Telzed

Understanding telecom technology and the real transformational changes

Insights for decision makers and investors

March 2021

File reference: Telecom_transformational_technology_09032021.docx

Details: A discusson paper

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Ver 09032021 Initial version

1 Technical changes impact the telecom business and customers in radical ways

1.1 Background

Telecoms is a rapidly changing industry – as shown by the traffic growth of 25-50% per year. This is not a new phenomenon and such growth has been seen for over 30 years. Fixed networks have grown in almost every region and the technology and services have changed over time. In parallel, radical changes have also seen the growth of mobile traffic and coverage, so that even emerging economies have significant services for all but the least economical customers and regions[1]. We now accept the ability to communicate both easily and cheaply (and with huge volumes) as a normal part of life. If broadband or a mobile signal is not working perfectly it is now often deemed not acceptable, yet such coverage and speeds are vastly better that say just 10 years ago. "Expectations always rise to exceed the available service" which effectively devalues the real benefits of the current services and how they have improved.

This has meant that changes are often dismissed. The growth is accepted as normal. It has meant that network capacities have had to grow by c10x every c8 years. This huge target has been met, in most cases, with little financial change to the consumer. Monthly spends on telecoms have remained roughly constant, but with the benefit of 10x more traffic (calls, messages, data, videos, banking, educational-classes etc.). The traffic has also been delivered at vastly higher speeds, so that more traffic is not degraded by long response delays. Reliability and coverage of the services has expanded. Customers may *feel that* it is never good enough, but the services are surely far better and cheaper per call or Gbyte.

Arguably telecoms has transformed the lives of most people. We now work in different ways and can "access the world" through the Internet. Home working and shared data or applications are now normal. The boost from Covid has speeded the already existing trends and technologies. It was just a few years since everyone suffered tedious waits for unreliable downloads. This still happens but usually just for a minority or for brief periods.

Underlying the changes in work and leisure are some profound and complicated technical and economic changes. Strategic thinking and financial plans have to be supported by real developments. So the underlying technical/economic complexity needs to be understood, as if any one part of the networks fails to expand, and in the right way, then none of the 5G and other "life changing use cases" cannot happen. The whole Internet and thus the global economy relies on the underlying telecoms layers and their technical developments. Yet many may not understand what these are and how they have affected the industry's development.

[1] The under-served areas and population is still a huge issue to be resolved. See ITU for example and other efforts to get low-cost services in (say) sub-Sahara countries. Even developed countries often have rural areas and low-income households without adequate affordable service. Technical developments help, but much more needs to be done

Most areas of telecoms have developed rapidly (mobile, fixed lines, voice, broadband, business services, Internet etc). But how did they combine to deliver such capacity increases without costing the end user vastly more, despite the huge increase in traffic? 5G is currently a main conversation topic in telecom circles, but has this caused a radical change to most end users, or is this "just yet more capacity and faster services?" What are the key technical changes that have enabled the world today? If we assume 40% growth per annum is not radical but normal, then what is a radical change and why?

This paper focusses on one relatively unsung technical change. This is of significance to fixed and mobile. Arguably this is more significant than 5G[2]! Digging and fibre cabling has been a Cinderella subject, but the changes are now becoming hugely relevant to all plans and it will significantly change the economic structures telcos. It is certainly at the root of current/recent radical changes in telecoms investment. Leaders, regulators and investors need to rethink how they assess the industry going forward.

Infrastructure's importance is discussed. This is done within an overview of some key components of the telecoms industry, to provide a contextual understanding of the history and trends. Understanding is a vital start for sound decision making.

1.2 Messages from this report

This report shows how telecoms has a number of technologies and services that interlink to deliver the end services to customers. A layered approach is useful to understand how lower-level infrastructure feeds into network services and these feed into other telcos and higher-level services. Even the end service or application (possibly on the Internet) can then be reused as an input to other services. The layered supply approach is helpful to understand what is an *end-user application*, and what is a *telecom service* that allows that application to work. This matters as benefits from *using* 5G-conveyed or broadband-based healthcare is not a telecom $ benefit that an operator can use to build the network. The two seem to be combined in some discussions. Some even promote the idea that telcos should provide the end application services, as well as telco conveyance. They are in different markets and the dangers of a telco moving into content or applications, should be self-evident. The layered view is long established but helps clarify the supply chain.

This report provides the following additional messages:

- As capacities and speeds have increased so much, one can argue that all aspects have been creating transformational change. However we accept such change as the "new normal" so rapid change is not transformational in itself, even if it could cause transformations in say education or video

[2] Yes, this is mildly provocative, but easily justifiable. E.g. Mobile carries typically only c3-15% of all traffic in developed countries, so fixed lines are the real platform for the economy. Users access applications on the Internet and if accessed on 4G, or 5G or on Wifi , it matters little. There are few services that are billable by the telco and those that exist like IoT are probably not going to transform the telco bottom line to enable masts in every street corner to give extreme reliable services. There is little revenue to pay for them. See many papers including those on Telzed such as the Vodafone analysis paper. Some countries have ~80% of traffic on mobile (no doubt moving to 4G or 5G), but these are normally emerging economies with low Gbyte/month per capita (see Telzed papers or Cisco *et al* data)

