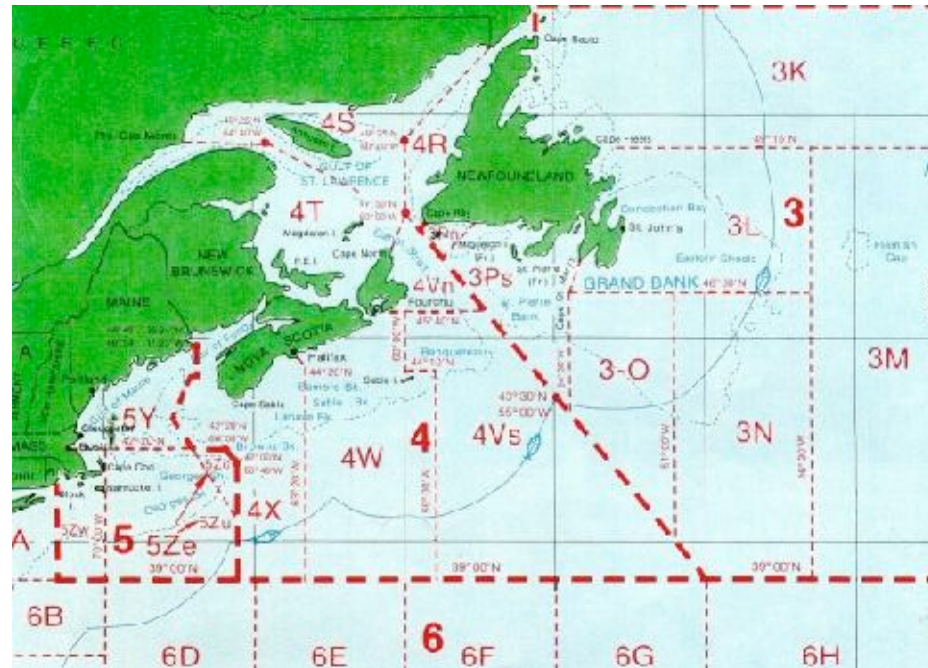# Perfect Storms, Internet Economics, and the Future of the Internet

David Meyer
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http://www.1-4-5.net/~dmm/talks/NANOG41/perfect_storm

Agenda

- Background and Context

- So what is the "Perfect Storm"?

- Three Pieces of the Puzzle

- A Few Considerations

- Discussion

Background & Context

- I'd been spending a lot of time studying complexity

  - http://www.1-4-5.net/~dmm/talks/NANOG26/complexity_panel

  - RFC 3439

- And looking at things like NGN and IMS

  - http://www.1-4-5.net/~dmm/talks/NANOG33/ims

Background & Context

- So I started wondering where all this is going

  - And how technologies like IMS (or more generally, NGN) interacted with the Internet Architecture

  - And what the implications of the growing number of *policy-based networks* really was

- And in particular, I wondered about the *implications of tying (perceived) high margin application revenue directly to the packet transport*

  - That is, can you really do that with the Internet architecture?

    - And if you try, what happens (hint: complexity)?

  - We'll see why this is an interesting question in a moment

Background & Context

- And as you might imagine (given my background/sensibilities), I was skeptical about what those technologies might mean for the Internet

- In analyzing the space a bit, I proposed a scenario that became known as "Meyer's *Telecommunications Perfect Storm*", or *TPS*

- The rest of this talk reviews the TPS scenario and its implications

What Exactly is the TPS?

- TPS is based on the observation that the following *three basic events* could lead to a significant restructuring of our industry:

  - *Low margin yet profitable IP packet carriage businesses emerge/exist*

  - *Access monopolies are weakened and/or cease to exist*

  - *A set of peer-to-peer applications emerge that co-opt the incumbent's revenue streams*

What Exactly is the TPS?

- So TPS is a set of observations about the current state/trajectory of the Internet

    - TPS convolves economics, public policy, technology, and the Internet Architecture

- TPS is based on properties of the Internet Architecture

    - As we shall see, the key property of the architecture here is the end-to-end (e2e) principle

    - We can argue (like everyone else) about what the e2e principle really says, but a good reference is

    - http://www.chiappa.net/~jnc/tech/end_end.html

Key Feature of the e2e Principle

- For our purposes here, the key aspect of the e2e principle is that it implies that

    - *IP packet carriage is a commodity business*

- I'll just note here that this conclusion "may be considered controversial" by some

    - And note that this doesn't mean that there isn't margin in say, 2547 (clearly there is); however, 2547 (and other VPN types) is really a small part of the overall traffic mix

- So let's look at each of the *TPS events* in a bit of detail

Event 1: Existence/Emergence of Low Margin yet Profitable Packet Carriage

- *The hypothesis here is that a direct consequence of the e2e principle is that Internet packet carriage is a commodity business.*

  - *i.e.,* the IP architecture *dictates* that the high(er) margin value proposition is on the edge

  - So if you're going to be in the IP packet transport biz, you're going to have to make your living in a low margin environment

- Contrast with all of the activity around trying to provide high-margin packet transport, usually by attempting to tie application layer revenue directly to the packet transport. e.g., IMS/A-IMS.

