Framework: Tech, layers and (un)bundling

This module aims at providing readers (A19 relevant staff) with an understanding of basic concepts and elements of market structure, market regulation and competition rules, which can play a great role in determining if, and to what extent, human rights, and particularly freedom of expression and information, are adequately protected in digital markets.

The way markets are structured and function - from a technical, commercial and regulatory perspectives - can strongly affect consumers' human rights.[1] For example, it can determine how easy or hard it is to shut down networks, restrict the use of certain services and applications, facilitate surveillance, prohibit encryption, monitor and censor content. Furthermore, allocating liability to companies operating in digital markets can be harder or easier depending on the market structure. Finally, possessing a better understanding of market structure and dynamics makes it easier to identify and implement remedies for human rights violations.

Therefore, in order to be able to adequately protect human rights, some familiarity with these issues is useful. The purpose of this module is to provide a reference framework when facing challenges related to digital markets.

Additional modules dealing with more specific topics can be built on this introductory/initial module. We have created three initial modules:

1. 5G Technologies: https://docs.google.com/document/d/1tO2HGoGjxIO6vx5hHhl_o9cIoI3C_sN6yh0zYlTlibs/edit?usp=sharing
2. Net neutrality https://docs.google.com/document/d/1CUr-h5WayWRWuUEIKqkqF9UMEuUFw1G9BkcUzIcoQnc/edit?usp=sharing
3. Smartphone apps: https://docs.google.com/document/d/1Uo6iT3NjA4ONczWag-OipL-BjnLsmjMQH9l__vTDlco/edit

At the end of each section, you will find self-evaluation questions. They are not graded, and frequently there is more than one answer. They are designed to assist the reader in choosing topics for reflection after reading the text. Nevertheless, we propose some possible answers at the end of each module. The proposed answers are not exhaustive and the reader is encouraged to go beyond the proposed answers.

A companion glossary is available here:

https://docs.google.com/document/d/1fxsbRxBYkSzh0stmc9liXTljqYIpQ7fdAH_rC31-zJI/edit?usp=sharing

1In human rights, we often talk about "users" of human rights, or "rightsholders". This document adopts the "consumer" terminology to fit with language found in other competition law texts.

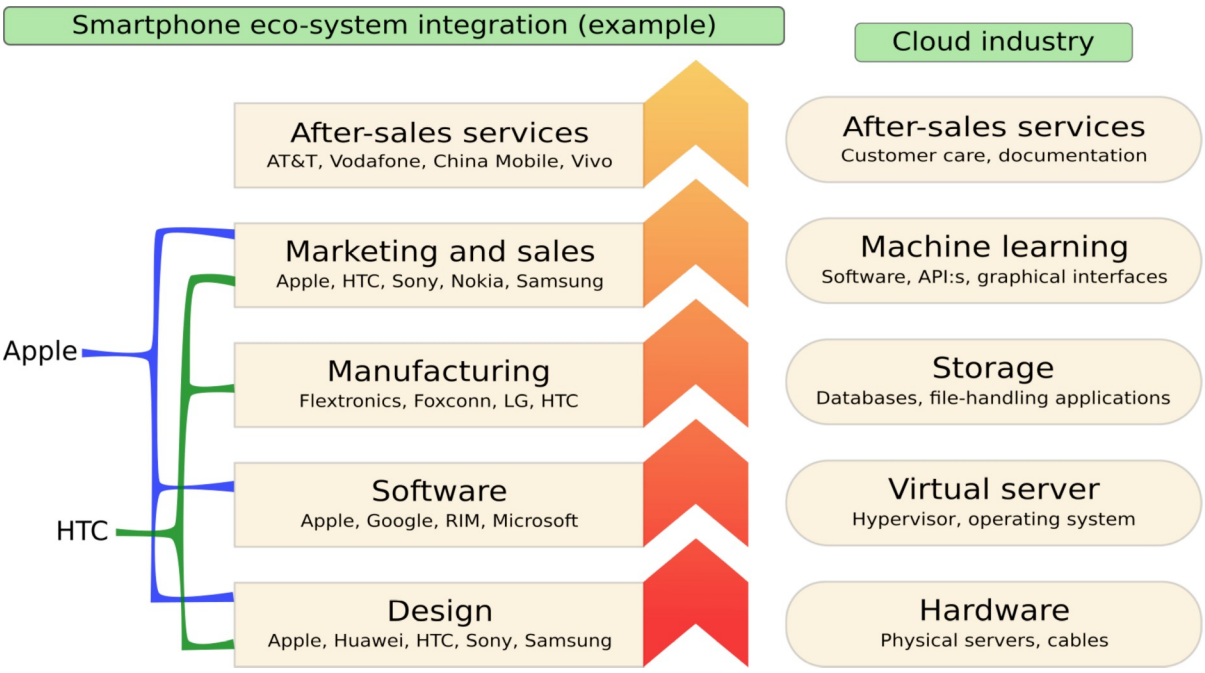
Basic concepts of market structure, regulation and competition

Vertical integration > Merger of, or cooperation between, companies at different stages of the supply chain. A supply chain is the organization of the market from raw materials to distribution of the final product. Integration can happen backward, when a company acquires its input supplier, or forward, when it acquires companies in its distribution chain. Vertical integration can produce efficiencies/gains:

- Lower transaction costs and synchronization of supply and demand along the chain of products;
- Lower uncertainty and stronger ability to do investment for the vertically integrated company;
- Strategic independence (especially if important inputs are rare or highly volatile in price, such as rare-earth metals).

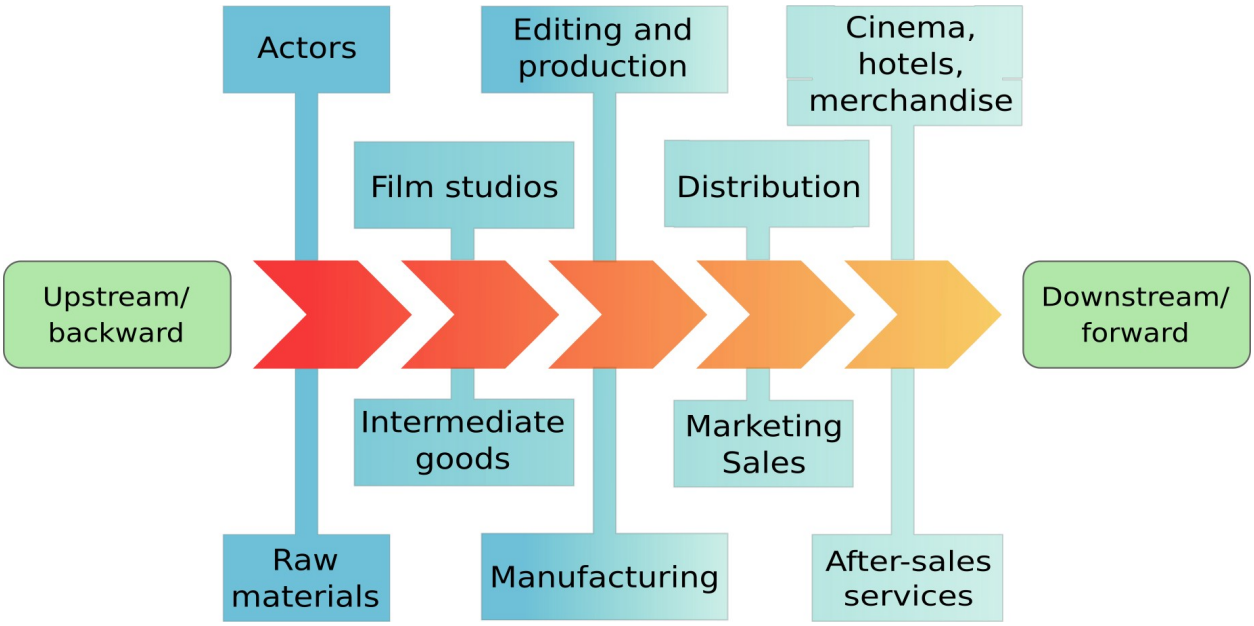
But vertical integration can also become an impediment to free competition in an open marketplace:

- Ability to monopolise market throughout the chain by market foreclosure, where market foreclosure refers to the practice of closing the market to competitors. For example, a chocolate producer vertically integrates by buying the company that supplies cacao. Then it stops selling cacao to other chocolate producers. As a result, competing chocolate producers are forced to leave the market.
- Exclusionary conducts and discrimination of competitors at retail level. In the chocolate factory example, this could happen if the vertically integrated chocolate producer would sell cacao to competitors at conditions (price, quality, etc.) which are worse than those it provides to itself.



