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What are the risks to the UK's 5G infrastructure? How can these be mitigated?

The risks to the UK's 5G infrastructure are that by including Huawei 5G technology in any part of it, you potentially compromise all of it. The concept of keeping Huawei at the 'periphery' is a term that's easier to put into a press release than it is to implement and maintain long term in a state of the art, constantly upgrading 5G network. To document all of the risks would take a lot more space than permitted within the three thousand word limit of this submission but to summarise, the risks are to the secure operation and maintenance of the U.K.'s 5G infrastructure and to every element of U.K. society and economy dependent for routine or crisis/emergency functionality on that infrastructure. By the time these networks are fully deployed and operational, that will be the majority of the British economy. Unless the U.K. can credibly deem Huawei as a trusted vendor for vital critical communications equipment now and into the future, then Huawei should not be included in a 5G network deployment.

Mitigation can be implemented by limiting Huawei's role to 'dumb' parts of the network, civil works and some other areas that do not in any way touch network management, traffic or transmission. However, it is unlikely that Huawei would be particularly interested in being limited to those functions. Mitigation can also take the form of attempting to constantly actively monitor and contain Huawei's ability to compromise any network that includes it. This is suboptimal for reasons detailed later in this response.

What is the role of government in 5G cyber security?

The same as it is for land, sea air and space security. The 5G/Cyber domain is a new strategic domain and will very soon be at least as important for government to protect and guard cyber sovereignty as for any of the other domains. 5G/Cyber will be a domain of future conflict as surely as the air domain started to be 1914. It is quite possible that history's next 'Pearl Harbor' will commence in the 5G (or subsequent generation, 6G, 7G+ etc.) cyber domain. Government must be a vigilant guarantor of security with a monopoly on large scale coercive power within the domain in the case that it became necessary to exercise it against a threat to national security.

To what degree is it possible to exclude Huawei technology from the most sensitive parts of the UK's 5G network while allowing it to supply peripheral components?

One of the major advantages of 5G is that the difference between the 'core' and the 'edge' of the network becomes blurred. In 5G, much of the processing power of the network, 'the cloud', is pushed to the edge. Much of what the 'core' did in 3G or 4G is moved out in order to drop latency and increase capacity and overall network efficiency. In short, in 5G, the 'core' isn't what it used to be.

The argument is made by some, particularly by the incumbent mobile carriers, that it's not a problem to have Huawei at the edge of the network (the radio access part, which is 'furthest from the core'). They argue that as long as the core isn't Huawei, everything is secure and can

be managed. In short, that isn't exactly correct. First, trade-offs will have to be made in performance if any part of the network architecture isn't 'trusted'. One of the central ideas of 5G is that once inside the network, everything is trusted. If you have any element from an untrusted or 'less trusted' vendor, then you're immediately put onto the defensive. You are going to have to mitigate risk inside what should be a 100% trusted network architecture. That's going to affect processing power, latency, speed and overall network performance. What you are going to end up with is something less than a robust and healthy 5G network. You are not so much going to have a 'poor man's' 5G network as much as a 'compromised man's' 5G network. It means you have to trade performance for security and with 5G and the pace of software updates etc., security will be an almost daily moving target. By placing Huawei at the edge of the network, if anything you are arguably making your network even more vulnerable.

Every end point (and there are at least ten times more of them in 5G than in 4G), the 'edge' (think about it as a stretched perimeter) becomes a potential vector point. If it is breached anywhere, entry is gained and your lines of defence are compromised. It potentially becomes a high tech 'Isandlwana'.

The counter argument to my above point is 'but that's true for any 5G network' and it is. However, put Huawei in anywhere and your security risk rockets so the likelihood of crimping performance also rockets. That's unless you eventually get worn down and relax security in return for better performance which I don't doubt would be the plan of embedded untrusted vendors and perhaps carriers eager to find new ways of cutting costs and finding margin. With Huawei, we would be building a more inefficient system to allow mobile carriers to prop up their obsolete business model and to provide an accommodation to the Peoples Republic of China.

What credible alternatives are available to Huawei systems?

