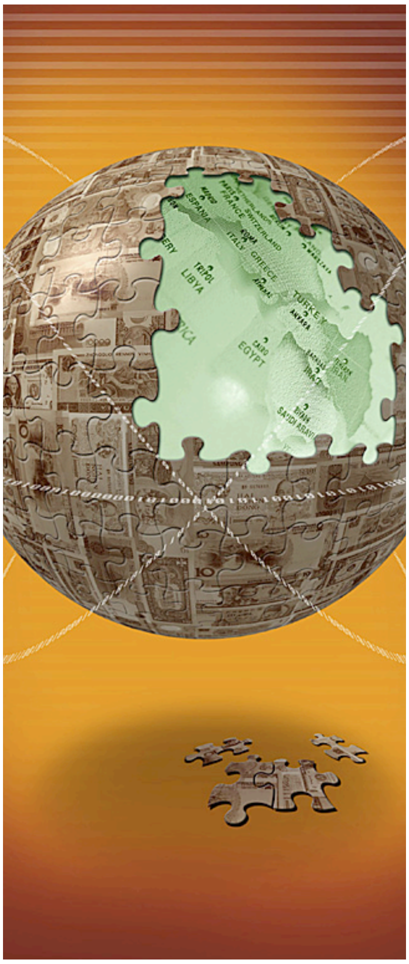
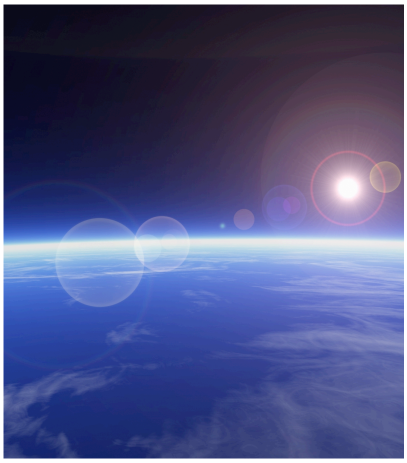


The Net is Flat

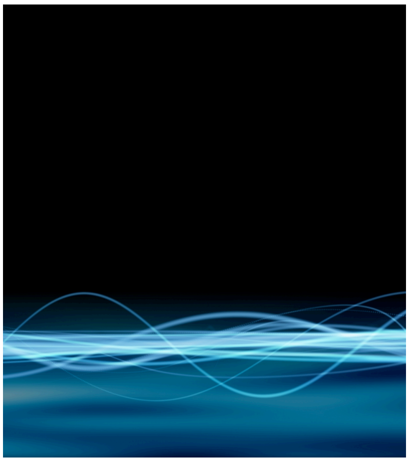
Alfonso Fuggetta
CEFRIEL

November 2007



Highlights

The telecommunication market is experiencing a turmoil. The advent of Internet has changed not only the business of "interconnecting computers", but has radically revolutionized several economic sectors, creating entirely new applications, products, and services. The implications of this revolution are not fully understood yet. In some cases, this inability of fully considering the implication of the Internet revolution is motivated by the fear or unwillingness to change the operational and business models that have guaranteed success and prosperity to many companies for decades.. Often, however, there is also a cultural difficulty in adopting and appreciating the new approach and perspective induced by the evolution of technology. *The net is flat*: this is the big news. And we need to understand the implications and effects of this radical change on the market and on our daily life.



The Net is Flat

Dinosaurs, Ocean Liners, and Low-cost Airlines

Until the fifties, a passenger who wanted to travel from Europe to the Americas had no choice: the unique possibility was to take one of those wonderful ocean liners, such as the Queen Mary, the Queen Elisabeth, the Italian Rex and Andrea Doria, or the famous Mauritania and Aquitania. For many decades, they were the symbols of wealth, power, modernity, and luxury. The only attempt to create an effective alternative to ocean liners were zeppelins. But the tragic explosion of the Hinderburg over New Jersey skies put an end to that dream.

