# Big-think strategies
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# Costings and open network issues in relation to FttH deployments

## This project has been lead and coordinated by Dr. Carl Gazia Managing Director Ambrose Dean

### An informal report by an informal group of international telecoms experts for Susan Crawford from the Obama FCC Transition Team

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December 2008
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# Purpose & Introduction

This brief document gives a high-level view of the costs and technological issues associated with ubiquitous or near-ubiquitous FttH deployment based on some non-US examples in order to address questions posed:

> *Could you gather your strongest FttH case studies, with*
> (1) *figures about how much it has cost per household*

*We also have included some examples in relation to the question*
> (2) *detailed descriptions of how other countries have dealt with encouraging open access FttH networks, to the extent they have.*

The key barriers to ubiquitous fiber deployment, either in the US or elsewhere, are not technical as the technology elements and constructions techniques are well established. The key barrier to ubiquitous fiber deployment in the US and elsewhere arises from the legacy 'business model' or 'public policy model' applied to providing connectivity.

It is commonplace to note that there are large positive externalities to ubiquitous broadband connectivity. It is less common to recognize what that means: the benefits to the economy as a whole, and society as a whole, of having such connectivity far exceed the portion of the benefits that can be monetized by whichever entity -- public or private -- actually builds the fiber and connects people to it. The 'fee for service' model begins to break down here, because the people paying the fees realize only a fraction of the benefits, and are understandably only willing to pay for the fraction they themselves receive. Bottom-line-oriented network providers -- again, public or private -- recognize this, and, because they do, are unwilling to make the sustained investments over time necessary to provide the full benefits of ubiquitous connectivity in the first place, for the simple reason that they cannot charge enough to recover their investments.

There probably was a time, when the basic unit of connectivity was a twisted pair of copper, and when essentially the only thing the copper was used for was voice calls, that the fee-for-service model made sense -- even though in those days there were massive cross-subsidies, from business to residence customers, from long distance to local customers, and from urban to rural areas, in order to promote 'universal service.' There was also probably a time when it made sense for many or most roads to be privately owned and managed as toll roads. Eventually, however, modern industrial societies migrated to a public policy model in which roads were publicly provided and open to all -- even though the actual construction of the roads is often handled by private contractors. We suspect that as we begin to recognize our shared need for ubiquitous, FttH broadband connectivity we will also increasingly recognize that the business and public policy model for providing the physical media for such connectivity may look more like what we use for roads, and less like what we use for railroads.

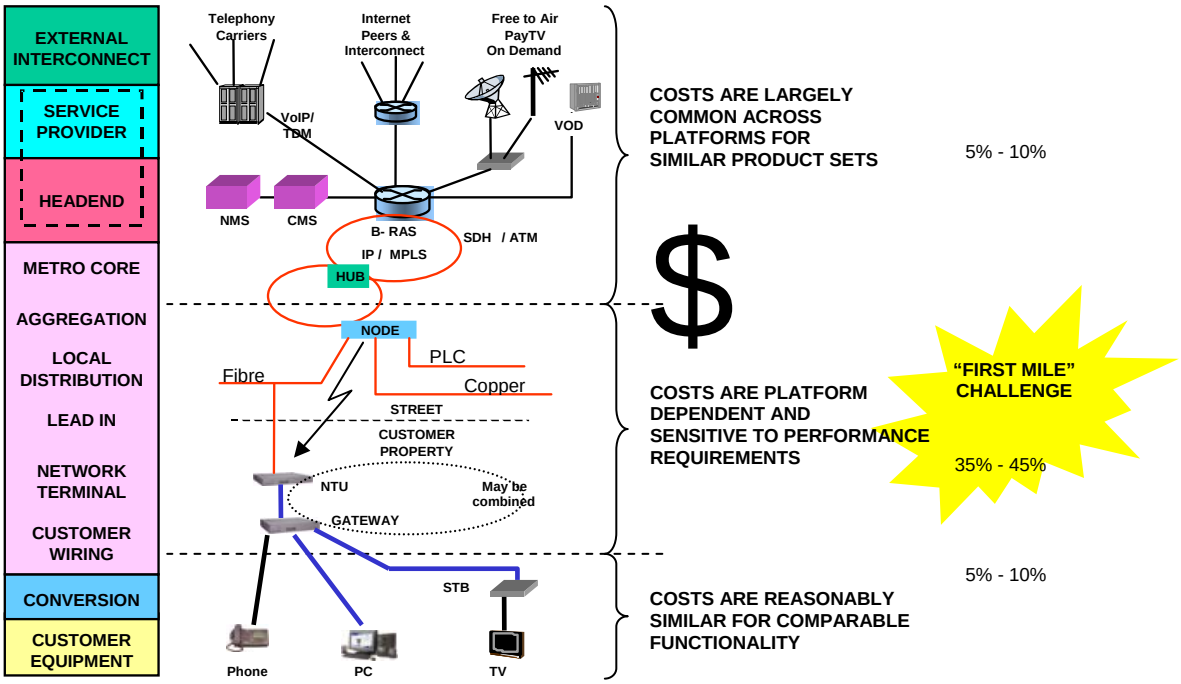
In addressing the question of fiber costs we have avoided any in depth discussion of alternatives such as broadband wireless.