Example B.1: Amazon is a well-known webstore and cloud-service provider. Their cloud-services consist of hardware (such as servers and cables connecting those services) and various combinations of software. A cloud-service can encompass a virtual server with an operating system (Amazon EC2), a virtual server with an operating system dedicated to storage (Amazon S3), or a virtual server with an operating system dedicated to storage with machine-learning functions (Amazon SageMaker).

Example B.2: Walt Disney Company is one of the largest vertical integrated groups. It owns the companies that create and produce film and television properties, and are then marketed and distributed by Disney throughout the world, who therein broadcast on affiliated networks, such as ABC and other channels and platforms like ABC.com. The home videos are manufactured by Buena Vista Home Video, which is owned by Disney, and oftentimes shipped to Disney retail stores, along with significant forms of other consumer products such as toys, games, etc. and sold directly to the customers. Many of the products are found in Disney's hotels, restaurants and theme parks.



Vertical separation > The establishment, within a vertically integrated company, of independent units operating different activity branches, or when a particular activity is branched off into a separate commercial entity

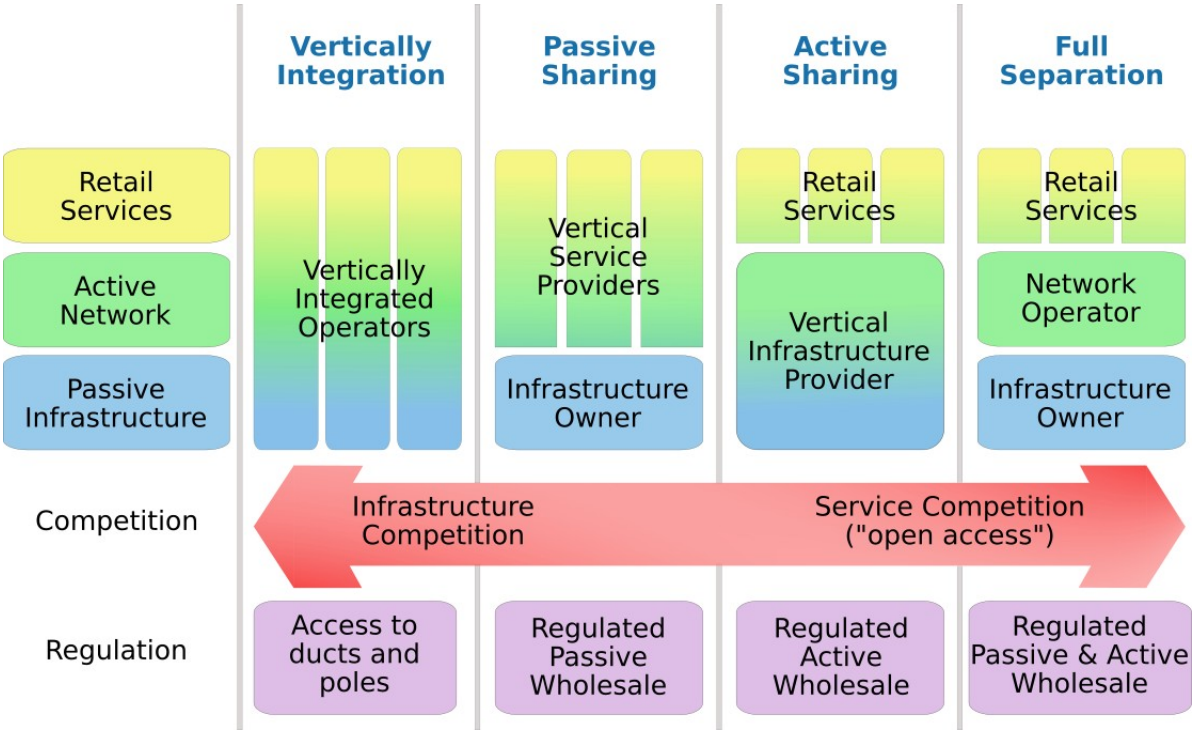
Vertical separation can be introduced through regulatory measures. A mild form of separation is requiring an entity to do *accounting separation*. The company is then asked to maintain separate records for its upstream and downstream divisions. This type of measure is meant to keep an entity from cross-subsidising upstream activities through downstream activities (through artificially low prices, for instance) or vice versa. For example, a company that owns the rail infrastructure and provides rail transport services may be required to keep the accounts of those two activities separated and not to use profits made in one to subsidise the other. This is

frequently referred to as *functional separation*.

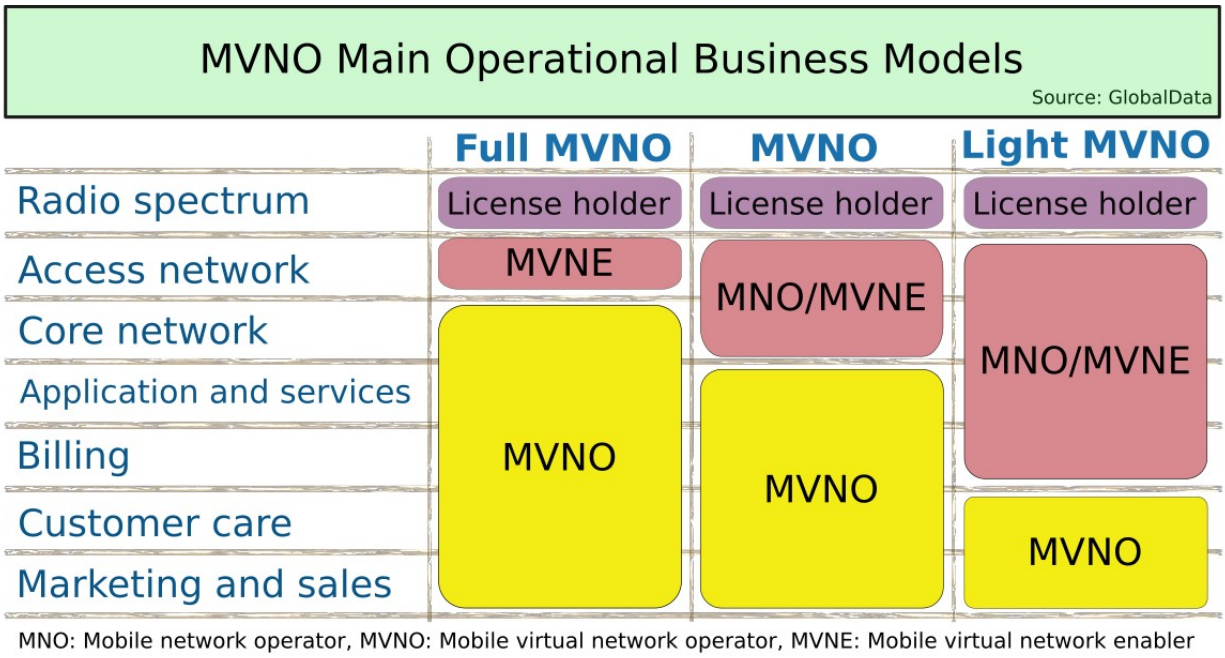
A strong form of separation entails regulators forcing the complete divestiture of the facilities/infrastructure into a separate company. In the railway example, the regulator would force the railway company to sell off its transport activities and all assets related to it (trains, station slots, etc.). This is frequently referred to as *structural separation*.

In between these opposite poles, there is a potentially infinite range of "operational" separation alternatives which impose various requirements. Regulators resort to these measures when the integrated company controls a hard or impossible to replicate infrastructure, or a facility which is essential for the provision of a product or service (so called “bottleneck” infrastructure or facilities).

Example B.3: Before the 1980s and 1990s, most telecommunications companies were vertically integrated voice communication carriers that owned networks and provided voice services. After de-monopolisation, some operators - notably in the UK and in Sweden - were vertically separated. Their physical cables were broken out into separate entities, OpenReach and Skanova, to ensure that competitors of the previous monopolists would have access to, and be able to provide services from, the copper networks on non-discriminatory and equal terms.