- The changes have benefited almost everyone hugely yet monthly spends on telecom remain roughly constant and telco revenues have remained roughly constant. The network investments have not increased prices as new equipment works faster and better at lower cost

- The access to premises by cables and cable-access to mobile sites, have been a major cost barrier, as each needs digging and cables. The high cost is from the labour times *et al*. Cables/fibres themselves have long been cheap and have got cheaper. So FTTH needs major incremental costs

- Mobile masts are also major civil works, like cable-diggings. This makes expansion (more masts) a major investment. This is hard to justify with roughly constant revenues. This is a barrier for dense 5G or 4G sites. It is a factor that has also limited the coverage. Low customer density and rural masts have relatively low traffic yet need even more access costs than a dense-area mast

- As digging and civil work costs are a major factor in fixed *and* mobile access, coverage and the deployment of faster services can be held back

- New technologies and ways of installing cables and masts have been happening. This is reducing the cost of access-build. Fibre/mast *installation* capex has been falling. This matters as these may dominate over the electronics and service-specific costs

- Reduced costs to deploy FTTH and FTTMast is enabling the move to fibre and faster/better broadband

- **A small reduction in cost can greatly increase the number of customers that are economically viable over FTTH**. Cost reductions can now be large. This allows radical changes. Of course rural and remote sites remain expensive – possibly uneconomic even if the costs fall

- There are other aspects of the telecom supply chain that should be appreciated. Sub-sea cables have expanded over 100+ years and over some 40 years (and especially in the last 20) have connected the global Internet and linked in the emerging economies. The technical advances are phenomenal and underpin the benefits of all applications/services. This helped reduce the cost per Gbyte. It is worth noting that this has happened almost without regulations. This market has been entered by the likes of Google, Facebook, Microsoft and Vodafone, **so major players in both end user applications *and* downstream telco players are moving into the lower infrastructure and transmission layers**

- The lower cost to dig is likely a more radical change than yet more mobile traffic (possibly on 5G) - as that trend is normal. Normal changes are not radically altering the industry directions. **Changing to focus more on infrastructure is a radical change**

- Lower costs to deliver FTTH are changing telco investments. There is little or even negative growth in revenue or profits from mobile/5G, in some telcos. Existing fixed line businesses may also have roughly constant revenues. An upside is building *new*

fixed access. This is evidenced by telcos actual actions and strategies. This may be counter to some commonly held beliefs that fixed lines are a static/dying business and the world will pivot around 5G (or 4G or 6G). The harsh facts are that c90% of traffic is over fixed lines[3] and that will not be threatened by any mobile development. Elementary understandings of telecoms networks and traffic show this[4]

- The best prospects of industry growth is probably in fibre and to a lesser extent in mast civil works. We see alt-net fibre telcos rapidly emerging to compete and invest. Mast-centred businesses and mast IPOs by mobiles are taking place. This is a significant industry move. Faster/new fibre-based access is more transformational than simply a bit more mobile data for about the same monthly prices.

The changes in each sub-area of the complex telecoms industry should be understood. Better holistic decisions can then be made. Digging holes may be a muddy job, but is it no less (maybe far more) important than, say, some IoT update from a customer's equipment that provides tiny revenues to the telco. The customer may benefit hugely, but not the telco.

5G and mobile success is not doubted. We use more and new applications for 5G arise giving large benefits. This paper centres on the *telco's* revenues and investments, not the end user benefits.

Investors, regulators, leaders etc. should appreciate the technologies as well as their cost trends. Some radical changes may not be getting the coverage they deserve.

See also Section 3 below for additional messages, from the insights in Section 2.

[3] In developed countries. In emerging markets most traffic is over mobile. But the traffic per capita is low. As benefits are proportional to traffic volumes, if a market is to develop then more fixed capacity will be needed. However mobile will likely always play a far bigger role in emerging markets than say USA, Europe and similar. There may be some exceptions but for mobile or FWA to have a greater role then mast numbers become high. See Telzed papers for other reasons that limit the potential

[4] Read Telzed papers or contact the author

2 Technical & economic changes enable the telecoms industry

2.1 Key changes in the lower layers of supply

Discussions are today often centred on "use cases" and how there can be benefits from using the Internet. This may even be done over 5G. 5G is of course *required* for some applications that must make use of the specific features of 5G. There are almost unlimited ways of using communications and the Internet. Education, Zoom calls, banking, monitoring systems, updating vehicles, head office communications of important information, Facebook, remote surgical operations (!?), shopping, financial transactions etc., are well known. These seem to blur into telecoms (or 5G) benefits in some discussion. These are the end applications and end user services. They are not telecoms services.

In this paper we separate such applications from the telecoms industry layers. These connect a user to Google or to a doctor, but the telco service is the same. This service occupies lower layers in the supply chain and the outputs are the telco services of voice, messages, data [broadband access and Internet access], plus the many business services such as secure connectivity. There can be huge benefits for (say) farmers to update tractors on weather or to signal soil tests in real time and so alter planting schemes "on the fly." This is an application of *using* mobile, not a telco service. It "simply" needs telecom service coverage in rural areas – not a trivial issue as rural masts will be expensive to cover the area and carry little traffic. The telco gets none of the end user economic benefits.

