RTT TECHNOLOGY TOPIC
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Fixed Wireless- Going Upwards Slowly?

In last month's Technology topic we discussed the economics of 5G and satellite beam forming for mobile and fixed access connectivity. This month we look at the delivery economics of terrestrial and satellite networks for consumer fixed access broadband.

The relative economics of broadband delivery are determined by the length of time over which the investment is amortised and the efficiencies and running costs of a guided media connection (fibre or cable or copper) compared to an unguided media connection (wireless).

Once installed, guided media will almost always yield higher data rates than wireless and more consistent throughput. For new installations, fibre is now lower cost than copper and more reliable (roughly half the fault rate of copper).

Theoretically the performance gap between guided and unguided (wireless) media can be bridged by implementing a narrow beam wireless connection, for example using a dish at each end of the link or configuring a flat panel antenna to deliver a sufficiently narrow beam. However wireless options will need to take into account rain fading on longer links, line of site loss and scattering and surface absorption loss. Rain fade is a particular issue for satellite; lines of site loss, scattering and surface absorption are particular issues for terrestrial.

A wireline connection although initially expensive to deploy, has a life expectation of thirty to fifty years with the potential for continuous upgrading. ADSL in the copper network, DOCSIS in cable (gigabit rates for DOCSIS 3.1, multi gigabit rates for DOCSIS 4.0) and coherent modulation in fibre are all contemporary examples which have yielded incremental gains in throughput and lower cost per bit.

For any wireless connection, it is relatively easy to weather proof base station hardware but harder to protect dishes and flat panel arrays from rain wind and extreme heat and cold. This means that through life operational costs may be higher than expected. It is unusual to find radio hardware that is over twenty years old, at least in the cellular industry. Our November technology topic referenced the two Voyager spacecraft as example of space radio systems still operational after nearly fifty years but this is an exception rather than a general rule.

Initial costs may also be higher than expected, particularly if consumer premises equipment needs to be installed. The cost of a VSAT terminal for instance in the satellite industry is reasonably easily amortised against a business broadband service offer but harder to amortise for a consumer broadband subscriber.

Together with lower than expected revenues, this at least partially explains why over the past thirty years a number of terrestrial fixed wireless networks have been deployed but have never achieved national, regional or global scale and why satellite networks to date have made a minimal impact on the consumer fixed broadband market (other than TV).

There is an assumption that 5G can deliver higher value per bit and lower cost per bit than legacy networks on the basis of delivering capacity gain from additional spectrum and capacity and range gain from ‘micro sectoring’.

5G can be regarded as being closely evolved from 4G and therefore can benefit from the scale economies that have made LTE a global success. LTE is however not widely used for fixed wireless partly due to limited capacity. This means that it is more economic to service mobile users where the value per bit is higher than the value per bit realisable from fixed subscribers or put another way, servicing fixed users imposes an opportunity cost.

The decision by AT&T and Verizon to introduce 5G initially as a fixed wireless service would appear to suggest that this economic rule no longer applies and that fixed wireless, specifically broadband fixed wireless, can be promoted as an economic alternative to fibre, cable and copper. This would mean that the terrestrial fixed wireless market would grow rapidly albeit from a modest starting point.

In 2019 the US Federal Communications Commission (FCC) concluded the country’s second auction of high band *‘5G-suitable’* frequencies yielding $2.02 billion from the 24 GHz band adding to the $700 million realised from the earlier 28 GHz auction so the assumption might be that these bands would be considered as the preferred option for both fixed and mobile broadband connectivity.

The counter argument is that the capex and opex costs associated with the site density needed for FR2 may slow the rate at which these millimetre bands are deployed in the US and other Rest of the World markets and may mean that terrestrial fixed wireless in these upper bands including the millimetre bands may be less successful than industry analysts presently assume. FR 1 spectrum has the benefit of better range but capacity limitations suggest that the opportunity costs of servicing fixed users will outweigh potential ROI benefits. Serving fixed users from space may have similar limitations though may have a longer term potential for changing the overall delivery economics of the fixed wireless sector both for established markets and the developing world but for both satellite and terrestrial, the following caveats apply

Lower value per bit - there are no convincing indications that fixed subscribers will deliver higher value than mobile and almost certainly will yield a lower return when measured on a value per bit basis. Thus, even if mobile market scale economies are applied to fixed access markets, it will generally be more profitable to service mobile users.

Higher cost per bit relative to copper, cable and fibre – the potential for increasing data rates through existing fibre, cable and copper is often underestimated- higher level modulation and improved coding have transformed the delivery economics of cable and copper and fibre throughput continues to improve. Higher throughput also improves the economic case for new fibre deployment.

Regulatory intervention to subsidize fibre roll out – in many markets the roll out of fibre including rural access fibre is seen as a national strategic investment.

User expectations are increasing faster than fixed wireless delivery capability. A simple example is TV where screen sizes are increasing year on year from 22 inch screens a few years ago to 65 inch screens which in turn implies a transition from SDTV to super high definition TV which increases a 2.5 Mbps data rate to 72 Mbps.(See our August 2019 Technology Topic 5GTV). These increases in data rate are relatively easily absorbed by fibre and even cable and copper still have room for higher data rates. They are problematic for terrestrial fixed wireless and can only realistically be supported by adding dishes to both ends of the link which would be generally uneconomic.