  - Not surprisingly, there is disagreement on this point

- Ok, but what is the relationship between a commodity business and its margin structure?

Classic Commodities and Margin Structures

- Classic commodity businesses are characterized by significant capital expenditures in their plants, low profit margins, and intense competition

  - Sound familiar?

  - And of course, capital has to be *effectively available*, otherwise up front CAPEX requirements can form a barrier to entry (e.g., submarine cables), and hence reduce/eliminate competition

- And watch out - *natural monopolies* can also form

  - This is case in which the incremental cost of incumbent capacity is *significantly lower* than the cost of new-entrant capacity, which can allow an incumbent to squeeze out competition

Commodities/Margin Structures

- Another property of classic commodities is that frequently cited is that they have the property that the incremental cost of providing the good or service approaches zero

  - *Well, what is the incremental cost of forwarding a packet in the core of the Internet?*

    - Approaching zero

- So the lack of differentiation in the core (QoS anyone) *and* intense competition has driven low margins, which combined with reduced plant costs has over time driven incremental costs towards zero

Commodities/Margin Structures

- So IP packet carriage is a classic commodity
    - Well, we knew that from the e2e principle
- So we know that margins are going to naturally be thin
- Conclusion: SPs need to be profitable in a commodity (low margin) environment
- *And importantly, the high-margin proposition isn't in packet transport*

Low Margin yet Profitable

- *What this is really all about is the convolution of the Internet technology with the economics of packet transport*

  - We want to *simultaneously preserve* the e2e nature of the Internet *and* have viable economics

  - *i.e.,* low margin yet profitable IP packet carriage

- And BTW, in case you were wondering, we understand the economics of all of this about as well as we understand complexity

  - *So we need to encourage (multidisciplinary) research in this area*

Event 2: Access Monopolies are Weakened/Cease to Exist

- Say, due to the emergence of technologies like WiMAX

  - Or just competition in the access

  - and what about things like 700Mhz?

  - and how about EU wide UMTS @ 2Mb/s?

- Truth in advertising #1

  - Some folks posit that competition in the access is *effectively impossible* due to its capital intensive nature, and thus access is a *natural monopoly*

- Truth in advertising #2

  - We still don't have a (inexpensive) wireless technology that is capable of delivering 100s (or even 10s) of HDTV channels

Weakened Access Monopolies -- Why this is important

- Competition makes it much harder (impossible?) to profitably field policy-based access networks. But why?

- Well, consider the cost of building/running one of these networks

  - and given the complexity, its reliability

  - and attendant cost to the consumer

- And there is no way your SP is going to be able to innovate at the same rate as the *entire Internet*

  - e2e principle (again)

- Consider the success of AOL or other attempted "walled-garden" providers

  - But then, what about IMS and the like?

Access Monopolies are Weakened/Cease to Exist

- Implication of all of this:

  - *Policy-based networks cost more to build and operate, are less reliable, and are (ironically) less "service rich"*

- Why cost more?   -- Complexity

- Why less reliable?   -- Complexity

- Why less service rich? -- Stay tuned...

Access Monopolies are Weakened/Cease to Exist

- *So this is about the convolution of the Internet technology, access technologies, public policy*

  - Net Neutrality++;

- Of course, access networks must also be profitable (under some models), so this is also about which business models are viable for access providers

  - Alternatively, access networks may be be considered some sort of public infrastructure (such as roads)

  - Debate on this one rages on, however...

Access Monopolies are Weakened/Cease to Exist

- So the most basic question is --

- How do we handle the next wave of access b/w requirements?

    - say, for IPHDTV?

    - and how will any *required upgrades* be funded?

    - and which *technologies?*

- Suffice it to say that there are real (and difficult) technology, business model, and public policy questions here

So Why Are Policy-Based Network *Less Service Rich?*

- Suppose you're a walled-garden (policy-based) SP....

- If history is any kind of guide, innovation on the edge will force you (the walled garden provider) to let new services through...Why?

  - Your customers will demand it (e.g., ports 80/443)

  - This is part of the reason why *the existence of competition in the access is a critical component* of all of this

- Once you let *almost any* port through, *everything* can then be tunneled over that port (*courtesy of the Internet architecture*)

  - *e.g.,* skype or any other OTT service (Joost, etc)

  - plus encryption + anonimzation + *lots* of app developers

Why *Less Service Rich?*

- And you can't really find this stuff with, say, a DPI engine

  - Why? Well, because while you may be able to find the signature of, for example, encrypted voice (today), you basically have to block everything that you can't identify.