There are three non-PRC global vendors that currently have the ability to provide end to end turnkey 5G networks. They are Nokia, Ericsson and Samsung. In addition to those there are others that can provide elements of a 5G network. Cisco, Dell, Parallel Wireless, Oracle, IBM and a number of others. In almost every single one of those cases the 'alternative' vendor to Huawei has a superior product, is not subject to the pressures and influence of the Communist Party of China and does not pose the same level of risk.

To what extent was the UK Government's decision on Huawei driven by political rather than technical factors?

For me, the answer to the question unlocks the bigger issue at hand. This debate has incorrectly been framed as a debate about technology (Huawei are comfortable engaging in those arguments), when what it really is, is a debate about a business model. To properly understand the context, it's important to understand that in the early 2000's, the U.K. and many other western countries locked themselves into a model of radio spectrum allocation that created serious long-term problems for the wireless industry in the West.

Huawei's path to global domination of the wireless network equipment industry has been carefully plotted in Beijing and calculated to exploit a fundamental structural weakness of the current Western model for network deployment.

In short, that weakness is that the vast cost of entering the Western marketplace leaves mobile carriers (the Vodafone's, EE's, 3's etc.) starved for cash, slow to make long term investments, and vulnerable to lavish financial and other incentives from the PRC encouraging them to choose potentially risky Chinese equipment for their networks.

The current model of spectrum auctions has the effect of placing valuable tracts of spectrum in the hands of a very small number of retail carriers, which have often paid enormous sums to acquire them leaving them highly leveraged, and compelled to squeeze every possible pound/dollar out of these assets in order to recoup the costs of spectrum licence acquisition.

Retail carriers, having acquired exclusive spectrum use rights, then spend hundreds of millions of pounds/dollars on a network capable of monetising that spectrum and serving customers across the country. This further leverages their businesses and means that the usual outcome is that many millions in capital have been expended before a single penny of revenue is generated.

This highly leveraged business model has a number of clear and observable impacts on the wireless industry:

- It slows the pace of development, because in the Western world, retail carriers, having invested tens of billions in spectrum acquisition and network deployment, are slow to invest further billions in network upgrades until it becomes essential. The oligopolistic nature of the marketplace, with just two or three truly nationwide retail carriers in most countries, significantly reduces the pressure on companies to stay ahead of their rivals in terms of network performance.
- This in turn affects the equipment manufacturers, which are often compelled to slow the pace of innovation due to a lack of willing customers for network upgrades. At the root of this problem is the financial pressure the current system places on carriers, who are incentivised to keep consumer prices high and the pace of new products relatively slow. It turns retail carriers into rent-seekers, more interested in maximising the revenue potential of their existing customers than in seeking to improve their service.
- It leaves carriers and equipment manufacturers very vulnerable to predatory pricing and financing from Chinese government supported vendors such as Huawei and ZTE. This is the door through which Beijing has quietly walked. It is important to note that in the U.K., due to better regulation, the carrier oligopoly has not had the ability to benefit from the cartel like pricing we see in the U.S. However, due to the scale of the U.S. market, the U.S. remains an important influencer of trends. When the U.S. carrier cartel puts the brakes on innovation and investment, the knock-on effect is global. It slows new deployments and reduces the potential order book scale and raises unit production cost of Western vendors. Whether Huawei's equipment ultimately reaches the standard of its Western competitor companies or not, it is available, fast, and cheap. It is also very generously subsidised.

Wholesale, open-access wireless addresses the current weaknesses.

Increasingly, observers of the industry in the West, including the GSMA and Ernst & Young, have recommended the adoption of a wholesale model for spectrum allocation, noting in the case of the GSMA, that:

"In most countries 4G coverage is still incomplete eight years after the technology was first introduced. For example, according to ARCEP, the French regulator, while the population coverage of the four licensed operators varies from 98% to 92%, geographic coverage ranges from 86% down to 69%. At the higher pioneer band frequencies, the roll-out of 5G is likely to be considerably slower if the traditional model is adopted."

This slow pace of deployment is directly attributable to the issues raised above, with the GSMA going on to note that carriers are slow to invest in network upgrades outside of those areas most immediately and dramatically profitable.