Example B.4: Mobile Virtual Network Operators (MVNOs)[2] are companies which provide mobile voice or data services to end-consumers without owning their own network infrastructure. To do so, they must be allowed to let their customers authenticate (prove their identity in order to get access) to the mobile network. In the European Union, competitor access to core facilities, such as when MVNO customers are allowed to authenticate, is regulated. LycaMobile is an MVNO that provides services in most EU countries, and provides cheap calling rates to foreign jurisdictions (in Africa, Asia or Latin America). In countries where infrastructure access is not regulated, there may not be any MVNOs at all!



MNO: Mobile network operator, MVNO: Mobile virtual network operator, MVNE: Mobile virtual network enabler

Example B.5: Outsourcing of activities that were previously managed inside of companies, such as cleaning or catering services, is a form of separation that can happen without regulatory intervention. It may also happen that a company sheds parts of its production line, for instance when Nokia stopped making mobile phone operating systems but continued to make mobile phones and mobile phone network equipment.

Bundling > A marketing strategy that joins products or services together in order to sell them as a single combined unit, usually at a price attractively lower than the total of their individual selling prices.

2See Annex: Glossary.

Example B.6: A wedding planner often offers all services – booking the venue, all catering services and the entertainment - as one package.

Example B.7: Some network access providers bundle television, internet, telephone and wireless communications into one package, often referred to as triple-play (excluding wireless) or quad-play (including wireless). ADSL[3] connections are mostly provided by companies that used to provide telephone services over a copper network, so internet+telephony was a "natural" bundling for these entities. Cable connections for television services became able to provide internet traffic through the DOCSIS standard.[4] This gave a "natural" bundling of television and internet services. The quad-play offer typically implies that the operator also enables WiFi.

Unbundling > The process by which a company with several different lines of business retains core businesses and sells off assets, product lines, divisions or subsidiaries. Unbundling may also refer to offering products or services separately that had been packaged together.

3See Annex: Glossary.
4See Annex: Glossary.

Example B.8: A personal computer package could be sold as individual pieces: it would be unbundled into its individual pieces such as central processing unit (CPU), graphics card, hard drive, monitor, keyboard, operating system and mouse, which would then be sold individually. This is common for computer gaming rigs, where individual pieces of hardware (notably graphics card) can make a big difference for the consumer.

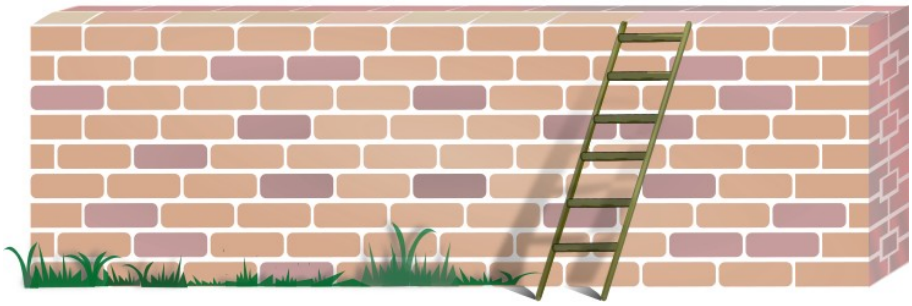
Example B.9: Previously in Belgium, mobile phones could not be bundled with mobile rentals (the subscription with the operator). It was feared consumers would buy mobile phones they could not actually afford if the true cost of the phone was hidden behind a monthly rental fee.

Example B.10: Traditionally, the generation and distribution of electricity were performed and provided to consumers in a bundled way. Then, in various areas of the world, regulatory interventions lead to **vertical unbundling,** a separation of the generation, transmission, distribution and (sometimes) retail functions into different commercial or administrative entities. This may allow competition in the various segments, and provides consumers with more choice.

Market entry > Refers to a situation where a new player brings a product or a service into the target market. When entering a market, the new market player may be faced with barriers to entry.

Barriers to entry > Costs or other obstacles that prevent new competitors from easily entering a market. Barriers to entry benefit existing companies because they protect their revenues and profits and keep out potential competitors.

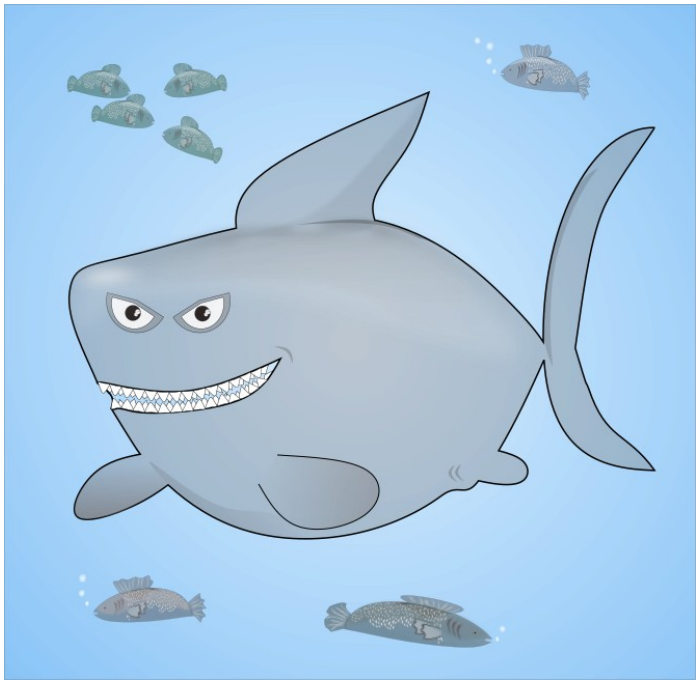
Barriers to entry can be: (i) natural (for example, high startup costs to drill a new oil well), (ii) created by governments (for example, by imposing licensing fees or patents), or (iii) created by other companies (for example, monopolists can buy startups - in some cases called *killer acquisitions*, or behave in a way that impedes market entry for competitors, for example by imposing high switching costs on consumers).



Market power > Can be defined as the company's 'economic strength' and its ability to act independently on the market, that is, without suffering competitive pressure from other companies or from consumers. In competition/antitrust law, a company with a certain degree of market power is defined as *dominant*. Dominant companies may be able to set higher prices or provide lower quality services than if they were exposed to competitive pressure from other market actors.

Traditional telecoms regulation in various countries has often referred to the concept of "significant market power" (SMP),[5] defining it in accordance with dominance under competition rules. Companies with SMP in telecom markets might be subject to asymmetric regulation (that is, regulatory burdens which are not applied to companies that do not hold SMP) to ensure that they cannot set prices too high or reduce service quality too much.

Dominance or SMP are established in relation to a relevant market. A relevant market is identified by reference to two dimensions: (i) what is on offer, and (ii) where it is offered. Roughly, different products or services are considered to be in the same market if consumers consider them substitutable. If a consumer wants to buy an apple, and a small but significant increase in apples' price causes them to buy a pear, then apples and pears are substitutable and competing in the same market. As for the second dimension, markets can be local (for example, transport services between the mainland and an island within the same country), national (usually, mobile communications services) or broader (for example, the market for raw materials).



Gatekeeper > A company with market power that is able to guard, and impede, market entry by other companies. Nevertheless, the concept of internet gatekeeper refers not only to economic market power, but includes also the ability to control the flow and accessibility of information and to structure the digital environment.

In some cases, gatekeepers can control the extent to which consumers can enjoy their rights and freedoms, for example freedom of information.

5Not to be confused with Social Media Platform (SMP), which has the same acronym but relates to an entirely different concept.

Example B.11: It could be argued that Facebook acts as gatekeeper of information, because it has the 'power to include, exclude and rank', which is understood as 'the power to ensure that certain public impressions become permanent, while others remain fleeting.'[6]

Example B.12: Operating systems are responsible for Application Programming Interfaces (APIs), which dictate how the software and hardware interact – including what information the app can access. APIs control the release of information according to the privacy controls in place at the [operating system] level[7]. Thus, operating systems act as gatekeeper for apps.