# Framework

The discussion focuses on the high capacity "access" network (where multiple technology solutions are possible), recognising that there are costs which are relatively similar:

- Upstream – for content aggregation and interconnection;
- Downstream – for content delivery and presentation in the customer premises; and
- Common – for network management and operations, and similar functions which will arise independent of delivery platform.

A schematic of the overall break up of likely costs is shown in the Figure below.
Note that costs relate to the access network technology and do not take account of a number of essential components including backhaul, systems support and content related costs. Access technology costs thus are portion of total required expenditure.




Legend: PLC – Powerline carrier (or BPL – Broadband Power Line) where high capacity signals are carried over the electric power distribution system
Copper – the telephony "Local Loop" supporting DSL technologies
Fiber – FttH which may encompass a variety of platforms including Point to Point or one of the various PON (Passive Optical Network) solutions

Other alternatives (not shown) could include:
- wireless broadband (such as WiMAX) or
- Hybrid Fiber Coax (HFC) distribution as typically utilised for Cable TV

# Exclusions

The discussions on network costs in this brief paper excludes:

1. Upstream costs related to
    a. Content acquisition and management and wide area networking
    b. "Backhaul" costs for transmission of content to and from the local area (say 10,000 premises) to an aggregation point where content acquisition and interconnection occurs
    c. We estimate that these costs represent perhaps 35% to 55% of total costs of an FttH system.
2. In-premises costs related to content presentation. This can range from a simple telephone to high end entertainment unit with personal video recorder and similar functionality, audio and television appliances, and a variety of computing devices.

# Typical Costs

For purposes of discussion costs will be estimated on the assumption of a study area of 10,000 premises. This could be the equivalent of a telephony central office, but equally may represent:

- A suburban environment
- A township
- Medium density development
- High density – such as 50 apartments buildings each with 200 premises

The major contributors to costs of the FttH broadband access network will be:

a. Civil works to accommodate the fiber cable. This can vary widely, from relatively inexpensive aerial distribution on existing poles (such as typically found for US Cable TV systems) to high cost underground pipes installed specifically for fiber accommodation. New pipework can be particularly expensive, particularly in hard ground or congested urban environments.

   As an indication only of potential costs, the variation may be from say $50 per premises to perhaps $5,000[1]. Clearly there is a very strong incentive for prospective network installers to find low cost solutions to accommodate intended fiber deployments. Some innovative approaches have utilised abandoned gas mains, stormwater or sewage pipes to avoid new construction, while aerial deployments continue to be economically attractive (where environmental and planning regulations accommodate this).

b. The cost of high capacity fiber cable has dropped significantly in the past few decades, and this cost component tends not to dominate intended deployments. The associated need for fiber splicing can make a significant impact on network

[1] A recent paper (Slater D and Wu T: "Homes with Tails" Nov 2008) refers to a San Francisco study which established an eight fold increase in cost for underground versus aerial deployment.

costs, though in recent times development of pre-terminated and connectorised cable systems has seen this cost component become contained.

Housing density (i.e., the number of premises per square mile) is a key factor in this element of the network as it determines the number of route miles of fiber required. However, the relatively low cost of cable means that the overall costs is more influenced by the impact of splicing and provision of the Passive Optical Splitters required to support PON distribution platforms, and the provision of a pre-terminated connector or subsequent splice for the customer connection.

Overall, allowing for density variations the expected cost of this component of the platform may be in the range of US $100 to $200.

c. Access network electronics will contribute significant cost to the FttH platform, though it can be noted that there has been a very steep decline in the cost of devices for PON platforms following technical standardisation in recent years.