Central to future strategic thinking is the need to understand what are the services that *telcos* can benefit from. *If* there are wider benefits from end user applications running on top, how can these transfer to build and sustain the telco networks? Generally this is not possible, just as it was not possible 20 years ago[5].

A telco can venture into the end applications markets, but this is fraught with obvious dangers. It could try to lock the application to the network, but competition, net neutrality and regulations stop most preferential treatment. Almost any application can revert to running over a basic data connectivity service (Internet) or a basic IoT data stream, so a premium connectivity service for some applications has a limited scope. Possibly zero, for the telco.

The telco services are the "top of the stack" for that industry and form an input to the application and Internet world (with their own stacked layers of service supply). It is useful to understand the components and layers below the telco final services:

- Core networks carry the aggregated traffic and services. Roughly similar in fixed and mobiles. These have central traffic switching sites, and transmission between the sites (normally over fibre cables for most traffic)

[5] In 3G licence bid days telcos hoped to control the end user service and application revenue. This failed. Telcos cannot charge Google differently from a bank transaction or Netflix download

- Fixed line access to the premise. Usually copper and/or fibre. A wireless service forms a similar function though technically it is effectively using mobile type technology [masts and radio]
- Mobile access. Spectrum, masts, end user devices
- Global connectivity. Every telco connects to others. Major cables and exchange sites are used. Very high capacity cables interlink countries. These may be on land or sub-sea cables. Satellites carry very little of this traffic
- National connectivity. Wholesale markets and services exist where telcos access each other's networks and services.

Lower layers can be identified:

- A transmission cable link has cables, ducts, digging, termination systems. Infrastructure layers feed into conveyance service layers
- A mobile access has masts, power, antennae, plus backhaul to the core (likely a transmission cable), again: infrastructure and conveyance layers
- Fixed line access has cables, ducts, cabinets, passive or active systems in the street, *plus* termination equipment and concentration systems in the core site.

Telco functional layers can also be defined, such as: Business Management; Customer Care/Service Management; and Network Management. Although not relevant here, it demonstrates how old layer-concepts can often still be useful for understanding the industry.

Key messages are:

- Telecoms can be considered in layers, from customers down to the fibre and hole in the ground
- A supplier can be active in all layers or in just a few (build just the fibre and sell dark fibre to other telcos, or build masts and rent them to mobiles, perhaps with power and backhaul). So there are many optional wholesale splits in the supply-chain layers
- Note how fibre cables and transmission connectivity underpin almost everything. They are central to mobiles, to wholesale connectivity and to connecting the world together (global connectivity)
- Cables and transmission are no longer just a core-network focus. Broadband access means fibres and high-speed transmission to the premise, are now a key direction. Gigabit/s type access does not work over old copper wires.

A critical message to note is how cables and digging (ducts) and the related civil works are central to mobile and fixed.

2.2 Technical developments have enabled the outcomes

Telecoms (fixed and mobile) has evolved over the last ~40 years. So faster, bigger, longer, better and cheaper systems have evolved. A 1Gbit/s fibre link between cities or countries was a major link in 1980s. Many 1000s of Gbit/s is now normal. A few kbit/s to a premise is now being replaced by 100s of Mbit/s or Gbit/s.

The effects are profound:

- The unit costs of a call minute or a Gbyte of data have plummeted
- The cost reduction has fortunately almost balanced the traffic volume and service speed increases
- Almost everyone gains huge benefits from the vast amounts of servicers and data.

But it is easy to forget such gains. Customers see almost constant expenses per year and ignore the say 40% per annum increase in usage. This leads to some important discussions on prices and benefits. Telecom prices (as a whole) are roughly constant, but the telecoms price per Gbit/s or Gbyte gets cheaper. So one can say telecoms has not got cheaper and also the prices have fallen x10 in the last 8 years – both statements are true. We need (or want!) the extra capacity and are willing to pay get the additional capacity for on HD video when just a few photos by email was enough not long ago. We do not save money by using the low resolution or the minimum #Gbytes per month. This is profound for price evaluations:

- Unit costs for services fall
- Equipment costs to provide the services cost less over time, but the total spends on equipment remain similar (capex and asset levels do not fall and are roughly steady)
- Total costs for the equipment match total spends on telecoms by end users. Hence we see a roughly static business. A few do increase profits, but others see less. Overall, it is roughly static and, without growth potential, share prices have often fallen.

So we need careful understandings to say if services are priced the same or vastly less on a like basis.

Pricing has also had to change to reflect the unit-cost reduction per Gbyte or Mbit/s. Each are an ever-smaller incremental cost. So the constant (or fixed *[sic]*) costs dominate and premium charges for additional usage are harder to justify. This is seen in most tariff plans from the low price-increments for more data or a faster service. This means that a greater focus has to be upon the fixed-cost elements: how to reduce the cost to access the customer (in mobile and in fixed line businesses)? This fixed-cost reduction allows a larger reduction in total monthly fees to happen, as the variable/volume costs are now a less significant portion.