- The implication is that most (all?) applications that are "over-the-top" must be treated by default logic

  - So you either have to allow nothing (temporarily) or everything

- **Conclusion: *You can't effectively stop over-the-top services***

  - If there is *competition in the access, and...*

  - You effectively have "Carterphone" for end-user devices

- YACAR (Yet Another Classic Arms Race)

Event 3: Applications Emerge That Target Incumbent Revenue Streams

- The 3rd piece of this puzzle is that a set of p2p applications emerge that *capture the incumbents' revenue streams*

  - e2e principle, again (shocking)

  - Key here: decentralized control

- Starting with voice

  - Large and easily co-opted revenue stream

  - cf. Vonage (or what's left of it), skype, Joost, etc…

  - But also video, FMC, presence, IM, …

- Service bundling seems to be the current SP hedge against this effect

Applications Emerge that Target Incumbent Revenue Streams

- *So this is about a convolution of the Internet technology (notably its end-to-end nature and the creativity that unleashed) with traditional carrier architectures and business models*

- In particular, while traditional carrier networks were vertically integrated (*the network was the application*), the Internet is horizontally integrated

  - This has the effect of making many of the *services* the vertically integrated networks provided into *applications* on the Internet

    - Canonical example: Voice

Summary: What happens if we wind up with...

- *Low margin but profitable packet transport providers emerge/exist*
  - As implied by the e2e principle
- *No (or weakened) access monopolies*
  - Competition and/or new access technologies
- *Large scale co-opting of traditional service provider revenue streams*
  - p2p (or other) applications target traditional and future revenue streams

Summary, cont.

- Does our industry restructure under such a scenario (and how)?

  - We know such restructuring does happen (and can happen rapidly)

    - Example: the recording industry

    - It seems highly unlikely (to me anyway) that there were many recording industry exec's sitting around thinking *"hmmm, peer-to-peer networking, that'll probably restructure my industry..."*

- And how much of the TPS is already out there?

  - *i.e.,* is this really "if"?

  - and interestingly, I was listening to Jim Cramer....

June, 2006 Cover of Telecommunications Mag...

and Sept, 2007...
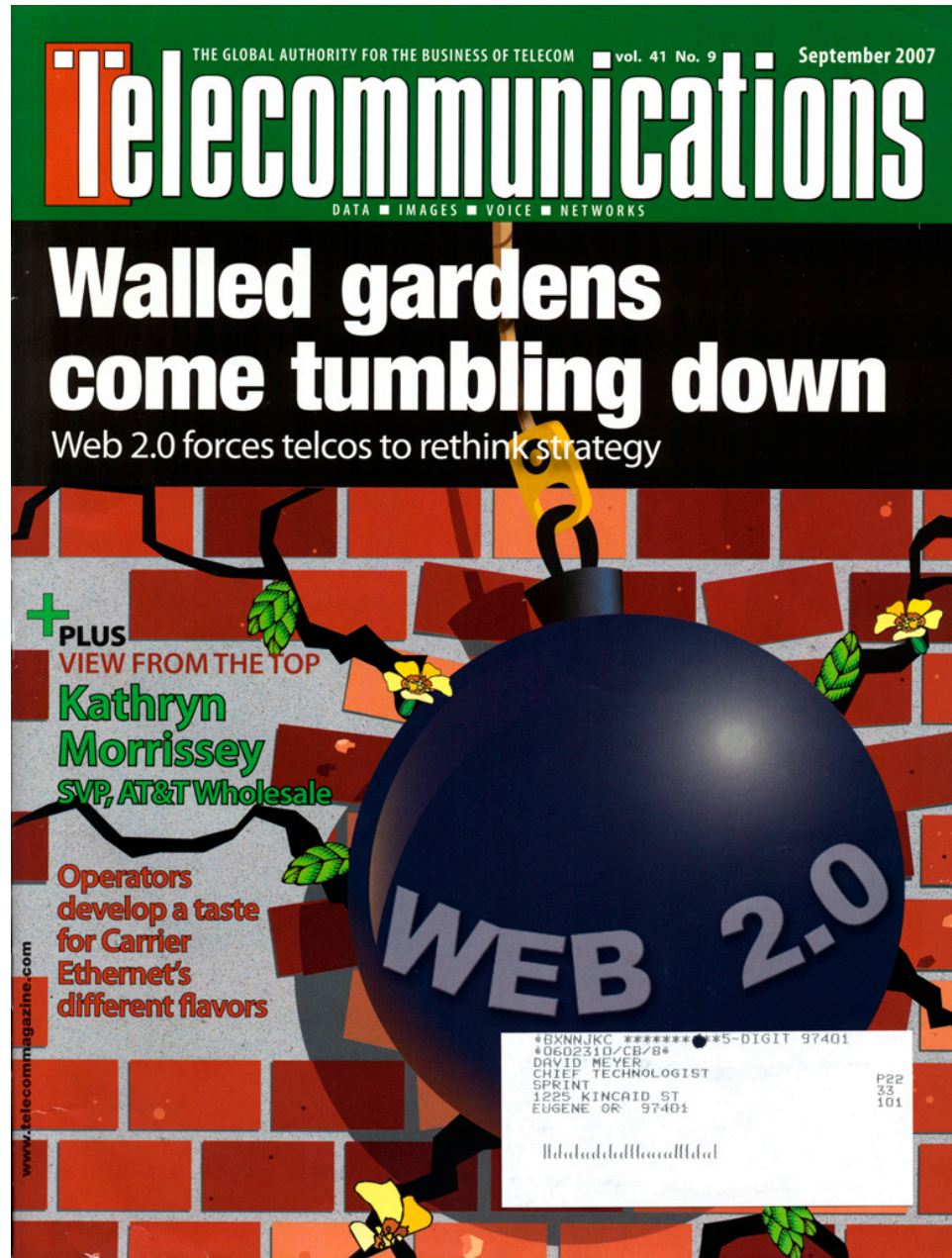
But There's A Catch...