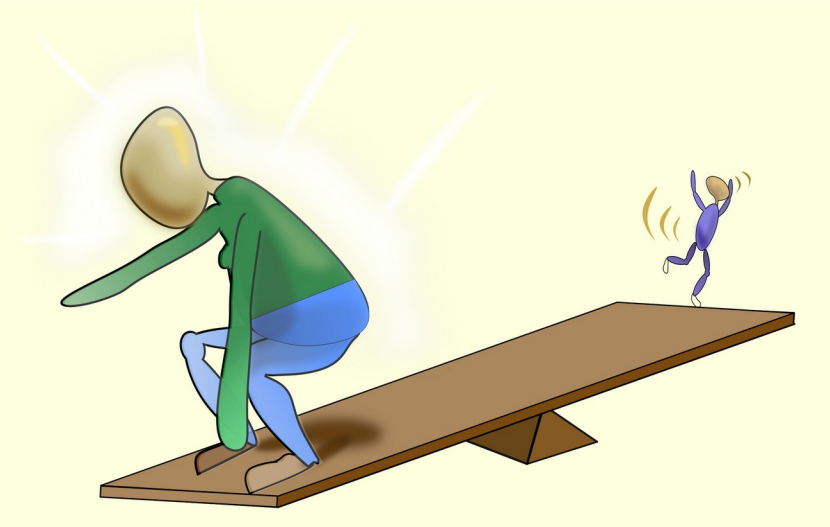
Leverage > Commonly used in antitrust law to refer to practices whereby a company with market power exerts such market power with a view to stretching it to a related market or to protect it from competition in the first (original) market.

Leverage can take the form of tying or bundling products and it can impede or make it more difficult for competitors to enter a market and innovate.

6Pasquale, The Black Box Society (n 39) 14.
7CMA, 'The commercial use of consumer data: Report on the CMA's call for information', CMA38, June 2015, 42. The relationship between operating systems, APIs and app is better explored in our module on Smartphone apps: https://docs.google.com/document/d/1Uo6iT3NjA4ONczWag-OipL-BjnLsmjMQH9l__vTDlco/edit?ts=5d67aabc#

Example B.13: Microsoft case: Microsoft bundled Windows media player with its Windows operating system to protect its dominance in the market for operating systems.

Example B.14: Google is dominant in the search engine market and leverages its market power by promoting its own shopping service in search results, giving it an unfair advantage over rivals.



Self-evaluation questions

1. Can you think of a different example of a bundled product than the ones provided?
2. Trace the value chain of one of your devices, for instance by looking up what chipset it contains, where the chips are manufactured, if there is information on who made the software, which software libraries it uses, and so forth. Sometimes tracing a value chain is tricky! But oftentimes you will find it with a simple internet search.
3. How could you classify each of these barriers to entry:
    a. There is no previous mobile network in a country?
    b. Providing the service requires a government license?
    c. A copyright license requirement?
4. Can you mention an example of bottleneck infrastructure? And a regulatory bottleneck?

Open Systems Interconnected Reference Model

The Open Systems Interconnections (OSI) model is a conceptual model for networked technologies ("interconnected systems") originally developed in the 1970s by the International Standards Organisation (ISO). It has broad international recognition and is codified in ITU-T Rec. X.200 (1994 E), a specification adopted by the International Telecommunications Union (ITU).[8]
OSI proposes that networked technologies can be, broadly, segmented into seven distinct layers, each performing specific technical functions, that are in principle different from each other. It started out as an attempt to create a technical standard for a network technology, where the features for each of the layers were provided independently of one another. Currently, there are no commercial implementations of a network technology following the OSI specifications in use, and the reference model is only a fairly good approximation of all network technologies that come after is.

For a human rights defenders, using the OSI reference model to analyse or contextualise social, economic and technical power has the advantage of the model being geopolitically legitimate. It has been defined through a rigorous, multilateral process over many years, and the reference model is endorsed by most governments worldwide. It is not connected to the products of any individual company,[9] so it is commercially independent too. In short, using it to portray social and economic power cannot be questioned solely on the grounds of it being biased towards any particular country, company or technology. We rely on this model as we believe that – because the way it organises technical features - it can help an activist visualise *who has the power over what* in a technical system. In combination with competition law, this is a powerful tool to question existing power structures in the tech industry and the influence these power structures have on human rights holders.

The architecture of a technology - it's structure, so to speak - determines which economic relations are more or less likely to occur in a marketplace. This translates into power over people (consumers), power over providers (think of a blogger providing content or some other service provider, such as a webstore) and power over politics (through the possibility of regulatory capture).The idea of this guide is to give the reader a quick and intuitive sense of the power dynamics that arise from the architecture of technology.

This section uses internet and wireless networks to illustrate the OSI reference model. It contains pictures to aid understanding of the model. We will be using the competition law

8The ITU was originally set up in the 19th century as the International Telegraph Union, but was incorporated in the United Nations (UN) structures in 1947. It is most famous for allocating telephone numbers to each nation, being responsible for country-code system of +XXX. In the internet age, it is most famous for its International Mobile Telecommunications (IMT) 20XX-requirements. They are published every ten years and contain expected future feature needs for mobile communications. IMT-2000 roughly corresponds to 3G, IMT-2010 roughly corresponds to 4G and IMT-2020 will roughly correspond to 5G.
9Which would not be the case for other similar reference frameworks, such as the TCP/IP reference model, which was originally created by Cisco to market the internet networking model.

language of section 1 to combine an understanding of the technical architecture with an understanding of economics.

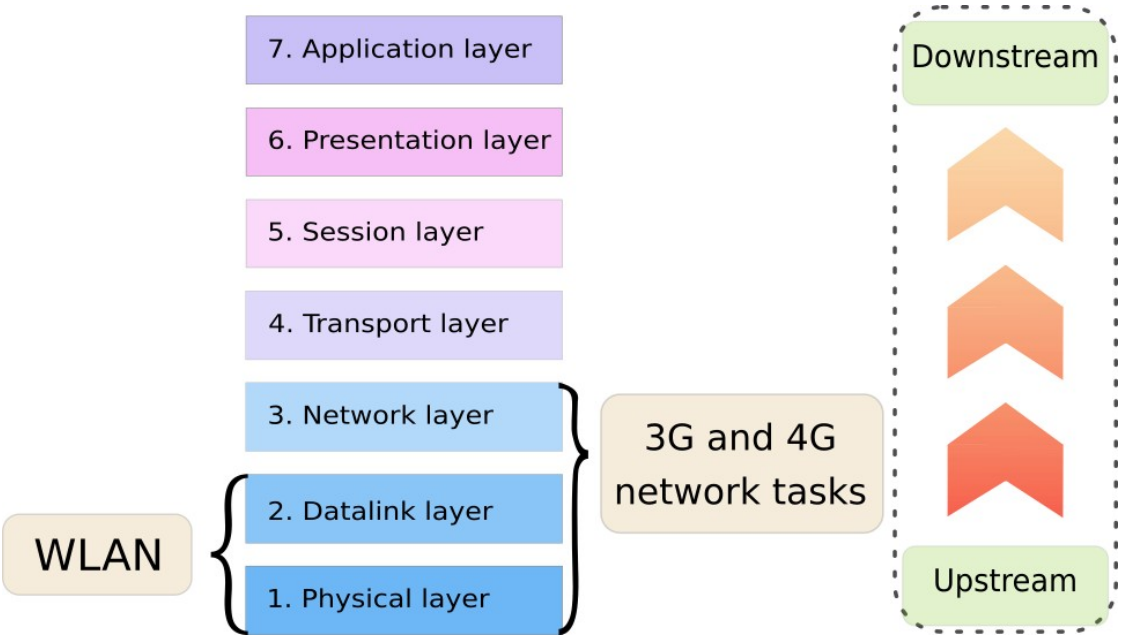
The Approximately Hardware Layers

Layer 1 of the OSI model is called “the physical layer”. It consists broadly of physical gadgets and its features are not implemented in software - radio transmitters, cables, chips requiring rare earth elements, can be approximately assigned here.

Layer 2 of the OSI model enables the physical layer to do stuff. Hardware with no features is just dead materials. A USB stick, for instance, is not only a small chunk of stuff, it can also communicate with your laptop.

Layer 3 of the OSI model is meant to provide interconnection between computers and networks. Unless you’re writing a thesis in engineering, being too strict with layer classifications will not be useful, so abstractly this layer deals with non-local stuff: it bears relevance not only on the physical hardware in your immediate surrounding but on other hardware too. Like how your router connects you to the internet.

3G and 4G mobile network technologies roughly cover layers 1, 2 and 3 of the OSI model. Wireless local area network (WLAN) technologies cover layers 1 and 2 of the OSI model.[10] They are different technologies and function differently on these layers. Consider this image:



Upstream there is hardware and low-level data protocols used to ship data in and out of cables to or from a harddrive. Downstream there are applications, such as e-mail, software or apps. In between there are a bunch of technical layers that help network equipment interoperate - send data to and from one another. Normally, the closer you get to the application the higher you are

10See Annex: Glossary.

in the model hierarchy, so features on the top are called "higher layer features". Similarly, the closer to the hardware you get, the lower you are, so these features are called "lower layer features". The upstream and downstream wording comes from dependencies: higher layer features depend on lower layer features, but the opposite is not true. The downstream features of the protocol stack depend on the upstream features of the stack, but not the reverse.