Equipment-prices often also need altered analysis. New alternative routers might each cost about the same as 5 years ago but each may have 5x the performance. This is critical to understand a telco's asset base and capex. What is the real value, based on a modern equivalent basis? This gives options in business evaluations and for regulators. Which is the best one to use? A five year old router may be worth 50% of the purchase price as it lasts ten years and is still available new for the same price. Or is it really only worth 10% of the purchase price due to the new alt-router performance? This needs to be done in the context of: what is the problem to be solved? Several options can each be best, depending on needs.

A re-think on prices and benefits from telecoms is worth further study. The per unit cost and total cost per annum trends each vary differently. Papers can show that telecoms consumer prices are constant but this really this not using "apples for apples." The cost per Gbyte is vastly less and we benefit from the additional Gbytes. Is this properly factored in?

Surely the benefits to the end user are from the total traffic and so 10x more traffic *does give* huge benefits. Is this a linear effect? Further work and discussions can be carried out. Costs per Gbyte are much less, but telecom total costs and capex are about the same.

Key cost and technical changes include:

- Mobile advances, 2G-3G-4G-5G enables more capacity and generally lower cost to carry a Gbyte
- A mobile G change is a step up, but each technology generation improves – more spectrum, more masts better systems allow more Gbyte for lower unit cost, even within one mobile generation
- Lower unit cost for transmission (fibre transmission)
- Masts and civil works get better. Mobile costs are dominated by the masts, so lower-cost masts are vital. Note how huge lattice structures are now rare – simpler mast systems exist that can be constructed rapidly as they are mostly pre-assembled. The cabinets, power and control systems get smaller and easier to manage. The capital costs per mast fall, and the capacity per mast rises. If this were not the case then mobile traffic growth and unit price reductions would not have happened (see say Tefficient data and many other papers). This is critical as more masts are an incremental cost, even if the cost per mast is smaller. So cheaper masts each with more capacity have been vital
- Lower costs to access premises – FTTx, especially FTTH.

This last point is the focus of this paper. A quiet revolution is taking place and arguably this is far more radical than lower cost per Gbyte on mobile or some application running over a 5G network.

2.3 The digging and cable revolution

Fibre cables and cable-diggings are not new. Fibre transmission was developed back in the 1970s. It just got better. Fibre to the premise technology was worked out in the 1980s and was being deployed widely in ~Y2000. But only in some countries. Sweden and Japan were among the leaders. Industry leaders should understand how, why and where this happened. Also, why/how it did *not* happen. Why did UK *et al* not deploy until recently when the technology and (arguably) a business case was viable 25years ago? Why did global leaders not move rapidly to near 100% FTTH coverage? This needs a longer discussion of the economics and business issues.

Governments and regulators also impacted the outcomes – sometimes causing no fibre deployment: the opposite of what they desired. Contact Telzed for assistance in this field. It is a pillar for understanding the complex dynamics of demand, supply, regulation and business economics and hence to understand the outcomes we see today. If you do not understand these factors, then perhaps you do not really understand telecoms.

Fibre and its installation have undergone a number of improvements over time and perhaps there is now a change that is almost a revolution. The fibre cables themselves are not very different to those of 30 years ago. They are cheaper in real terms (per fibre-km). The traffic per fibre has increased. The unit cost per Gbit/s has fallen. This is the “normal.”

Fibre to the premise technology is not radically different to that of 20-30 years ago[6]. The fibre cable costs (on the drum) have fallen, but this is not a radical change.

Fibre costs are not dominated by the electronics systems. Even the cable is often not the largest cost. The major cost is in the civil works – installation in ducts, digging and pulling of the fibre cable. Joints and splices in manholes are needed – these are often manual stages, but have reduced in complexity/time to install. This is well known to those with fibre/transmission/technical backgrounds or to those with experience of telecoms cost structures in accounts or business models. A fibre cable may cost a few $1000 per km, but the street digging and install costs are $20-100k per km. This varies hugely from city centres to bare earth fields in the country, and by country. This cost dominates.

The high costs to dig and to make ducts, then to pull fibres into the ducts has been a major limitation. In core networks (inter-city and inter country), this is not a problem as the fibre is used by so much traffic. Also, core fibres were often built years ago and the electronics on the same cables can be upgraded. The old fibre works almost as well today as a new one.

The cost to dig to a mast for 50Mbit/s of traffic or 10Gbit/s of traffic is the same. Mast deployments may be held back by this incremental cost. Many small masts each need a fibre. Mast civil works are also needed for each. Microwave links avoid the fibre, but need line of site and may not have the capacity needed. Mass-5G masts with microwave transmitters on a lamppost next to bedroom windows have further problems (think or ask).