GSO satellites have serviced the TV market successfully for many years and could scale the existing 12 GHz service offer to 18 GHz or above to support all or any of these TV subscribers. It is however challenging to meet interactive expectations and most market indications point towards more TV over fibre and less over satellite over the longer term.

Additional costs – installation costs have undermined almost all existing terrestrial fixed wireless business models. Twenty years ago, the Ionica network in the UK (fixed wireless at 3.5 GHz) had a business model predicated on between 2 and 3 installations a day. The actual rate was at best two and usually one a day with a high number of quality issues that needed to be resolved post installation. The Ionica network was also based on ISDN (144 kbps) which by the mid/late 1990's was comfortably overhauled by copper ADSL.

Cost per bit and value per bit trends over time –future fibre upgrades will potentially deliver **a faster reduction in per bit cost** than band limited/power limited wireless.

Investment sentiment – the appetite for longer term returns ebbs and flows but fibre investment yields dependable dividend returns within 8 to ten years and once fully amortized can deliver sustained profitable income.

User expectations - the rate at which user expectations are increasing (see TV example above) dictates the **value per bit** and it can be observed this seems **likely to increase at a slower rate than the cost per bit** over time.

Whatever the absolute economics, the rate of roll out is determined by the **relative** economics of fixed wireless broadband and mobile broadband (or enhanced mobile broadband in 5G terminology).

The regulatory expectation is that rural broadband access should match urban access data rates and pricing. Data expectations increase over time and include those proud owners of 65 inch televisions installed in their country homes coupled to a state of the art interactive games room. Monthly data consumption is already ten times average mobile consumption in many markets, 250 g/bytes is not untypical, and the ratio may increase over time given that few people will be carrying a 65 inch or larger screen around with them.

Serving these users from existing mobile masts or present and future satellite systems therefore occupies bandwidth which could realise higher value per bit from mobile subscribers including ESIMS (Earth Stations in Motion) in the satellite sector. The same caveat applies in urban areas where millimetric fixed wireless solutions are being promoted.

There are other fixed wireless markets other than broadband for example narrow band connectivity for applications such as agrarian IOT which can be served economically from satellite or terrestrial wireless so the relative economics depend on how fixed wireless is defined.

If defined as users who are stationary and including low bit rate connectivity then it is possible to produce a number which is a significant percentage of overall subscriber numbers with an expectation of growth equal to or possibly marginally faster than overall subscriber growth though even this market may be more efficiently serviced via Wi-Fi or for wide area, more specialist radio systems.

If defined as an alternative to fibre, then it is hard to avoid the conclusion that cellular operators will fail to make an adequate financial return on fixed wireless investment. The service offer may be maintained for regulatory reasons but will not be aggressively marketed. AT&T and Verizon both publicly state that fixed wireless is a stepping stone to mobile 5G. Operators with proprietary fixed wireless solutions will have an even harder struggle and do not have mobile users as a fall back.

Summary

There have been at least three generations of cellular radio based fixed wireless service offers none of which have been sufficiently profitable or successfully enough to scale globally.

AT&T and Verizon's apparent enthusiasm to deploy should be treated with caution partly because it is a convenient way of temporarily managing regulatory exhortations to provide rural access broadband at competitive prices. In reality there are substantial associated capex and opex costs that are irreducible, compounded by user expectations that move faster than the wireless technology deployed.

While it is possible to deploy dedicated beams to cover individual fixed wireless subscribers on line of sight links it will generally not be possible to support non line of sight particularly in any of the FR2 bands. This incurs repeater and or relay costs.

Any marginality on the link budget will mean that an external antenna will be needed at the subscriber's house. This incurs initial installation cost and ongoing support costs. The satellite TV industry and terrestrial TV industry have years of experience in home dish and antenna installation but these are systems optimized for one way delivery.

Terrestrial millimetre wave has an economic deployment problem in most markets and in the short term C band is proving more than adequate as a basis for initial 5G roll out in most markets. There will therefore be minimal terrestrial operator appetite to aggressively deploy millimetre band hardware prior to saturation of C band which is probably going to take at least five years. C band has more than enough capacity for mobile users but could become saturated if fixed subscribers become a large part of the subscriber mix. This is potentially problematic if these subscribers cost more per bit and realise lower revenues per bit

The high count LEO constellations are well up on their launch schedules but the big challenges are down on the ground and are similar to 5G with low cost AESA Active Electronically Scanned Array (AESA) antenna availability being a particular issue.

GSO satellites will continue to provide an economic option for delivering TV particularly for subscribers in remote locations (or at sea) but for most other applications every mile of fibre deployment reduces the addressable market.

Whether GSO, MEO and LEO satellite operators can scale their business VSAT offer into the consumer broadband market therefore remains open to debate

The underlying assumption probably has to be that within twenty years fibre will be as ubiquitous as mains electricity and indeed at some stage it may become obvious that electricity and broadband provision should be delivered as a common utility which would further reduce costs.

Fixed wireless may move slowly upwards but fibre is the big way forward.

5G and Satellite Spectrum, Standards and Scale

Our latest book, **5G and Satellite Spectrum, Standards and Scale** is available from Artech House. You can order a copy on line using the code VAR25 to give you a 25% discount.

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