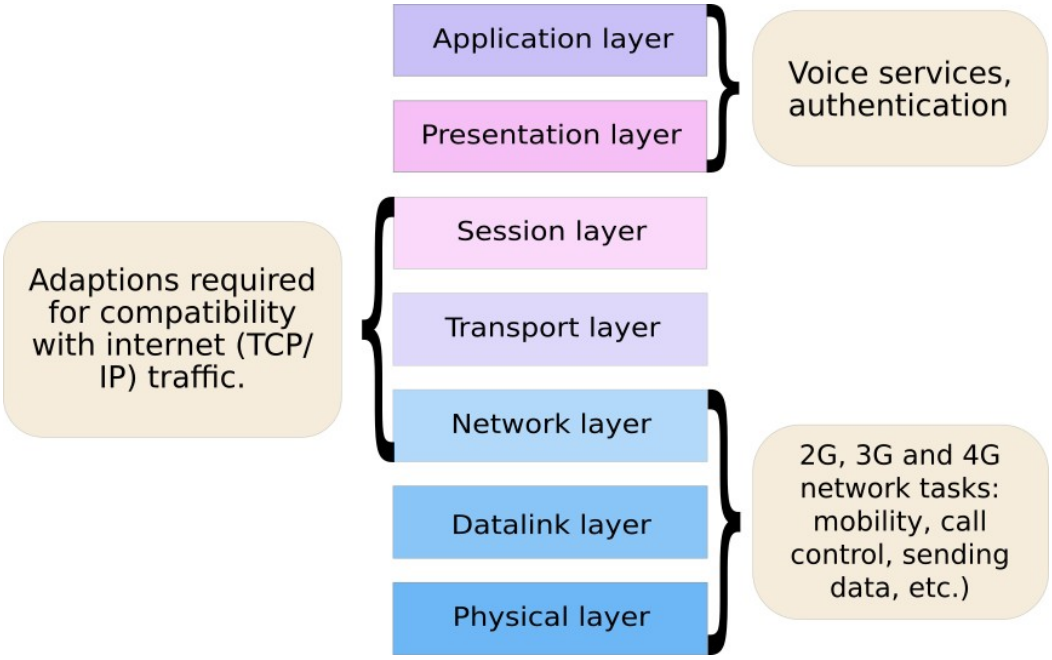
Example O.1: WLAN technologies do not broadcast unless they have found a *channel* which is not occupied, while mobile networks broadcast without knowledge of the occupation state of a channel. When WLAN and mobile networks have to share the same spectrum, WLAN technologies are at a disadvantage. Since it *listens-before-it-talks*, the more talkative technology, the technology which broadcasts into the channel without ensuring that it the channel is not occupied, may end up monopolising the communication.

Example O.2: 3G and 4G networks include fairly good mobility features. A mobile network consists of base stations[11] that together make a web of radio towers. Mobility features allow a device to pass smoothly from being connected to one base station to being connected to a different base station, for instance when someone moves (consider maintaining connectivity while on a train, in a car or when you are walking). In a mobile network, connectivity works at long range too, at distances of hundreds or thousands of metres. A WLAN access point,[12] on the other hand, may only be able to provide high-quality connections from within 20-30 metres. A moving device might have more challenges passing from one access point to a different access point. Access points are wifi base stations, and base stations are mobile access points.

Mobile and WLAN are competing on the same OSI layers, and knowing this will help to understand when and how technical design choices influence the relationship between different technology providers. It will also help understanding how different regulatory choices can give precedence to one technology over the other.

An OSI representation gives a rough sense of the types of bundling, unbundling, vertical separation or integration that are possible, reasonable or assumed. In wireless technologies, such as WLAN and mobile networks, some form of technical integration between layers 1 and 2 is assumed.

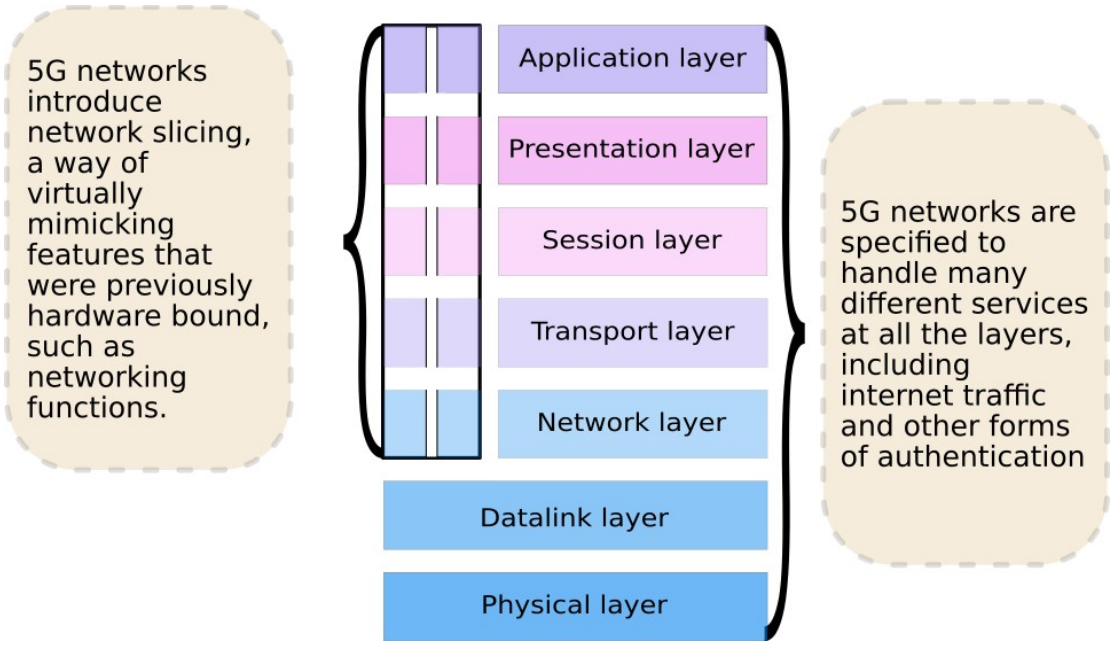
11See Annex: Glossary.
12See Annex: Glossary.



3G and 4G networks contain higher layer methods of verifying consumers' identity (for instance to do billing), but also voice call and text messaging features. The voice and text message functions are legacies from the age of telephones and mobile equipment vendor experimentation in the 1990s. But the authentication functions are a mandatory part of a 3G and 4G network, and imply that any higher layer service cannot be provided to a user if the user is not able to perform the authentication function as prescribed.

Example O.3: Internet traffic and mobile network traffic overlap at the network layer (see picture) while the application and presentation layers have completely separate implementations as compared with internet networks. This creates some technical difficulties in the reconciliation between internet and mobile types of data transfer, which translates into competition since different companies are specialised in different forms of technical transmission. Competition between technologies can create political conflicts, both at a local market and at the global stage. How such conflicts are solved can impact many things, including human rights.

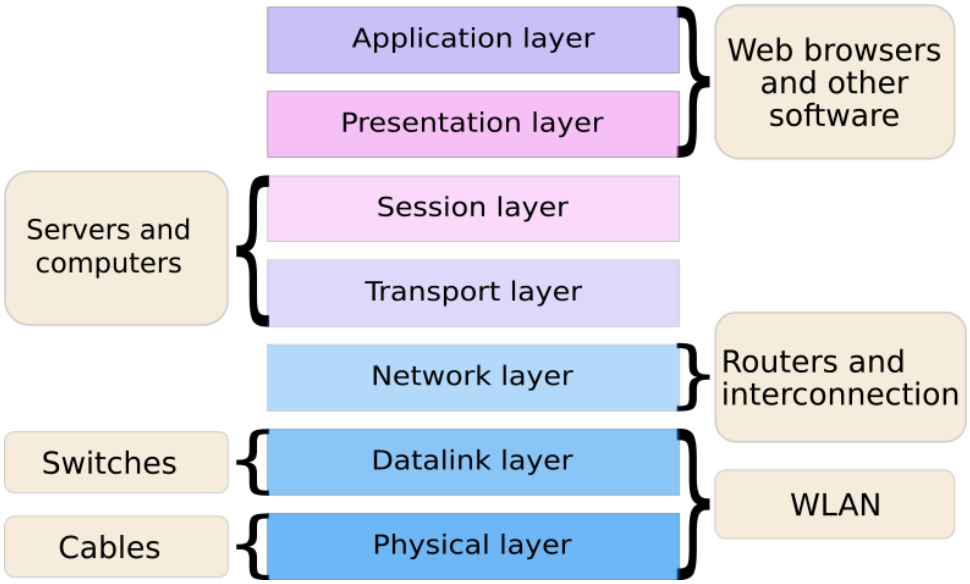
Mobile networks are more vertically integrated than WLAN technologies, since they technically bundle functions as a core feature of the technology. In particular, they bundle physical infrastructures (layers 1 and 2) and higher layer functions (layers 6 and 7). In a sense, the technology is built to allow the network to take as many decisions as possible to enable or allow, or disable and disallow any user actions, such as making a call, using data, at what speed data can be transferred, or, if there is not net neutrality, which type of application services can be accessed. But 5G promises to take even further steps in this direction.