Digging fibre to fixed line premises has been a financial barrier. Costs are for a cable for 1000+ homes as costs are shared [4km at $40,000/km[7] for 1000 subs = $160/subscriber]. But networks branch out and so one cable later covers perhaps only 10 premises. 200 meters at $20,000/km means capex of $400/subscriber, just for the fibre build. Then the last link to the premise (drop wire equivalent[8]) could be another 50+meters at far higher cost per meter with no sharing of costs between premises [30 meters at $20/m = $600/subscriber]. So FTTH could easily have capex of >$1000 per premise and a lot is concentrated in the last few 100meters. This is offset by:

- Very long lifetime
- Lower opex. This is often forgotten. FTTH should have lower opex costs compared to copper
- Radical change to the access networks to remove all legacy copper structures. Eliminating cabinets and local exchanges to long-line in many thousands to far fewer central nodes can reduce long run opex. But legacy copper structures, old-telco thinking and regulations have tended to make this difficult. This is changing and the new alt-nets are now doing fibre in ways that the incumbents should (?) have done

[6] GPON and point to point fibre systems are not new

[7] City centre digging is more expensive than sub-urban, which is more than rural digs

[8] Note that drop wires (or fibres) on poles are often not used even for copper but the drop to the premise or drop wire needs an equivalent with fibre so the terminology is sometime used. Aside: there is lower capex from putting copper and fibre on poles c.f. in ground, but the opex (fault rate) rises with distance and with adverse weather frequency. So telcos have a short term or longer term trade off that varies hugely by country. Invest for long term lower opex is surely a better approach. Also pole cables may be now discouraged by planning rules

~20 years ago. Readers may think further about why it did not happen and why things may have now changed.

But capex is still a major barrier. Reductions come from re-using existing ducts if available. But these are often already filled or do not exist – cables were directly buried. Also access is a regulated service[9]. In any case the access rights and work to pull cables, even into clean ducts, is still an involved process. Also the final drop to the premise is likely to need both new fibre and bespoke digging. It is anecdotal to the premise. Certainly countries with more MDUs [multi dwelling units] have major advantages here as one access fibre cable then services say 10-100 premises.

In core networks the cost to carry 1Mbit/s or a Gbyte of traffic has fallen as electronic systems get faster and have more capacity for about the same price. The equipment simply does 10x more and in a better (easier/cheaper to manage) way. The cables exist as noted earlier[10]. This contrasts to access. A copper cable or a fibre cable for one or hundreds of customers still has to deal with the capital cost of one dig. Also the revenues per month to pay for the one access line are roughly constant – so little or no additional revenue exists to pay for additional capex. This has surely been one of the key barriers to FTTH (or to very close to the premise, with some copper, coaxial cable or maybe radio link over the last few meters to supply the drop wire equivalent).

But, **the cost to dig and install have changed radically**. Digging was highly manual (back-hoe diggers, men with spades) and subject to planning rules/fees to block roads or traffic. Hence the high costs. A number of developments have occurred:

- Rapid digging machines. Able to cut pavements or roads and make narrow trenches over long distances in hours, not days. Dig, install and bury in one day is possible
- Micro trenching is normal. Men in trenches over a meter deep is a rare sight
- Direct bury ploughs that cut ground and install a cable or duct all in one stage leaving the ground covered as it passes. This works well in rural areas (grass verges and fields). Can also be used in gardens or driveways to access a premise
- Directional drills. Cables and ducts can be installed over significant distances remotely without digging. New cables can go under roads, paths or premises' driveways direct to the house. They can be steered to come out accurately say, 30meters away (over 100m is possible). Even rock can be drilled
- Lower cost civil structures. Ducts, cabinets and manholes get cheaper. These used to be expensive concrete items, possibly bespoke. But some slight reductions from standard sizes and using fewer plastic ducts to replace the expensive concrete ducts or tunnels[11] is possible

[9] Duct access or access to existing holes and poles is often more complex and expensive than many expect [author experience]

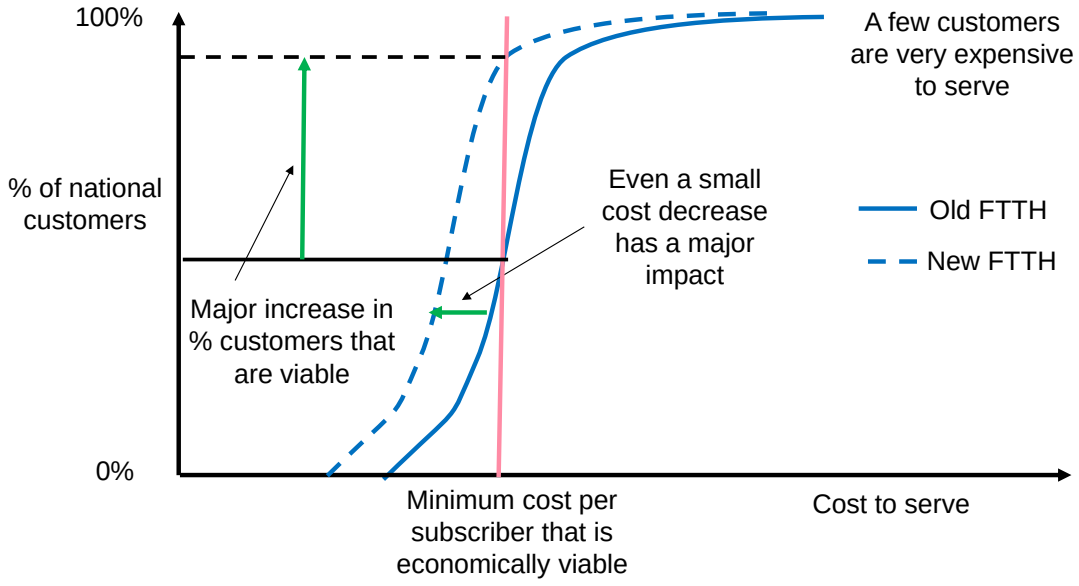
[10] New fibre cables have almost the same specification of fibre size and loss per km as a fibre installed in 1980s. So the old 1Gbit/s transmission link of 30+ years ago can be replaced by many 1000Gbit/s on the same cable

