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Another Negroponte?

In the 1980's, Nicholas Negroponte observed that it was only due to an accident of engineering history that static devices such as domestic TV were serviced by radio waves whereas devices that were personal such as the telephone remained connected by cable.

Negroponte suggested that a transition would occur with TV connected by cable, copper and fibre and telephones connected via wireless networks. Popularized by George Gilder this became known as the Negroponte switch.

Like many predictions it was partly right.

In the 1980's mobile phones were still considered to be niche products used by business users but this was to change dramatically through the 1990's. A few of us still have fixed line telephones connected by a twisted pair but we are a vanishing minority.

But other parts of the prediction have taken longer to happen than might have been expected.

In many countries including the UK many people still watch terrestrial TV delivered at the lower end of the UHF band.

The number of terrestrial TV subscribers is reducing over time but it seems likely that terrestrial TV will be with us for at least the next ten years. The TV part of the Negroponte switch will have happened but taken nearly 40 years.

The slow rate of transition for TV services can be partly explained by slow broadband connections over cable and copper and the fact that fibre to the home remains far from universal even in urban areas. In many markets terrestrial TV remains the lowest cost option both for the subscriber and the broadcaster. It is hard to compete with eighty years of network amortisation.

The open question is whether another switch is beginning to happen from earth to space.

Delivering universal fibre access is expensive and it may just be possible that many existing and future services presently delivered over terrestrial guided media (cable, copper and fibre) could be delivered more efficiently from space.

Similarly the capex and opex costs of delivering universal demographic and geographic coverage from terrestrial wireless networks could be higher than delivering the same services from space.

This has already happened to an extent with the shift from terrestrial TV to satellite TV. Early C band (3.7-4.2 GHz) deployments remain widely used in Africa, Asia and Latin America, Ku-band (10-12 GHz) has been widely deployed throughout the developed world and Ka-band allocations (18-20 GHz) have been assigned for high definition and ultra-high definition broadcasting.

It could be argued that this transition has been driven by a shift in content ownership particularly sports rights but space economics have certainly helped. Companies such as Viasat are shifting the present essentially passive space based consumer content delivery model to active (higher value) internet access, in the longer term a more sustainable economic proposition.

The potential facilitators for this ongoing shift to space can be summarised as lower cost launch capabilities, lower cost space hardware, more RF power and more RF bandwidth. Flat panel active and passive arrays in particular can achieve significant link budget improvements.

Next generation Viasat geostationary satellites for example have a throughput of 1000 gbps.

Multiply this by the number of geostationary slots available (180 assuming two degree separation) and multiply this again assuming multiple satellites are co-located at each slot and you have combined GSO throughput of hundreds of terabits per second, a figure that even Arthur C Clarke would have found difficult to comprehend seventy years ago.

Colocation (where separate satellites seen from earth seem to be apparently at the same place) has been historically complex to manage. Multiple satellites have to be contained within a 150 kilometre box but separated by about 5 kilometres from other satellites in the group to avoid collision or mutual interference. This has to be achieved with a minimum use of fuel to avoid shortening the life of the satellites.

The alternative is to station keep using ion thrusters (electric propulsion) or to dock two or more satellites together, sometimes described as 'buddy sats'. Buddy sats have become more viable due to the progress being made in GSO robotic servicing.

Supplement the rapidly expanding power and RF bandwidth of geostationary satellites with the bandwidth and RF power available from new high count medium and low earth orbit satellite constellations and upgraded legacy LEO constellations (Iridium successfully launched another ten 'Next' constellation satellites on a Space X rocket last week) and you have a step function increase in capacity and functional capability.

But the Iridium Next constellation highlights that this is not just about consumer connectivity but a mixed model of military, civilian and consumer connectivity with communications as an important but by no means dominant part of the delivery offer.

Read on

This takes us back to March 23 1983 and an 'address to the nation' speech by President Ronald Reagan which came to be known as his 'Star Wars' speech (it coincided with Return of The Jedi, the third of the Star Wars films). The speech set out the rationale for an increase in defence spending on space based missile interception.