   Assuming that a PON is deployed (allowing the costly upstream electronics to be shared by say 32 or 64 premises) an estimate for costs is say $20 per premises for the upstream electronics and perhaps $100 for the customer drop electronics. Some allowance needs to be made for accommodation and facilities at the upstream end (e.g., shelter, climate control and power requirements). Similarly, there needs to be recognition that cost variations can occur at the customer end if provision has to be made for external housing, battery back up (for service continuity in the event of mains power failure) and the cost of the fiber connection between the street and the premises.

   In summary, the electronics component may be expected to incur costs from say $200 to $250.

## Summary of Major Cost Elements

Costs will ultimately depend on the particularities of the deployment scenario, and may be highly variable. As a guide the above would indicate the major components to be:

| | | |
|---|---|---|
| a. | Civil works at say | $100 (though his could be much higher) |
| b. | Fiber with associated splicing and splitters | $150 (subject to housing density) |
| c. | PON electronics and customer drop | $250 |

No allowance has been made in the above for costs which are common to various platforms but can vary across operators and deployment scenarios:

- Content acquisition and management
- Network management and business systems support
- Backhaul from local area and Long distance transmission if required

Reference is made to total cost per home from reported studies in the sections below.

## Impact of Penetration Level

The penetration level (or take up rate) indicates the number of premises with access to the FttH network that acquire a connection. This parameter can have a major impact on the effective cost per premises connected, as very large components of the overall cost are relatively independent of the percentage of services supported. Thus, civil works (such as expensive pipework) and the majority of fiber cable infrastructure will incur a cost whether or not premises passed by the network actually connect[2].

## Recent Studies and References

International comparisons have been undertaken in some recent studies. A comprehensive review undertaken for the European Competitive Telecommunication Association (ECTA)[3] indicates variations for FttH PON platforms from country to country:

**Investment per home connected (in Euro), market share 50%, urban cluster, stand alone first mover ****

| Network Type | Country [in €] | | | | | |
|---|---|---|---|---|---|---|
| | DE | FR | SE | PT | ES | IT |
| VDSL | 457 | n.v. | 352 | 218 | 254 | 433 |
| PON | 2,039 | 1,580 | 1,238 | 1,411 | 1,771 | 1,110 |
| P2P | 2,111 (54%) | 2,025 | 1,333 | 1,548 | 1,882 | 1,160 |

** Based on the investment of the urban cluster and a market share of 50%. If other marekt shares are used, it is mentiond in brackets.

"Economics of Next Generation Access" *op. cit.* p XVI

US data reported by Slater and Wu[4] indicates total costs and variability reported by a large network operator:

> Verizon's average cost per-customer is around $3000-4000 assuming a 40 percent take-up rate. At 20 percent, the cost is closer to $7000. Verizon is focusing mainly on dense metropolitan and suburban areas, with a mixture of aerial and buried fiber, and in close proximity to businesses. Less dense suburban and rural areas would be significantly more expensive.

We expect that these reported costs would include allowances for items excluded from our hogh level estimates ( that is, content acquisition, systems etc).

[2] The Salter & Wu paper referred to earlier records Verizon estimates for cost per customer doubling when penetration levels drop by 50%

[3] Elixmann D, Ilic D, Neumann K-H, and Plückebaum T: "The Economics of Next Generation Access - Final Report", Sept 2008

[4] Slater & Wu: "Homes with Tails" *op. cit.* P 8

## *Case Study - Sweden*

In 2000 Västerås was the first municipality in Sweden to form its own commercial company (Mälarenergi Stadsnät) to build and operate an open urban network. Mälarenergi Stadsnät, with 22,000 households, 13,000 apartments and 1,700 companies connected, allows consumers to decide which services they want. Mälarenergi Stadsnät's business model is based on a system whereby the network owner and the service providers share revenue generated by the urban network, with up to 20 service providers offering their services direct to the users instead of running their own broadband connections to the customers they want. The service providers pay for gaining access to customers who are already connected to the network. Users hook up to the system and then buy the services they themselves want direct from the relevant providers. The urban network offers more than 50 services including alarms, surveillance, support and operation, training, as well as Internet-based services such as VoIP, IPTV and VoD. About 70% of all network communication is local and does not go via the Internet.