[11] Many cables in streets in city centre may need tunnels for 100+ cables. These may still be needed where cables concentrate but plastic ducts may be enough where there are fewer cables. Also, as one cable can carry vastly more than say 20 years ago, fewer fibres and cables are needed so huge numbers of cables are not required. Large copper cables are not needed. Just one fibre cable can carry many terabit/s. This can leave duct space as a

- Better planning rules. This has been a never ending complaint of telcos. The rules (and costs) to dig can be complex and even varies by city. These have got simpler in many countries. The overheads to manage the local municipalities or pay landowners was a major factor (likely still a barrier in many countries[12])
- Centralised records – other utilities such as water, gas electricity and other telcos can be easily cut, unless records are available and processes exist. Paper was once the only record. Look in any hole in a central city and you will probably see many other cables and pipes. Hence the high costs to dig in cities
- Detection tools can find/detect other cables and pipes and avoid the expensive accident.

A wide range of sophisticated digging, drilling pulling, pushinig(!) etc. equipment now exists. This removes much of the labour and time needed. **It is a key factor in new fixed line access and in mobile mast access** where pre-existing ducts and cables usually do not exist. This is tipping or has tipped the industry to a new regime that is centred on fibre to the premise. The cost change is helping more mobile masts by the lower backhaul-fibre costs and also from using the same fibre[13] as used for fixed access. Arguably this is not changing mobile access *very* radically but the impact on fixed access *is* profound.

Figure 1. As the FTTH costs fall, it increases the addressable market



Source: Telzed. Even small cost reductions can be significant. Real reductions may be large

stranded asset – it will never be filled, depending on new-fibre cable plans. So, space shortage is relevant to access duct & for more fibres, so both incumbents *and* alt-nets are concerned with additional new-fibre-dig cost

[12] Author anecdotal experience. In one country the local municipal councils used the fees from "rich telcos" and utilities as a type of local tax. No doubt the money seemed even sweeter to some municipalities if the telco was owned by central government (nationalised)

[13] Telzed has noted before that mast backhaul is only cheap if there is FTTH to share the costs with. So if fixed access were significantly substituted by mobile/FWA then the FWA cost would rise. This is just one of many reasons why major substitution by mobile/FWA cannot happen in most developed countries

This is not a sudden revolution as the digging/install technology has evolved. But the evolution to today has now reduced costs to a level where a dramatically different view of the economics of building fibre to the premise is now prevalent. This is causing a rapid (revolutionary?) change in attitudes and business structures. Once the altered costs, demand and business-need all align, then we see the radical changes that are now happening.

2.4 Examples of the rapid changes caused by the fibre digging/installation changes

Evidence for how the lower costs and relative ease of fibre-build is easy to see:

- The UK alone now has over 70 FTTH builders. Other countries will surely have similar mushrooming numbers of alt-net builders of fibre for broadband. Some will surely also sell fibres to 4G or 5G masts *if* the mobiles ever build huge numbers of additional masts. So mast backhaul costs or capacity limits ought to be less of a barrier[14]

- Vodafone is expanding FTTH fixed broadband across Europe. This is the prime way to expand revenues and the only practical way to carry the traffic. See Vodafone papers referenced in a Telzed analysis[15]

- Even fibre in rural areas is now economically feasible. The fibre costs are roughly proportional to distance and inversely proportional to density. Normally, rural areas were not economic. But it *can* be done. See B4RN[16] or some UK alt-nets. Fast plough methods are clearly more viable in rural areas – much cheaper than urban-road digs. So the costs to serve have altered, perhaps radically more as a percentage than in cities. That said, rural FTTH still has barriers as does mobile/FWA as a solution[17]

- Almost all countries have embarked on FTTH programmes. This is driven by the desire to have broadband with 100Mbit/s to even 1Gbit/s. But, the political and business desires would probably not have crystallised without the underlying costs structures also having changed. Certainly, some countries went that direction c20 years ago but only recently has it become mainstream in developed countries

- BT spent many years on FTTCabinet that re-used existing copper and left FTTH for just a few. This has been reversed and full fibre is now a central basis. The many recent alt-nets building FTTH is surely a primary cause. This writes off much of the FTTTCabinet investment, as it will often be left stranded. FTTH capex could have

[14] The real barriers to building many mini masts are obvious. Please read Telzed papers and/or do some ratiocination or ask Telzed for help

[15] See Telzed Vodafone analysis – this paper is relevant far beyond Vodafone and its markets, The primary growth market is FTTH, not 5G/mobile

[16] https://b4rn.org.uk/

[17] Mobile coverage in rural areas is problem that has not been properly addressed by operators or Ofcom/government in the UK. Coverage is likely a problem in many countries as the same economic/technical factors are relevant. Mobile performance is not adequate for many. Using mobile or a FWA variant to serve rural areas is more limited than some think. The huge traffic levels are the primary barrier. So FWA is often only a niche solution even in rural areas. See Telzed paper on rural FWA

been low for BT as it has the existing ducts. So the now-cheap access digging costs was not the primary reason for the changed strategy[18]