An OSI perspective on 5G at the same time illustrates both perceived opportunities and perceived risks with the technology. 5G tries to create a much more vertically integrated technological “stack”, where more features from a larger range of layers are dependent on the mobile network equipment and mobile network operators. 5G may increase the leverage or market power of mobile equipment vendors, or of mobile network operators, or of both. 5G may also create opportunities for new, and more limited, mobile network operators, for instance in a network slice. Additionally, many 5G white papers envisage that 5G networks will simply do many more things and enable many more services than traditional networks do. Identity management and various forms of traffic shaping and prioritization in critical environments are notable. Deterministic networking could allow network operators to choose the path of data, with a view to providing better latency[13] or confidentiality guarantees in a local network.These new features could crowd out solutions and services that were previously provided independently of the network.[14]

There are ways in which an internet network consisting of ADSL,[15] fibre optics or WLAN would be different from the mobile network reference models.

13See Annex: Glossary.
14For deeper reflection, see Using layers for policy analysis: 5G Technologies.
15See Annex: Glossary.

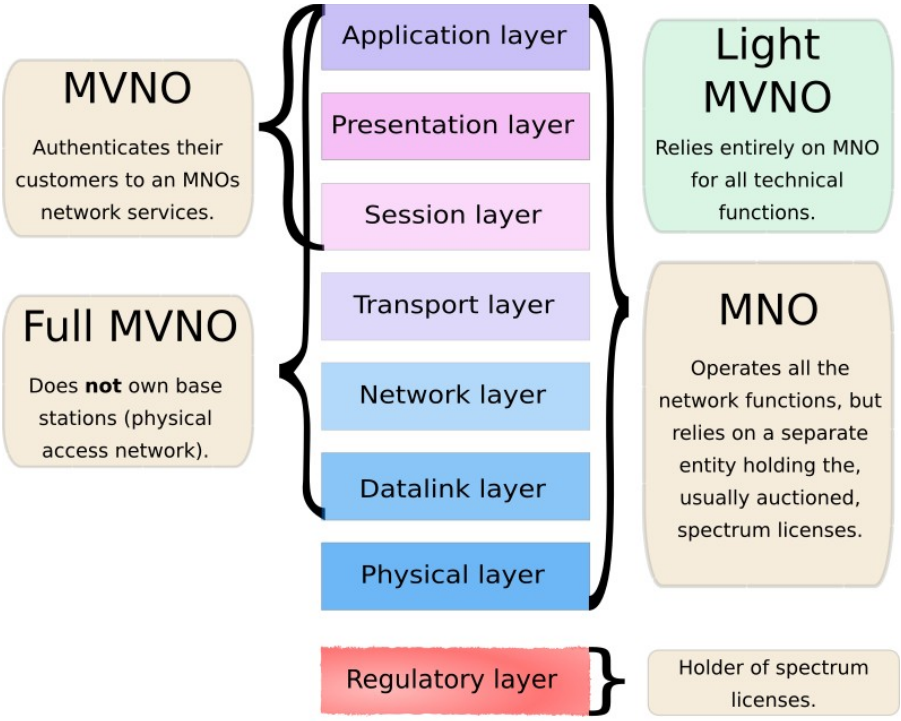


Layers 2 and 3 in this image shows a technical unbundling between physical infrastructures and higher layer functions, by which we can understand that the interconnection between higher layer functions can in principle be done by different commercial entities. Unlike in 3G, 4G or 5G networks, lower layer functions do not need higher layer functions to work. This architecture is the reason that the internet is sometimes referred to as a *network of networks* (the layer 2 and 3 functions allow networks to interconnect). If a local network is connected to a larger network which in turn is connected to a global network, in principle higher layer functions can be passed from one local network to a different local network through the other networks.

The *barriers to entry* for building a local network are lower in the internet architecture. It is easier to envisage an *unbundling*, or *vertical separation*, of different technical functions in the internet architecture than in the mobile architecture, and it's also easier to foresee a modular approach to a network, where devices on different layers perform different tasks and are produced by different entities.

Example O.3a: Anyone who buys a wifi-router can set up their own wireless local area network, either in a café, at a university or in their home. Mobile networks often have to be provided by a mobile network operator, and if the mobile network operator has not built a base station close to a building, the owner of the building would usually have to ask them to do so but cannot invest in infrastructure themselves to facilitate mobile network access.

Example O.3b: If the inhabitants of a village decide that they want to create a local area network that connects computers or mobile phones in each of the houses in the village, they can later connect their local network to a larger network (for instance a regional backhaul network or national backhaul network).[16] The inhabitants of the village could choose different equipment providers for the cables, switches, servers and routers that they need to make the network work. A mobile network comes as a full package: the entire infrastructure would come from the same equipment vendor. Regulatory barriers are often in place to ensure that villages do not build their own mobile networks, and often a village would have to wait for a mobile network operator to roll out infrastructure before they got a connection.



Relying on conceptual models for technologies can assist a policy analysis in the same way that conceptualising market layers (such as billing, customer care or marketing) does. It provides an understanding for which market functions have or require technical solutions, and which market functions are independent of the technologies used by a consumer. Consider the following examples:

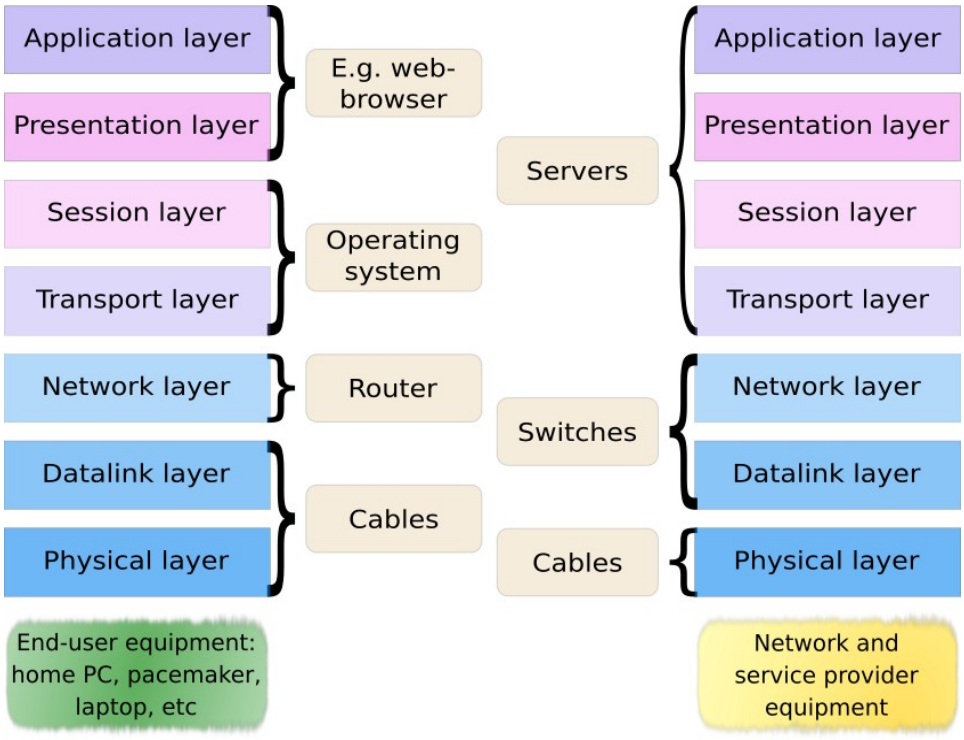
16For definition of backhaul, see Annex: Glossary.