All of this is compounded by the fact that the wireless industry has reached total saturation in terms of devices per population:

There is at least one device for every person and the pie isn't growing under the current model, so the retail carriers are fighting for market share in a stagnant market, but also desperate to maintain their "average revenue per user," or ARPU in industry jargon. 5G promises an explosion in the number of devices-but that can only happen if we have much greater pricing flexibility and much lower average prices-than we currently see. Only a wholesale-only carrier can offer that flexibility and the price reductions needed to fully take advantage of the possibilities that 5G offers.

A wholesale model, with wholesale-only network operators responsible for building and managing their network infrastructure, and consumer-facing service providers competing to purchase bandwidth on that network, would have the following benefits, none to the advantage of Beijing:

1. Retail carriers would be relieved of the financial burdens of spectrum acquisition and network deployment. This would allow them to focus on consumer services and compete on the basis of consumer price and product innovation. This would have the impact of increasing the demand for better technology than the Chinese can provide and also speeding up the pace of, and demand for, innovation.
2. Wholesale operators would accrue very significant economies of scale. Put simply, servicing and upgrading a large wholesale network/s will incur much lower costs than the industry currently faces in an attempt to upgrade multiple networks at once. This will reduce the wholesale operator's sensitivity to Chinese price incentives and increase the demand for higher quality Western equipment. That is not to say Wholesale networks should have a monopoly over 5G, they shouldn't but they are badly needed to provide disruptive and creative competition to what is an indolent carrier industry.
3. The Chinese network-equipment industry has been built to take advantage of the existing model - a slow pace of innovation, a focus on cost reduction, and a relatively fixed ecosystem of large consumers. Shifting the model to one with a faster pace of

innovation and a focus on coverage and network capacity would play to the skillsets of innovative Western manufacturers and undermine a strategy China has spent two decades perfecting.

4. Wholesale network operators would transform the criteria by which the marketplace is judged by changing the customer base of the operators within it. At present, carriers serve their retail customers, which allows them to focus on the most profitable segments of society at the expense of the others. Wholesale networks, mandated to provide a service nationwide (including rural), would dramatically increase the size of the marketplace and exponentially improve the service provided to rural subscribers.

A wholesale open-access wireless strategy will undo China's financial strategy.

The Chinese strategy to harness Western carriers has been underpinned by a set of financial assumptions about the trajectory of the price of data over the next several decades. Chinese suppliers, supported by the government and the banking system, offer cheap equipment to Western carriers, and augment this with very attractive vendor financing agreements, and in some cases, equity investments in those networks. These investments in turn are supplemented by western dollars from institutions like the World Bank. In some cases, a Chinese investment of one dollar will result in an additional investment of three to four dollars from supportive non-Chinese financial institutions following Chinese money.

The advantage of wholesale, open access wireless is that it confounds these financial models, and would throw Chinese strategy into disarray, for several reasons:

1. Open access wireless will result in an explosion in demand for data because of the price model. When a wholesale-only carrier is committed to selling every gigabyte of data available, on a price-sensitive model, down to prices just fractionally above zero for the least-in-demand capacity, that will dramatically increase demand. It will do so because uses of capacity that were not previously economically viable will become viable.
2. This increase in demand will be accompanied by a dramatic, and rapid, decrease in price. This is because the wholesale operator is committed to selling data at virtually any price, as long as there is demand. This will allow many MVNOs and other new market entrants to offer consumers service at a much-reduced price to that currently available. For example, U.S. prices for data currently retail at up to ten times the price in Germany, and other European countries and though U.K. mobile data prices are substantially below those of the U.S. and Canada (which now suffer from carrier cartel pricing) the U.K. is still substantially more expensive than some European competitor economies.