- *All of this analysis breaks down at the resource saturation point*

  - e.g., you've max'ed out your fiber, FIB, ...

  - At that point you're looking at non-linear cost

    - Fiber builds, fork-lift upgrades,....

- *So we need economic models that both preserves the IP architecture and provide sufficient ROI to sustain the industry*

- And lest you think the b/w thing isn't real...

MINTS - Minnesota Internet Traffic Studies - Mozilla Firefox

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Current (mid-2007) annual Internet traffic growth rates	
U.S.	50-60%
World	50-60%

Year-end 2006 monthly Internet traffic estimate	
U.S.	450-800 PB (PetaByte = 10^{15} bytes)
World	2000-3000 PB (PetaByte = 10^{15} bytes)

Year-end 2006 estimates for monthly Internet traffic (GB per capita)	
Australia	0.7
Western Europe	1.5
Japan	2.0
U.S.	2.0
Hong Kong	13.5
South Korea	12.0

Estimates for Australia and Hong Kong are based on official government statistics, while that of Japan is derived from cooperative ISP data collection in that country. In all cases, extrapolations were made to provide estimates for year-end 2006. Figures for other countries are based on various snippets of information, including confidential reports by some service providers.

Done

So OK, that's all fine, but what's an ISP to do?

- Be realistic about the complexity-opex tradeoffs

    - "Be Rational" -- Vijay Gill

    - We need better tools here, as we have little or no analytic capability in this space

- Keep in mind that the governmental intervention and/or regulation is the "trump card" here

- Work with the vendors, standards orgs, and the open source community to build protocols and platforms that have the needed properties

What Should Vendors Be Doing?

- First...listen to the SPs

- But the problem remains thorny as vendors (like everyone) want to maintain margins

  - Even *if* the perfect storm scenario materializes, vendors *will* able to preserve advantageous margin structures for *some* customers

- However, if what evolves is the need for low margin interfaces, then vendors may need to *hedge* against their margin strategies

  - Perhaps by simplifying things and riding the ethernet cost/performance curve

  - BTW, could there be such a thing as a "disposable network"?

So Where To From Here?

- All of this is just the scenario in which the e2e Internet that we all know and love continues to grow and thrive

  - Contrast with the "value-added-transport" position

  - And noting that *everything is Over-the-Top* on the Internet

- Continued understanding of our evolving needs

  - What is the effect of new bandwidth drivers like video?

  - or having access speeds approach core speeds?

  - or 2M to the handset

  - or migration of TDM to packet

  - ....

A Few Final Thoughts

- There is a clear need for education in our *community* at large about these issues

  - Where *community* includes SPs, enterprise operators, content providers, researchers, vendors, users of all kinds, regulators, ...

- We need to encourage (i.e., fund) multidisciplinary research in this area

  - Theory, data, and practice are all slim

Finally...

- A bad outcome (tm) would be to find ourselves in a situation in which

  - Service Providers can't be profitable enough to continue bandwidth upgrade cycles

  - Service Providers then attempt to choke off innovation for (perceived) self-preservation

    - via legislative/regulatory action, and/or by technical means

- Obviously, we *all* want to avoid this outcome

Questions/Comments?

Thanks!