Example O.3c: Billing is an integrated part of the mobile network technology through the authentication functions, but it is not an integrated part of WLAN technologies or Ethernet networks. A mobile network operator knows who to bill and for how much because every access to the network is always authenticated, and this authentication is performed as an interaction between the lower and higher layers. In WLAN and Ethernet technologies, billing is solved by a service provider at a higher layer, typically at layer 7 (Application) through direct interaction with a user (for instance a web interface, such as a captive portal). That means authentication functions do not have to be built into the lower layers of the technology.

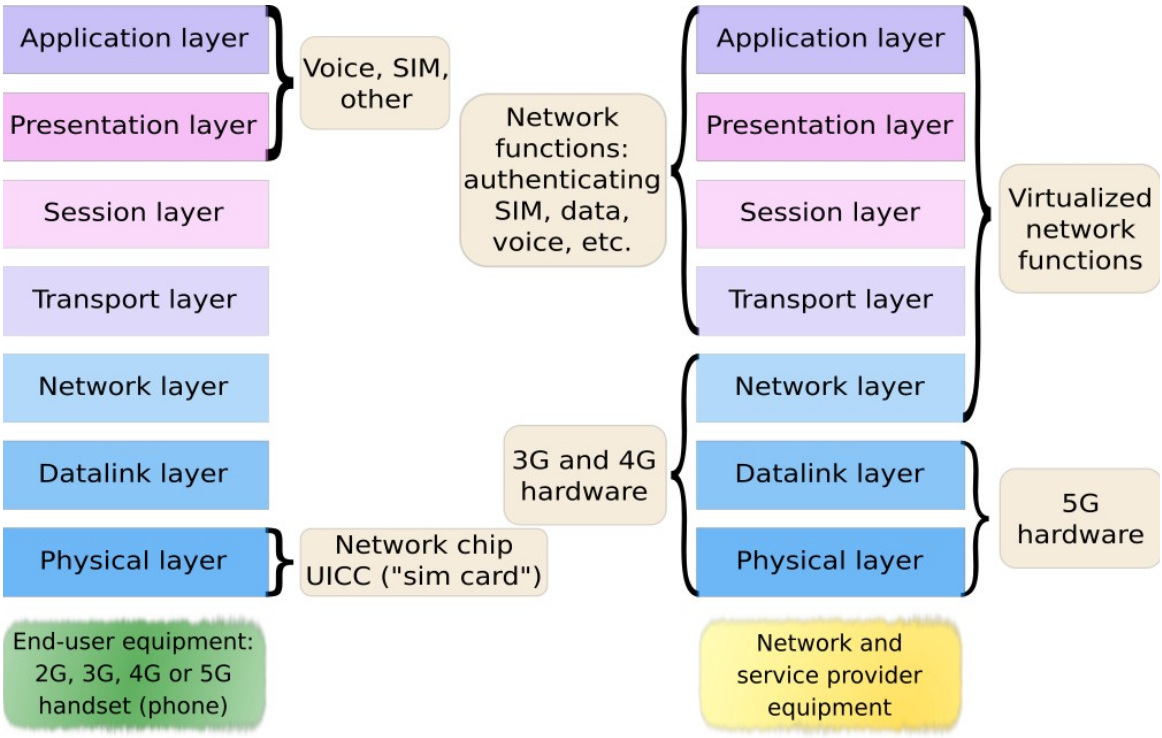
Example O.3d: Customer care is generally independent of the technical service, as is marketing. There is no technical feature which can be built into a network that makes customer care or marketing function better - even if technical features can be helpful to customer care personnel or enable more flashy marketing. Holding a spectrum license is similarly not a technical function - it is a regulatory function. No amount of technical features changes the spectrum license, since it's a document from the government. The OSI model does not ordinarily contain a layer to display regulatory functions, but we can extend it. On the other hand, the virtuality of an MVNO is easily seen: it has no physical infrastructure, and so is virtual.

Different tech, different layers

The following two images show how the technical segmentation is different on the network and service provider and end-user equipment sides.



In an **internet architecture** many features are implemented in the end-user equipment, and the end-user can configure or control how these features behave - including in interactions with network and service providers. For this reason, internet architectures are sometimes referred to as *user-centric*.



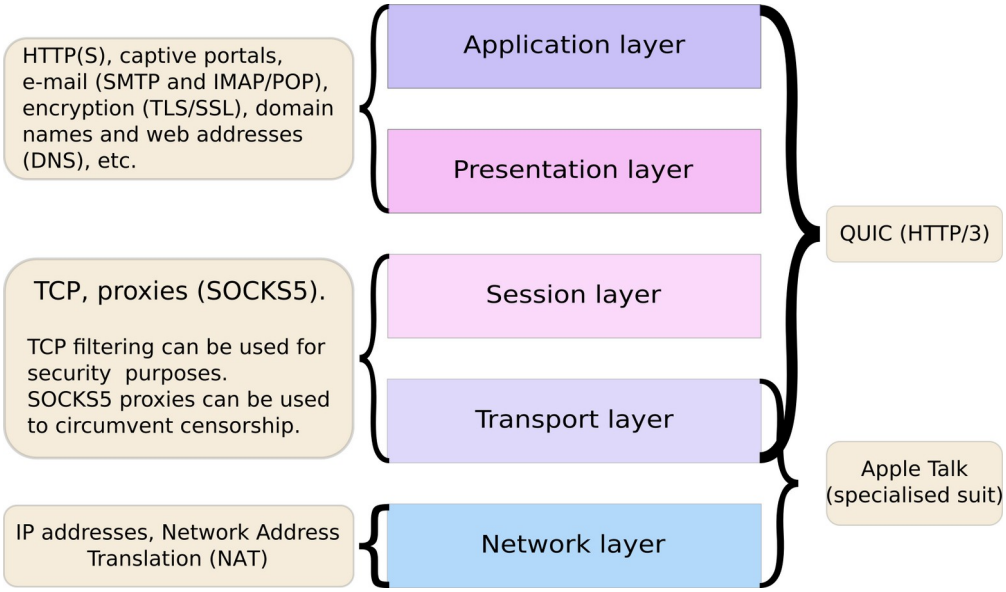
In a **mobile network architecture**, fewer features rely on the end-user equipment. This architecture is sometimes referred to as a *network-centric*.

All The “Higher” Layers

We have so far mostly explored lower-layer technologies, but may ask if there is any use for OSI model conceptualisations in higher-layer technologies as well. The contrast between internet and mobile architectures already hinted that this might be the case: web browsers, for instance, take care of many functions in the higher layers and are increasingly posing many interesting problems of market power and control.

There are formal definitions of layers 4, 5, 6 and 7, but they may feel convoluted in a modern technology setting. It’s not clear that any modern technology actually conforms with layer 6 (Presentation Layer), for instance.

The highest layer, layer 7, is where we encounter technical terms that are used in every-day conversations: the Hyper-Text Transfer Protocol (HTTP) in the beginning of each web address, the Transport Layer Security (TLS) encryption that protects confidentiality and integrity of web traffic, or the IMAP/POP that some of us have to deal with when configuring e-mail clients such as Thunderbird, Apple Mail or Microsoft Outlook. On layers 3-5 there are some services that you may run across if you try to follow tech policy, such as Transport Control Protocol (TCP), Internet Protocol (IP) addresses or Network Address Translation (NAT):



In the higher layers, it's not clear that the OSI model is a sufficiently flexible model. In the module on Smartphone Apps[17] you find suggestions for how to extend conceptual models of vertical separation to broader settings.

Example O.4: At the transport layer we find the Transport Control Protocol (TCP), which is often used by firewalls or intrusion detection systems to sort out good traffic from bad traffic. Good traffic could be e-mails or websites that contain information that an internet user wants, while bad traffic could be malware, DDOS packets, and other things that disturb the network. The sorting is done by looking at packet headers, a small dataset which contains information about where the packet is from and what type of data it contains.[18] This type of security infrastructure increases the market entry barriers for updated TCP versions, such as MultiPath TCP (MPTCP) or perhaps HTTP/3.

