BOURSE - Broadband Organization of Unregulated Radio Systems through Economics

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Apr 9 and Apr 10, 2002

Wireless or Pointless?

or

Grassroutes Networking

(pun intended)

This is talk about the likely evolution wireless networking, in the speaker's opinion.

`http://www.cl.cam.ac.uk/ jon/out/bourse.pdf`

I want to acknowledge the newarch project, and conversations with Steve Hailes at UCL and Richard Gibbens in Cambridge.

Abstract

We can divide the world of networking into three domains:

Utility-like Companies - telephone (like gas, electricity, water roads)

Mass Media like companies - film, music, radio, tv

End User Owned - Internet, books, fanzines, clubs, etc

In general, the first two derive from a top-down approach to deployment. This means that they entail a very solid understanding of a market and usage, before the investment can be raised to build the infrastructure for the network, justified by analysis of cost of production of content, sunk costs, and user willingness-to-pay.

The latter characterizes the Internet. We argue in this talk that wireless networking should follow the pattern of the Internet deployment (at access and wide area levels) rather than the former two, since there is little or no knowledge of the applications, content-value, or user valuation of service or content. The less from mobile phone (phone+always reachable, not actually mobility) is not relevant, except in the negative sense (the US receiver pays problem, caused partly by lack of market understanding, and partly by existence of free local calls).

3G (and 2.5G) will probably be killed by cities tiled with 802.11 wireless Ethernet, and wide (and ultra-wide) band CDMA.

background

Networks are not just in the business of delivering information from A to B.

Networks have structure, and economics, which are really quite subtle.

Networks (including transport networks such as road, rail, sea, air) have complex topologies targeted at services and usage patterns.

Networks also have interesting cost recovery and profit making structures.

Networks are also highly varied in terms of ownership (whether self contained, oligopolistic, anarchic, or bundled with other, higher level business such as services and content).

Four types of Network

Phone - originally conceived as wired radio! now well understood (Erlang) business model due to traffic

TV/Radio - derives from Cinema

IP - grass roots....both core (overlay on telco and edge (Ethernets, or local loop from other nets).

Road - "who needs roads" (back to the future:-), but also see London and UK Road Congestion Pricing plans! Remember history - grass roots! recall canal v. rail.

IP Evolution

Started as a set of research project i.e. had a *community*

ARPA (wide area) and Xerox (local), as well as grass roots (modems, dialup, bboard etc etc, uucp etc etc)

Mutability of software systems (accessibility to the mass of now educated programmers), means evolution is rapid, and selection is by market itself, not by marketeers...IETF mantra (*working code*) etc

e.g. HTTP yes, FTP no

e.g. VOIP, no, Real, yes.

Telco and Broadcast - Extinction or Adaptation?

Telco net optimized for 3^3 - 3 minute call, call 3 people, 3% utilisation. note call “holding time” a poor fit to browse == opportunistic use of net. or download == high utilization. or always on == reachable at any moment (c.f. mobile)

Broadcast optimized for downstream (“couch potato”) - note most valuable customers also serve ....sprint trial showed this.

Adapt? difficult - systems are hardware optimized.

Truth in advertising - the IP sabre tooth tiger economy

It is true - it is now hard to adapt IP - core systems are optimized; IOS is very very hard to modify (though easy to add yet more features (TM) to).

However, genie is out of lamp, Pandora is out of box, we can now overlay again, just as IP did to telco and broadcast nets, we can overlay on IP.

P2P (hype? not IMHO) shows the way

Software evolves

Trend for software systems is to let users enhance, modify (if you don't they will write a new one). Costs are actually quite low.

Business model for s/w system is tricky (not really understood at all yet) - personally, I like the FSF/GNU model since it rests on the value of the professional (ability to program and maintain) rather than marketeer....(ability to predict - always good in a pack, terrible in a downturn).

Ethernet - make it so

So what about wireless?

Well, GSM begat GPRS, begat 3G.

GSM adds a single feature to existing telephony system - reachability mobility is in fact a red herring). It's not really interesting beyond that - its true that SMS (and email/sms) is a hint of something else, although real value isn't high (people pay very little for it).

So what about 2.5 and 3G? Well, too little, too late?

lets see. To be useful, GPRS has to be globally available. We need to have every base station turned on on a flag day? is that right?

No. What we want is certain critical places with good access - e.g. business hotels, airports, etc. Can i really read email or browse while walking, driving along. No. So...