- Fixed line broadband numbers almost always rise[19] and so, as speeds and traffic capacities must rise, this forces a move to fibre. A move to FWA or mobile as an alternative is not viable for mass markets in developed countries
- Some countries with poor copper went direct to fibre. So lower costs than copper existed over c20 years ago, even without the recent further reductions. The business case for green field build was clear. A worthy question is why many developed markets did not use fibre even in these new-build zones[20]?
- There are a number of sources for global FTTH levels by country. They are all (?) rising, sometimes rapidly. Some countries are even closing in on full coverage
- There is money from governments in many countries to build fibre. This can help make a business case or improve the margins. This gives evidence[21] that fibre is the "right way," and it is both economically viable (even if marginally so in some areas) and benefits citizens.

So in the last few years a change to FTTH has been happening. The lower costs and other factors combined to move strategies from mobile-only or from upgrading copper, to new-build of fibre.

2.5 The switch to FTTH based capex needs revised telco analysis and strategies

As telcos spend on FTTH, the cost structures change and need to be understood. In the past the access costs were in the copper and digging infrastructure. It was a steady market with demand that rose slowly. Capitalised labour related costs often dominated so using accounting values were adequate. A slight revaluation up was sometimes used in current cost accounting and related economic thinking. It often did not matter much anyway. But with far lower modern costs to dig, the real value of past access and digging-assets has fallen. Over-engineered ducts and tunnels are now irrelevant. Costs are lower. Hence, the many operators now doing it.

This has a number of implications:

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[18] Understanding BT's thinking and how it got to the current situation of now *following* alt-nets needs further study. This has major implications for Ofcom and government. The impact on new/past investments and on subsidies need evaluation. There are likely to be similar investigations worth doing in other countries. There are implications for BT investors and for the alt-net investors

[19] For example https://telecoms.com/508907/pandemic-provided-a-shot-in-the-arm-for-us-fixed-broadband/ This shows US broadband access numbers rise yet further, even in a market that is already well served. NB Cable TV and fixed broadband both need fibre and the same lower costs to dig for new premises. Mobile simply cannot carry the traffic see any of several Telzed papers and some simple numerical analysis (pocket calculator complexity), See also World Bank or ITU amongst other sources

[20] Again think/ask. This is the sort of thing that gives the deeper industry insights that decision makers should have

[21] Some may also think that any government support is a sign that it must be the wrong way as a government is always wrong. We do not discuss this further

- Regulatory costing may need revised, possibly radically. Past methods and assumptions that costs/values vary roughly as per average salaries, are now not valid
- The incumbents' asset base in the access network needs to be revised if current values are needed. Historic accounts are less valid
- More work should be focussed on infrastructure, not on fashionable 5G benefits and use cases. Digging and mast infrastructures are behind the current changes to FTTH and mast-based InfraCos[22]
- Regulatory pricing may need to be altered as past methods do not reflect the real incremental costs seen today. This opens up a deeper discussion as prices need not be cost based - it depends on the cost definition and what the aims are. UK had access prices that allowed more than the cost of capital to be recovered as that would help with future fibre investment (interestingly BT built FTTCabinet instead of FTTH). So a complex analysis of cost and prices and strategic thinking is needed along with understanding of the competition and investment economics. No problem for NRAs [National Regulatory Authorities] then…
- How do costs vary with more than one FTTH builder in the same locality/street? What sharing is negotiable, allowed or encouraged? What are the different rules needed between new entrants and the incumbents? Do any NRAs believe they are really all on a level playing field?
- **What happens when some or many alt-net FTTH builders fail?** It is easy to forget the telecoms is full of failures (they may also be "consolidated" which disguises the reality). Many small telcos are unlikely to all be viable [economies of scale and scope]. Investors and NRAs must plan ahead. Planning for failure is not a strange new idea[23]. It is vital
- How to encourage and protect the competitive new FTTH investments? Protection from incumbents is obvious but perhaps also from other competitors and collective lemming stupidity. A single telco failure is not new and not normally serious, but many failures have on going wider implications as asset values in fire sales are so low. Almost no new-builds are then possible as they must compete with the cheap failure-assets[24]
- Should the access business be a full service telco (ServceCo) or just a wholesale bit-stream provider (NetCo) or an InfraCo (just the dark fibre and duct)? The layered view described above is central to the understanding of this
- Should NRAs regulate the FTTH alt-nets? Do they have local market power? How to protect consumers if (when!) they fail? What if any wholesale access is given by alt-nets versus incumbents?

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[22] It is often useful to consider InfraCos, NetCos and ServiceCos as a simple three layer (Company) supply chain

[23] Telzed noted the benefits & risks of FTTH and entire-telco failures back on 2012 and again in a Telzed submission to Ofcom's strategy review in 2015. **NRAs and investors should note that this is far different from "one project failure in 100" that is normal in business and covered by the cost of capital**

[24] A similar lesson can be seen from telco failures cY2000 or the sub-sea cable and international carrier failures, also around then

- How will incumbents write off past copper or FTTCabinet investments?
- Have subsidies helped FTTCabinet or other solutions that are to be replaced by the new FTTH builds? What happens to the subsidies for past investments?
- The lower costs to serve mean that the amount to subsidise marginal areas, changes. There will always be locations where FTTH is very expensive, but the thresholds alter
- How to combine any intervention monies with alternative options such as satellites, or FWA/mobile? Governments and NRAs need to understand the technologies, cost structures and how each are rapidly changing
- With changing costs, the competitive, servable and non-economic-to-serve definitions vary over time. How do investors and NRAs each need to change as a result?