The Västerås urban network guarantees data speeds of 10Mb/s while the network itself has a transfer capacity of between 100Mb/s and 1Gb/s. Since 2003 Mälarenergi has incorporated PacketFront's ASR 4000 broadband routers and BECS control and provisioning systems. Mälarenergi will eventually replace its existing equipment so as to operate a single system in its network regardless of access technology (Fiber, cat 5, VDSL or ADSL).

There are a number of incentives for home owner involvement in the Fiber project. Banks which provide low-cost financing and have the security of the home for the loan, while home owners can reduce infrastructure cost by up to €500 in tax deductions. Mälarenergi starts building when 60% of targeted homes sign up. Fibered homes can reportedly increase in value by up to €5,000. Over ten years, the cost of FttH including initial build is cheaper than the equivalent ADSL service.

## *Case Study - Netherlands*

During the last few years The Netherlands' comprehensive DSL and cable networks have been supplemented with wide-scale fibre deployment. Much of this infrastructure has been based on proven municipal involvement as towns and regions endeavour to safeguard their 'fast broadband' credentials and thus secure and retain an edge in the competitive market for jobs and skilled labour.

By mid-2008 fibre accounted for about 2% of all broadband connections and by 2012 about 10% of all households are expected to be connected. Given the pace of KPN's fibre roll-out, fibre penetration could reach 90-95% by 2020-2025.

Most activity is currently in Amsterdam (the Citynet project, nearing completion), Deventer, Almere, and Eindhoven. The recent decision by KPN/Reggefiber to invest €6-7 billion in a national FttH network within the next few years with further consolidate this lead. The country will become the regional benchmark against which other European operators and regulators will be assessed.

KPN/Reggefiber has also recently proposed offering wholesale fibre for between €12 and €17.50 per month. The price difference depends on the area type and CAPEX - higher monthly fees compensate for increased build costs.

Costs submitted by KPN/Reggefiber to the Dutch regulator were reported in five bands, with an overall range of €775 to €1025 per premises, assuming 100% coverage. Note that these figures refer only to the fiber component from the Central office (or equivalent) to the premises, and thus do not include backhaul, content related investments and systems for upstream and customer activities.

## Conclusions

As we have stated upfront, the big questions will relate to the business models (and hence regulatory approach) to create an attractive investment environment.

Similarly the details of deployment location will be critical to establish the major unknown costs - ie civil cists (low cost aerial deployments vs. very expensive new conduits in brownfield deployments and easier models in Greenfield deployments.)

Government involvement in FttH infrastructure should be based on the social and economic benefits that the country derives from it. None of the serious issues such as spiralling healthcare costs, increased educations costs, environmental and climate change issues can be solved by FttH. However, none of these issues can be properly addressed without a national FttH infrastructure.

The international experts group concludes that only true utilities based costing models for FttH can be developed based on infrastructure that is structurally separated from any other services provided over that network. As such this becomes an infrastructure construction activity and not a telecoms issue in such models we have seen underground infrastructure prices coming down to around $1000 per home connected, aerial deployments have come down in some situations to around $350.

Increasingly we also see the arrival of home owner models, this greatly reduces the costs to the infrastructure builder, some municipalities in the US and Sweden as well as deployments in Norway and the Netherlands are currently experimenting with these models.

Regulatory models are pointing to a monthly access charge for dark fibre deployment in the vicinity of $10 to $15, this should be the benchmark for future regulatory.

Participants in this study have indicated to be prepared to answer further specific questions and or provide more details on certain elements.

## Other reports

Backgrounds reports some of the ones that have been provided in the past include:

## *FttH Costs*

- Global - Broadband - FttH Overview & Statistics
- Global - Broadband - Regulating Fibre Access
- Asia - Broadband - Fibre to the Home (FttH)
- Europe - Infrastructure - FttH & NGNs
- Netherlands - Fibre-to-the-home Developments
- Sweden - Broadband Market - Overview, Statistics & Forecasts
- United Kingdom - Broadband - Fixed Network Overview, Statistics & Forecasts
- France - Broadband Market - Fibre and wireless services
- Australia - National Broadband Plan - Analysis late 2008
- Australia - National Broadband Plans from Telstra, Terria & others
- New Zealand - FttH Planning
- Japan - Infrastructure - FttH, NGNs & IP
- South Korea - Infrastructure - FttH, NGNs & IP
- China - Infrastructure - FttH and NGNs
- Canada - Infrastructure - FttH, NGNs & IP
- USA - Broadband Market - Fibre to the Home (FttH) Overview, Statistics & Forecasts
- Global - Investing in the Communications Revolution