Very little of the preceding summary has to do with which 5G equipment vendor is used. As it happens both Nokia and Ericsson are currently better technically positioned to provision such a dynamic wholesale network. The key factor isn't technical, it is instead financial and it is financial because it's a question of how you go about financing a currently obsolescent wireless carrier business model if you want to deploy 5G equipment into it? If you aren't willing to change the business model, then you need someone to subsidise its dysfunctionality for you. Huawei and Beijing have been there to do it. That's where the politics comes in. If you are an influential incumbent carrier that wants to avoid disrupting your obsolescent business model,

then you need those subsidies. To get those subsidies, you need to remove any potential barriers to them by the engagement of politics. Proof further that it was politics, is that major U.K. mobile carriers started to deploy Huawei 5G equipment in Spring of 2019. They did not wait for the government decision. Only someone very confident in their lobbying power and influence is going to front run a government decision like that. They knew their horse was going to 'win'.

How will the UK Government's decision impact the UK's geopolitical position?

I believe that the U.K. has already taken a significant reputational hit and that it has harmed its geopolitical standing with some of its closest and most important strategic allies. I know from personal experience that the degree of disappointment in Australia in particular was acute. I have heard it compared in Australia as akin to "the fall of Singapore" in the impact that it will have on Australian strategic thinking. In Washington D.C. I have encountered surprise and not a little anger. It had been clear enough to me since spring of 2019 that the U.K. was going to green light Huawei 5G (because the U.K. carriers started to deploy Huawei 5G equipment without waiting for permission) but there was a trust and belief in Washington by some right up to the time of the PM's announcement, that the decision would go the other way. Clearly, there was some misreading of signals going on. "Two countries divided by a common language" and all that.

The impact on Britain's closest allies is one thing and something that can be absorbed over time, though leaving scars. The perhaps deeper concern is that many other countries that would quietly look to the U.K. for leadership will note what they will certainly see as a 'Kowtow'. That the U.K. did not think this a matter worth fighting for. That if Huawei 5G got into the U.K. then probably the fight is lost and there are no real alternatives. That's certainly been part of the message that Beijing has quietly been delivering to other governments. A sort of 'resistance is futile'. I also know that if Britain were ready to stand up and flip the 5G business model on Beijing and Huawei, many other countries, perhaps even a majority, would follow suit. The Covid-19 pandemic potentially providing even more impetus to such inclinations.

How will the UK's allies, particularly those in Five Eyes, respond to this decision?

This has been referred to in Australia as being as significant a strategic event as the fall of Singapore. I know this is rubbished by many in London but it's important to note that it is far less rubbished in Canberra and Washington. The U.K. is at risk here of telling itself what it wants to hear. Another comparison that I have heard raised is 'Suez'. My impression is that close friends of Britain's in America are very concerned that the U.K. still does not appreciate the severity of how this decision is viewed. In the U.S. there is no other issue with such bipartisan agreement. It is true that the Five Eyes allies need the U.K. but it is also true that the U.K. has very serious dependence on those allies and to be seen to be the weakest link may have costly consequences down the road.

In a radio interview given by U.S. Senator Ted Cruz shortly after the U.K. Huawei announcement, the Senator, not completely tongue in cheek, expressed the sentiment as follows: "Four eyes are better than six eyes."

It is worth briefly noting that Japan is increasingly seen as an extraordinary and reliable ally to the U.S. Japan has moved swiftly in the wake of Covid-19, to shift manufacturing out of the PRC. It has implemented a de facto Huawei ban and more. It is considered by some to have shown a far greater degree of understanding of the nature of the PRC 5G threat. Japan's sun is rising as a trusted ally and early informal discussion has begun on Japan's joining this trusted inner circle.

How will this decision impact the UK's security and defence capabilities and the UK's interoperability with allies?

I believe significantly but I also believe that the various allies are not listening to each other as well as they might on this issue. Some on the U.K. side are making the point that vital intelligence will never be shared on these commercial networks and presumably that's true but it misses the point. It is not about the vital intelligence itself being intercepted, it's about the ability of raw metadata on commercial 5G networks being available and potentially accessible real time and before anything is even analysed. It's even more about the infrastructure that all of this runs over. Does anyone really think that a Beijing that has been willing to play power politics with vital lifesaving PPE supplies wouldn't do the same to operations, maintenance and supply chains for essential high-tech communications equipment?

How important it is for the UK, separately or with allies, to maintain industrial capability in this field?

I believe that it is vital that the U.K. and its close allies maintain industrial capability in this field. There are few other fields that will be more important to the future security of the U.K. and her allies.