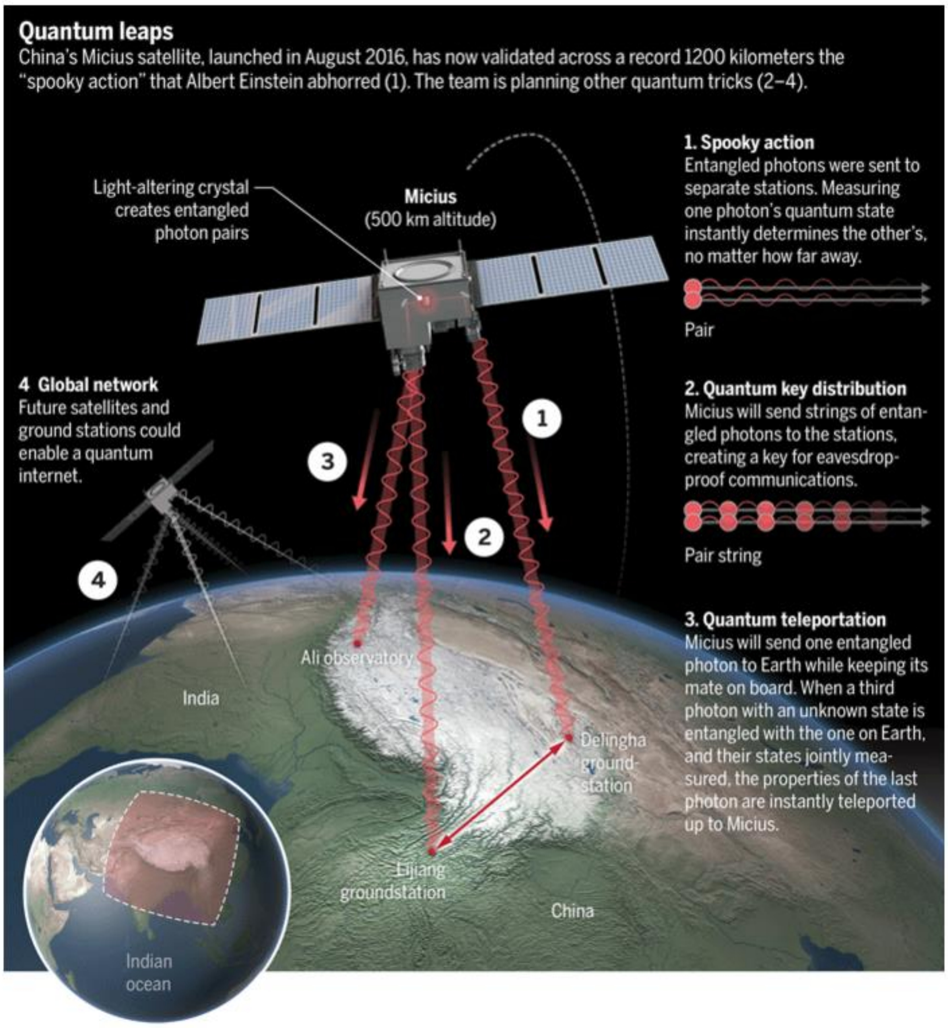
Realising systems that actually worked took longer than the President or Congress anticipated and cost a lot more but 35 years on space based weapon and defence systems are becoming progressively more cost effective and capable. The Boeing built X37B is one example of the advantage of an orbital rather than sub orbital platform – it would be hard to find a way of keeping an F35 in flight for two years, it is relatively easy in space.

It is also hard to take out space based defence systems and relatively easy to take out terrestrially based assets such as aircraft carriers. Even submarines are arguably now vulnerable to space based attack which make you wonder why we are investing so much money in new aircraft carriers and nuclear submarines.

The developing military and commercial importance of space was recognised In April 2016 when Congressman Jim Bridenstein, the Republican representative of Oklahoma's 1st Congressional District, sponsored the US Space Renaissance Act.

The act describes space as the ultimate high ground and argues the case for more intensive use by the military of civilian satellite systems both for imaging and reconnaissance, attack detection and space based interception.

Space is also considered as crucial to future cyber security though China rather than the US has being making most of the recent headlines with its successful distribution of quantum cryptographic keys from the Micius low earth orbit satellite achieving a distance of 1200 kilometres, ten times the distance achieved to date over terrestrial fibre.



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New capabilities are also being introduced into Earth Exploration (EES) Satellites at 26 GHz. Over 150 of these satellites have been launched in the last ten years with more than 350 planned by 2025. These satellites collect terabytes of imaging and atmospheric data which needs to be beamed back to earth in bands which the 5G community would like to use.

Last but not least, new GNSS constellations are being launched. Japan's Michibiki 2 satellite (Michibiki means guidance in Japanese) is now operational and is the second of four satellites in a quasi-zenith constellation with three satellites in inclined geosynchronous orbits and one in geostationary orbit.

This produces a figure-eight ground track over Japan with one spacecraft always within 30 degrees of zenith. The constellation will be operational in 2018 with another three satellites being added by 2024 and will broadcast the GPS compatible L1C/A, L1C, L1S, L2C, L5, L5S and LS6 signals. The 4000 kilogram satellites have a design life of 15 years at the end of which they will each still be producing over 6 kilowatts of power. The end result is centimetre accurate positioning (needed for construction and earth quake detection) and enhanced coverage for automotive and intelligent transport systems.

Hitachi Automotive Systems, the Denso Corporation and Japan Radio Company have set up a new joint venture called the Global Positioning Augmentation Service to develop these markets.

All of which highlights that some things can only be done from space, some things can be done better from space and some things can be done at lower cost from space.

It would seem ridiculous to suggest that satellite networks could take over from terrestrial networks. Talking to a base station fifty metres away must be more efficient than talking to a satellite hundreds or thousands of kilometres away but the cost differential may be reducing over time and it depends how you calculate efficiency and added value.

Dense terrestrials networks are not intrinsically power efficient and incur expensive site and backhaul operational costs. Moving to the centimetre and millimetre wavelengths increases the amount of RF bandwidth available but much of the available RF power will be lost in surface scatter.

By comparison satellite networks can scale from VHF to E band and from 2 kilometre radius cells to 1200 kilometre radius cells. The nearly always nearly overhead line of sight coverage available from high satellite count LEO and MEO constellations or mixed orbit constellations will minimize surface scatter. There is no rent to pay in space and a limitless supply of free electricity.

So it is feasible that there is a cross over point where many mobile and fixed services presently serviced from terrestrial wireless and wireline (fibre, cable and copper) networks could be serviced more efficiently and at lower cost from space. Integration with other space based services such as GNSS will also potentially be more efficient and effective.

Through the 1980's financial analysts consistently underestimated the growth and margin potential of the cellular industry. It is possible that the growth and margin potential of the satellite industry today is being similarly underestimated. Another Negroponte may be closer than we realize - although of course it might take 40 years.

Ends

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