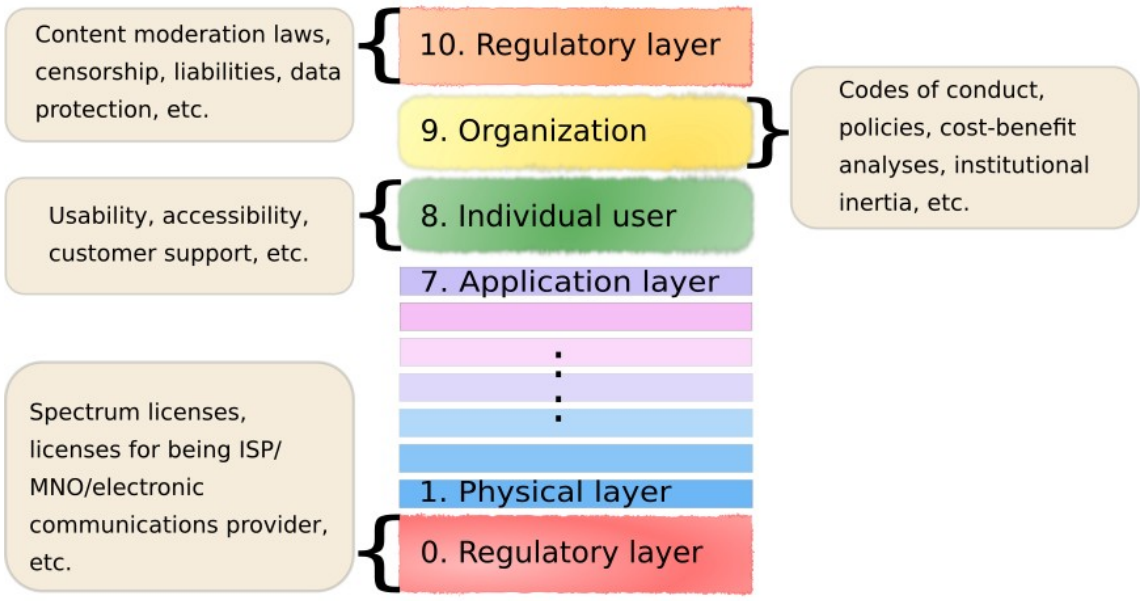
Example O.5: AppleTalk is a specialised protocol suit for layers 3 and 4. When the Apple eco-system is sometimes dismissed as a "walled garden", this is a reference to Apple making improvements on existing protocols in a way that does not necessarily ensure interoperability with other companies' services at other layers. An Apple app that uses special Apple features may not be available at all on other platforms, for instance. This is vertical integration on the technical level.

17See the module Using layers for policy analysis: Smartphone apps.
18Explanation of packet headers and illustrations available for instance here: https://www.inetdaemon.com/tutorials/internet/tcp/tcp_header.shtml

Example O.6: QUIC (HTTP/3) is an improvement on previous website delivery that speeds websites up a bit compared to older versions of HTTP. It creeps lower in the layers than previous HTTP versions.[19] One way of looking at the OSI representation is that Google, a driving force behind QUIC, is expanding downwards in the OSI layers, while mobile operators are trying to expand upwards. When there is talk about increasing *consolidation* in network technologies, this type of increasing vertical integration is the focus of concern.[20] Other types of consolidation, such as telecommunications companies buying television companies, is also happening, but this is not having much effect on technology standardisation yet.

The OSI model is heuristically extendable to different use-cases. We have already added a regulatory layer at the bottom to describe market conditions for all the technical layers (spectrum licensing). Let's call it "layer 0".

Other non-technical extensions have also been proposed, including a "layer 8" of individual users.[21] It is meant to sensitise engineers to how individual users will end up using a particular design. "Layer 9" consists of organisational policies (cf. Example 4) and "layer 10" has regulatory aspects such as content laws, copyright or trademark laws, data protection laws, liabilities and tort law, and other similar influences on the technical infrastructure.



19Some notes about HTTP3, Rob Graham. https://blog.erratasec.com/2018/11/some-notes-about-http3.html
20Consolidation, Internet Architecture Board (IAB), Internet Engineering Task Force (IETF). https://www.ietf.org/blog/consolidation/
21Layer 8, Wikipedia-article. https://en.wikipedia.org/wiki/Layer_8

Example O.7: Copyright holders have long claimed that internet service providers (ISPs) should be liable for copyright infringement by internet users. ISPs used to argue that liability was more appropriate for higher layer services, or individual users. Recently, copyright holders claim that also higher layer services should be liable for users' infringements.[22] These services object that liability should be placed with individual users. Since lower layer functions affect higher layer functions, the functionality in higher layers may be negatively impacted by liability of lower layer functions.

22The copyright holders' calls expand to video sharing platforms too. A recent example is Italy, where Mediaset, one of the major broadcasters and content producers, sued a number of video sharing platforms for copyright violation, asking for the removal of videos from the platform and related damages. The cases against Dailymotion and Vimeo have already been decided by the lower court, while 5 similar cases are still pending. See: https://www.lexology.com/library/detail.aspx?g=da1eb71f-73f9-4f3c-b4ca-5424805ffcc1&utm_source=lexology+daily+newsfeed&utm_medium=html+email+-+body+-+general+section&utm_campaign=lexology+subscriber+daily+feed&utm_content=lexology+daily+newsfeed+2019-07-29&utm_term=

Self-evaluation questions

1. Can you make an OSI sketch of the Vertical Integration Model from section 1?
2. Local-loop unbundling was a regulatory measure in the EU in 2000 which obliged network operators whose networks extended to private residential homes to allow access to service providers. Compare this with the MVNO Operational Business Model and the Vertical Integration Model for the telecoms sector by sketching your own OSI charts.
3. Do physical and data-link layers have to be wireless technologies?
4. Make a sketch of the 7 OSI layers on a paper. Mark down the following operational business models:
    a. A fixed network internet service provider who also provides e-mail services to customers.
    b. A WiFi network provider who allows users to log on via a captive portal.
    c. A provider of home routers.
    d. A web design company specialised in security and privacy-friendly designs.
5. Looking at the authors of IETF documents for QUIC[23] and MPTCP,[24] bear in mind the competitive situation described on layers 1-2 between WLAN and mobile networks. Reflect.

23QUIC Working Group, IETF. Compilation of working documents, drafts, RFCs, e-mailing lists, meeting agendas, etc. https://datatracker.ietf.org/wg/quic/documents/
24MPTCP Working Group, IETF. Compilation of working documents, drafts, RFCs, e-mailing lists, meeting agendas, etc. https://datatracker.ietf.org/wg/mptcp/documents/

SEQ Proposed answers

Some of the self-evaluation questions are such that there isn't a definitive answer. For some of the questions, we provide examples of what answers could look like.

Basic Concepts

1. The sale of a car can be bundled with an insurance and maintenance services. Zero-rating is a form of bundling: you get connectivity and additionally access to some pre-selected services. If you buy a soccer kit, you're buying a bundle of jersey, shorts and socks. Your imagination is the limit.
2. One of the authors' smartphones: all chips (network, graphics, etc) are from Qualcomm, companyware is from Sony and Sony also manufactured the phone. The original operating system was from Google Android, but it now runs Jolla SailfishOS (the phone is jailbroken). The SIM card is from Light MVNO Comviq (with no obvious clues as to the original hardware manufacturer available with a quick internet search). Comviq is wholly owned and operates on the networks of Tele2. Apps are by different developers.
3. a) Natural.
   b) Regulatory.
   c) Regulatory.
4. An example of bottleneck infrastructure is the railway network: it is difficult, if not impossible, to replicate and it is essential to provide rail transport services. An example of regulatory bottleneck (that is, a bottleneck created by regulatory measures) is the spectrum license, which is essential to provide mobile communications services.

OSI Model

1. For instance

2. Local-loop unbundling relies on the network of networks feature of internet technologies. It's actually a vertical separation introduced in layer 1-3 infrastructures, that allows more market actors to provide services on layers 2-3. Compare with MVNOs and Light MVNOs, or with Vertical Service Providers, Retail Service Providers and Network Operators.
3. Answer: No. Definitely not.
4. a) Trick question. It depends on whether they are vertically integrated. It could be layers 1-3 and 7, or layers 2-3 and 7, or all the layers (considering that e-mail services require a server with layer 4-7 capabilities).
   b) Layer 1-3 and 7. You might need a layer 4-7 server to handle user identities, etc.
   c) Layer 2-3.
   d) Layer 7. If the web bureau also provides hosting, it needs a server and layers 4-7 capabilities, of course.
5. They could be seen as reflections of different visions for how the mobile environment can be made faster, more efficient or more user-friendly.