In recent weeks we have seen the vulnerabilities that can arise from dependence on Communist China for 'dumb' products such as PPE, face masks etc. We have seen the PRC's cynical use of these points of leverage over allies of the U.K. in a moment of distress. In light of the fact that we are seeing the cost of dependence for even such low-tech product, it is surely now highly questionable whether a high degree of confidence could be applied to higher tech and more security sensitive supply line dependency.

Beijing knows that splitting 'The Five Eyes' alliance on 5G will be a huge victory for China. It will seriously compromise future capability in the key cyber domain.

Beijing had to peel off one off 'The Five Eyes'. They failed to get Australia, New Zealand or Canada to break ranks first. Beijing knows the U.K. establishment is challenged over Brexit and that was before the pandemic hit. The establishment understandably wants to keep all trading options open and fears going into an unpredictable 'unknown'. That's potentially made the U.K. establishment even more vulnerable than usual to regulatory capture.

China is the U.K.'s 5th largest trading partner but in some ways the China trade relationship is more important than even that ranking suggests, especially given the path the U.K. may think it needs to carve for itself post Brexit.

UK carriers all want to use Chinese 5G kit as China subsidises it via discounting and predatory vendor financing. The carriers want to prop up the spread between the production cost of data and what they sell it for via their (dysfunctional) consumer business models.

For some of these retail carriers, Beijing's subsidies are the difference between being able to maintain the current model of 'Buy wireless oligopoly position in auction and rent seek via "this is the price take it or leave it" model', or having to change their business model.

The carriers don't want to risk changing their business models because like all rent seeking oligopolies, they hate risk. Risk is the stuff that entrepreneurs do and wireless rent seeking carriers aren't run by entrepreneurs, they're run by accountants.

And so the accountants that run the big wireless carriers need the Beijing subsidies, otherwise they genuinely don't know how they'd deploy 5G. Change the business model? No, that involves risk and work. So they lobby to maintain the status quo.

So what they do in the current environment in the UK to lobby? Sufficiently worry officials on the one hand 'without 5G in the UK by X date the UK economy will lose badly etc.' There's no other way to do it because Chinese kit is way ahead (it isn't but stay with me here), then they give the security assurances 'we are confident that there is no serious security risk, that any risks that are there can be easily mitigated, ignore the Americans because it's just Trump's protectionism (ignoring that the U.S. has no big 5G vendor to protect).' Worries are fanned about alienating the world's largest economy and what may post Brexit become a key trading partner for U.K. That this is not a wise moment to annoy Beijing, 'we have national interests that we must balance' etc. Beijing provides some appropriately ominous background music.

All this sets up the UK for a regulatory capture rollover to deliver what retail mobile carriers want, Beijing's subsidies for U.K. 5G rollouts. The Carriers have been the Trojan Horse Beijing has used more effectively than any Greek ever did. They'll split 'Five Eyes' on a key domain and God forbid there is one but if there is, the first 10 minutes of the next great war will be fought in the Cyber Domain and it'll make 'Blitzkrieg' look slow and contained. China has to be stopped now, the carrier lobby has to be banished on this issue, the 5G stakes are enormous. This will in turn force existing carriers to lower their prices, in order to remain competitive.

The financial plans underpinning the Chinese strategy rely on a gradual decline in data prices over the next two to three decades, one carefully managed by an oligopoly with common interests. An announcement that the U.K. was choosing to pursue a wholesale, open-access network would radically undermine these price assumptions that underpin the Chinese network-financing strategy. It would cast doubt over Beijing's entire strategy, and would deter those non-Chinese financial institutions currently assisting Beijing's financing of Western networks by calling into question the long term value of those investments.

By accelerating that price decline dramatically, an open access, wholesale wireless network in the U.K. (and subsequently beyond) would obliterate ten years of financial planning by the Chinese and their non-Chinese co-financiers.

In short, if you have the right business model, you don't need the subsidies and you can unlock the latent gigabyte demand in the economy. Do that and there will be a ready supply of orders to keep a UK and allied industrial base healthy and busy for decades to come.

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