So new investment thinking is needed. Revenues overall to telecoms may remain static but demand rises. So optimising costs is vital. Lower fibre and infrastructure costs are central to reducing the costs/investments. International cables are also growing. More on these lower infrastructure layers is now vital. This is valid for mobiles and FTTH.

This is a different line if thinking to 5G based use cases IT on line applications. These are significant and the benefits maybe huge, but many telcos are looking in other directions.

3 Conclusions: low-cost digging, infrastructure & fibre transform telecoms and need action

3.1 End user benefits are mostly outside a telco's market

Telecom change is not new. Change is normal. More data, faster services better coverage have been achieved without significant price changes to the end user. The underlying technology has got better. So demand-growth is balanced by cost reductions to give total revenues that are roughly static. These trends are broadly similar over 20+ years.

A direct result of this is the seemingly never-ending capex to upgrade older systems. There is no reason to expect this to change. There is also little concern that the network advances will stop. This is fortunate as, if any one part of the supply chain could not grow its performance at roughly constant cost, it would stop the march to ever better broadband and Internet services.

Much focus is now on the applications and how telecoms is used. Much of this is part of using IT and the Internet. It is *not* part of the telecoms industry.

To make decisions and understand business cases, it is vital that the end services and their benefits (and revenues) are clearly separated from the direct telco services. The benefit of telco services is to access the on-line applications such as banking or video. The telco service is broadband or IoT data etc.

Much focus has been on 5G services and use cases. Perhaps these will transform end users' lives and our ways of working, in ways that cannot be done on fixed/WiFi/4G etc. networks. 5G supplying faster speeds and/or lower cost to carry or adding more IoT or helping with the never-ending coverage problem, **is not a transformation**. Evidence so far shows that telcos' finances are not being transformed. Revenues are roughly static. It is vital that the end user experience and benefits are clearly separated from the telco service.

We propose that analyses carry out breakdowns of:

1. Use cases
2. End user applications
3. Benefits
4. Telco services.

The items (and revenues) can each be defined for 5G-based delivery (only works on 5G) and those that can be on 4G or fixed/WiFi. This gives a disaggregated view of services and more critically of the numbers. The business case that gives telco revenues for building new 5G if existing 4G does not work, starts to look very much smaller than the benefits from remote access to a doctor or a car recovery truck or tractor sowing seeds autonomously.

Understanding the supply chains within the telecoms service provision should be basic for all leaders in the industry. This shows a layering services and systems and hand-overs to others in the supply chain. The layer approach identifies how critical the infrastructure costs are.

3.2 Infrastructure is a primary investment area

The cost for digging and fibre to the home installation, have long been falling. Thresholds have now been reached by significant recent reductions. This enables new investment plans. Telecoms is transforming from "just" a focus centred on mobile services and upgrading traditional fixed networks. The move is to build new FTTH.

Falling costs for digging and installation of cables now directing many telcos' actions. The changes enable the gigabit/s services and vast traffic volumes needed. Lower fibre costs also benefit 5G and mobile, but not enough to take more than a fraction of total traffic in developed countries. The primary platform has to be fixed (FTTH centred). Mobile cannot realistically carry the majority of traffic[25].

The importance of lower cost infrastructure is shown by the rapid increase in FTTH telcos and investment. This is a $ growth area while mobile and much else in telecoms is more static. Solutions like FWA or private networks and corporate 5G, are worthy but not big enough transform a major telco's finances. Contrast to: 10million premises on FTTP at less cost than existing access or 5 million *additional* customers for a new entrant.

Lower cost infrastructure is also reflected in masts. So there are changes in the supply change and major investment-interest in this area. This is below the mobile-service and application layer. Mast investment is a separate sub-market that is also benefiting from lower build-costs at the infrastructure layer.

A new regime with multiple FTTH builders is happening. Major investment is taking place. EU initiatives[26] will encourage this. The UK government's number one priority is infrastructure[27].

This radical change has major risks of failed investment. Not all players will succeed. Plans to cope with the changes *and failures* are needed. Most operators, regulators, investors and governments will need to act.

Digging holes and laying cables may seem less glamourous than 5G use cases but there is money to be made and costs to be reduced. Perhaps some commentators are looking in the wrong direction for what can alter the economics of the industry. Where there's muck, there's brass[28].

Please contact Telzed for further advice and help

See Telzed web site for additional papers

[25] Should that not be obvious, please read Telzed papers, think or contact Telzed
[26] E.g https://ec.europa.eu/info/sites/info/files/communication-digital-compass-2030_en.pdf
[27] https://dcms.shorthandstories.com/Our-Ten-Tech-Priorities/index.html "Our 10 Tech Priorities"
[28] UK proverb. Here, brass is a synonym for money