SO why not just use 802.11

Moore, Metcalfe and Reed's' Laws etc

Moore says CPUs (memory, storage, and bandwidth) double every 18 months for same price.

Metcalfe (co-inventor of Ethernet) said "the value of a network (meaning network in its most general (social) sense) is the square of the number of users".

Reed said – "Well, could be more than that - could be $n^2 ln(n)$ even ".

Crowcroft disagrees - we don't all speak the same language, have the same interests - AOL (and channel 5) make money because for some value of content, we can all be couch potatoes - we can be in a *walled garden*

Small World

So how could we organize wireless networking around these ideas?

walled gardens? not quite

small world gardens....

so we need a garden, a landscape gardener (a chancy gardener:-) and so forth - a set of design rules

Implementation 1 - just a framework

BOURSE - Broadband Organization of Unregulated Radio Systems through Economics - has several components:

personal node (terminode) - is a terminal and a router.

community a region, set of personal nodes, or users that share some common enterprise - not necessarily geographic or explicitly economic - self defining.

community builder - a focus for personal nodes in the same part of a small world to find each other (a bit like a location service, but also a common interest point, landmark, etc)

network design a set of (p2p) servers that offer network designs to communities

bourse a distributed market management system (stock market) where community builders list capacity/power/regions, network designers list their network designs, and bids/offers are placed and an auction is (continually run) with the results published.

node-ware repository a site that can offer the relevant modulation software to a personal node or community of personal nodes.

Implementation 2 - Xenoserver platform

Cambridge university has a platform suited to executing untrusted code - this could be used for all the components above!

We're looking at using it (Xenoservers) for some other things more like traditional time sharing combined with cluster and p2p computing

This work may use it more radically!

It accommodates some nice resource control ideas including an economic model and virtualisation of entire operating systems slightly above the level of vmware (i.e. virtiaulises a Linux like I/O and CPU/Bus/Memory model, rather than an Intel 386 processor architecture).

Implementation 3 - network-on-design repository

Network design rules include kruskal and prim and so on...

node placement and link sizing are well known problems

fast polynomial approx. algorithms are emerging for the harder parts...

Implementation 4 - community auction service

Auctions (English, dutch, vickrey) etc are very subtle things

more work is needed to work out auction schemes that retain privacy and avoid collusion!

network games can teach us something, as can the rapid evolution of GSM contracts in the UK for example (massively deregulated already and intensively competetive).

Implementation 5 - Regulatory Matters - stability and fairness

Where is the regulator in our system?

Nowhere, and yet everywhere

Anyone could join any community and see what their rules are.

People could trust third parties (brokers) to join communities at ramdom and check that they are behaving sensibly.

Note that without a community, of course, someone could gratuitously do damage. This is a hard problem!

....

Discussion

Model is like a control system - analogies abound, from eco-systems, from fields and physical power laws, and from economics and game theory

attractive forces are the community common interest. repulsion forces are competition. The network design system takes advantage of the non linearities in these to find reasonably efficient solutions (power law network topologies are beginning to be reasonably well understood. Also ad hoc is like p2p where small world models abound and re-enforce optimizations of the topologies etc).

Opposing appropriate forces leads to convergence and stability and may be used to help the network design system provide some (to be defined) level of intra-comminity and inter-community fairness.

Note the community idea is recursive (communities/regions can of course be nested, or intersect - to be studied!).

Cohesion is provided by policing, but policing is by consent - consent works because non -cooperation in these scenarios is worse than sub-optimal - it is simply infeasible to use an ultrawideband net with a large number of users without cooperation!

Some Economics and Ecology

What we are proposign is somewhat like a generalisatin of the Internet Economy (see Kelly et al) - weighted proportional fairness, however, now applies to a geographic area nad spread of the spectrum, rather than to a single bottleneck *router* or *line*.

Note that (in my reading) economists still cannot explain the distribution of company sizes, and ecologists have a hard time (c.f. Kauffman) explaining the number and populating of species - we an simulate life, but we cannot predict it -

This may be because of initial condition sensitivity (chaos). But it may just be we need to do more work.

Summary and Conclusion

Future wireless networks will be rooted in communities.

Communities can decide whether to use cellular access networks, or multihop, and whether to user predefined or dynamic sets of modulation (e.g. CMDA, frequency hopping, etc) or mixtures of the above.

Some techniques are needed to get buy in from equipment and regulators.

An evolutionary path from here to there is also needed,although observation of early use of 802.11 and GPRS is already happening that way anyhow....

Should be fun!