potential is enormous
- Today we already have
  - Microwave ovens, washing machines, DVD players, mobile phones, car engine management systems with automatic start/stop
- Tomorrow we can expect software to be embedded in practically any piece of hardware that could benefit from adaptive control
  - The old “hardware/software trade-off” is becoming a non-issue

System Level Integration (SLI)

- The Semiconductor Industry Association (SIA) predicts that it will soon be possible to place 100 million transistors onto a chip
- It will be possible to put complete systems onto a single chip
  - This takes integration beyond VLSI and into System Level Integration or the System-on-a-Chip (SoC)
- The design and verification of such systems are major challenges
  - Design re-use, virtual components, hardware description languages
- Institute for System Level Integration (ISLI) on Heriot-Watt's Research Park

MicroElectroMechanical Systems (MEMS)

- Miniature systems for sensors, communications and actuators
  - Mechatronics in miniature
  - Nanotechnology
  - Molecular machinery
  - Micro-motors
- Tremendous scope for applications in medicine and healthcare
  - Pacemakers, cochlear implants, prosthetics
  - Nanorobots running around in the blood stream breaking up clots to avoid thromboses
- All sorts of mundane objects could become active and reactive

Semantic Web

- The Web in a machine usable form
- Currently information is provided in a form suited to viewing by us
- What if all the information could also be provided in a form suited to computer programs?
- We could send agents out into the Internet to find appropriate information, combine it and process it in order to answer our queries
- A semantics is needed to describe each item of information so the agents can identify what is what (cf. Meta-tags)
- This is the Semantic Web vision

Obstacles to the Emerging Technologies

- Mechanical wear and tear
  - All mechanical devices create friction
  - Eventually moving parts wear out
  - Preventative maintenance
  - Friction can also lead to overheating
  - Cooling devices
- Electrical power supplies
  - All electrical devices require power supplies
  - External power sources
    - Connecting with power cables defeats the object of a lot of these technologies
  - Batteries have a finite capacity
    - Preventative maintenance
  - Overheating again

Technological Paradigms

- Peer-to-Peer Systems
- Grid Computing
- Pervasive Computing
- Ubiquitous Computing
- Utility Computing
- Obstacles

Peer-to-Peer Systems

- Networks composed of computers which opt in and out at will (ad hoc)
- Opting in makes your computer an equal member of the network with all of the benefits and liabilities which that entails
- Nodes in the network make their resources available across the network but can also use any resources on the network
- Pros and cons
  - “Cornucopia of the Commons” – Variety
  - “Tragedy of the Commons” – Freeloading

Grid Computing

- The grid is a reliable, scalable, heterogeneous, dynamic, global infrastructure which links a wide range of computing and noncomputing devices
- Offers enormous capacity in processing power and storage volume (cf “the cloud”)
- Can also make complete facilities available
  - Already being used to link scientific laboratories so that researchers in one lab can conduct experiments in other labs anywhere on the grid
- Grid of services is on its way
  - “Prosumers”
  - Web 2.0

Pervasive Computing

- Computing resources everywhere in a “right here and now” sense
- Not necessarily transparently
- The Holy Grail is universal availability
  - computers in everything
  - personal digital assistants (PDAs)
  - mobile phones
  - wearable computers (in our clothes)
  - smart buildings
- Enormous number of research projects working on this paradigm
- Pervasive computing is often treated as if it is synonymous with ubiquitous computing ...

Ubiquitous Computing

- Computing resources everywhere in a “background” or “somewhere but I don’t care where” sense
- Transparent and invisible are the two most common descriptors
- The Holy Grail is that users should become oblivious to the technology which surrounds them
- Calm Technology

  “The ubiquitous computer leaves you feeling as though you did it yourself”

  Mark Weiser, Xerox PARC
- The European concept of Ambient Intelligence subsumes the ubiquitous computing paradigm

Utility Computing

- Computing resources supplied just like any other utility such as electricity, gas, water, etc.
- The return of computer bureaux?
- Low entry cost to an enormously powerful information processing system on a “pay as you go” basis
- Service level guarantees
  - “The real barriers are cultural and political, fear of losing control, concerns about sharing resources, security concerns, software licensing issues”

  Peter Hindle, Hewlett-Packard UK
- The ultimate in outsourcing?
  - Cloud computing

Obstacles to the Technological Paradigms

- Security
  - This will probably be the most serious obstacle to the take-up of the distributed paradigms
  - If the shirt I am wearing is “internet-enabled” then I want to be pretty certain that it can’t be messed with by just anybody anywhere in the world
- Vested commercial interests
  - The distributed paradigms will require commercial enterprises to work together to an extent which is completely unprecedented
  - There are signs that many are prepared to do this though [Java]

Societal Paradigms

- Home Working
- Computer Supported Cooperative Work (CSCW)
- eCommerce
- eGovernment
- eDemocracy
- Obstacles

Home Working

- Already here to a degree
  - High tech crofting
- Why isn't there a lot more of it?
  - Do we like commuting?
  - Do we like communing?
  - Broadband speeds
- Improvements in the quality, cost and availability of streaming video systems might make home working more attractive
- Productivity of home workers is an issue for some types of work
- CSCW is also likely to be relevant here ...

Computer Supported Co-operative Work (CSCW)

- We're all doing it already but in a hap-hazard and slip-shod fashion
  - Mailing lists, discussion fora, etc.
  - Documents and spreadsheets passed around amongst contributors
- CSCW sits between organisational and individual computing
- Research in CSCW focuses on systems to support small groups of workers
- CSCW is "socio-technical"
  - Social scientists are needed to find out how we use, and what we want from, them to make them more useful

eCommerce

- Already with us
- There has been a remarkable take-up rate in online shopping
- Data-mining can lead to better targeting of direct marketing which will be more acceptable to consumers
- *eCash*
- Security issues

eGovernment

- Electronic service provision and “joined up government”
  - “Joined up government”
    - Integrated databases
  - Public service information
    - E.g. Directgov at http://www.direct.gov.uk
- The UK has had -
  - Office of the e-Envoy which aimed to “ensure that the country, its citizens and its businesses derive maximum benefit from the knowledge economy”
  - e-Government Unit which aimed to “improve the delivery of public services by joining up electronic government services”
  - open.gov.uk and ukonline.gov.uk which offered an “A-Z of Government”
  - Online income tax and VAT returns at a Government Gateway
- All of which have now disappeared!

eDemocracy

- Virtual surgeries
  - Communication between constituents and elected representatives
- Intelligent FAQs
  - Automatic answering of common questions which constituents ask
- Constituency alerting systems
  - News alerts for representatives re issues affecting constituencies
  - Data-mining by representatives for issues affecting constituencies
- Online opinion polling
  - Representatives can “test the water”
- Online voting

Obstacles to the Societal Paradigms

- Trust and privacy
  - Intrusive monitoring of home workers
  - Confidence tricksters and reliability of deliveries in *eCommerce*
  - “Big Brother” in *eGovernment*
- Personal contact
  - We are a gregarious species
  - We prefer to work together in a workplace and not all alone at home
- Alienation
  - Disenfranchising those without access to *eStuff - creating an underclass*
- Bureaucratic conservatism
  - “Joined up government” threatens mini-empires within the Civil Service