Despite their success and even the myths surrounding their existence and operations, in the early sixties ocean liners basically disappeared. A new transportation means replaced them. Almost simultaneously, two american companies, Boeing and Douglas, released two incredible airplanes. Prior to World War II, airplanes were "noisy, cramped and vulnerable to bad weather"; moreover, "few had the range needed for transoceanic flights, and all were expensive and had a small passenger capacity." But the newcomers, the beautiful Boeing 707 and DC 8, were able to fly at about 1000 km/h, carrying almost 200 passengers. The autonomy was sufficient to cover transatlantic travels, and operational costs were affordable. Most important, passengers were able to fly from Europe to the USA in about 10-12 hours compared to the several days needed by an ocean liner [1].

It was the end of an era. Suddenly, ocean liners disappeared. Some were transformed into floating hotels; other silently terminated their lives in some remote harbor or dock. But liners as such didn't disappear. They are reborn as cruise liners. Indeed, contemporary liners are even bigger and more luxurious than the giants that used to cross the Atlantic during the first half of the past century. These new ships, however, have totally different characteristics and purposes. They are not used to travel from one point to another, but to enjoy life while traveling. *The old dinosaurs disappeared because a new breed made life for them impossible or forced them to change completely in order to fit the new environment.*

Incredibly, in the past decade something similar happened to large airlines. A new generation of airlines appeared on the market: low-cost carriers. They offer basic services, often exploiting secondary routes and airports. On-board services are almost inexistent or significantly reduced. There is a single class of service. Aircraft operations and maintenance are streamlined and simplified through the adoption of a single airplane model, with low operating costs and maximum operational flexibility. The emphasis is on providing the passenger with cheap ways to move across countries. Low-cost carriers have made air travel affordable to anybody.

One of the key factors that has enabled low-cost carrier to innovate the air travel market is the introduction of comprehensive and easy-to-use web-based systems. Customers can easily plan and organize their travel on-line, at their homes and offices, anytime. Consequently, airlines' selling costs are dramatical reduced. Overall, *the customer pays only the pure cost of transportation*; at the same time, the airline can *concentrate on core operations*. Simultaneously, airports have dramatically increased the number of services for travelers, *who can decide if and where to spend the money they saved by purchasing cheap tickets*.

The death of ocean liners and the rise of low-cost airlines are both *the results of technological and market innovations*. In particular, the introduction of new and cheaper airplanes, the increased airport capacity, the creation of new airports, the introduction of efficient air traffic control systems and web-based systems caused a radical paradigm shift. Usually, such changes cannot be limited or stopped. Maybe, they can be slowed down or somewhat hindered, but sooner or later "the tide destroys the bank". It is difficult if not impossible to stop the wave when it comes. The only possibility is to anticipate and ride it.

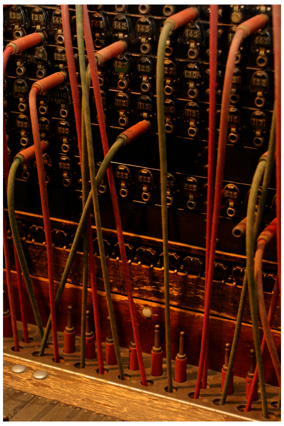
This paper discusses the innovations and breakthroughs that are transforming the telecommunication market. The transformation is deep and radical, with implications that are similar in scope and extent to those discussed in the previous examples. It is essential, therefore, to understand the main directions and effects of such transformation. For this reason, the paper analyses the nature and characteristics of modern telecommunication infrastructures. Then, it presents the most important applications and services exploiting these infrastructures, and how they are changing many existing businesses and industrial sectors. Finally, the paper discusses the implications of these changes from an economic and market structure viewpoint.

The Evolution of Telecom Infrastructures

From Circuit Switching to Packet Switching

In telecommunication technology, we are witnessing a radical revolution that is comparable to the introduction of airplanes and low-cost airlines. Since the introduction of phone services in the late nineteen century, telecommunication was based on the notion of circuit switching [2]:

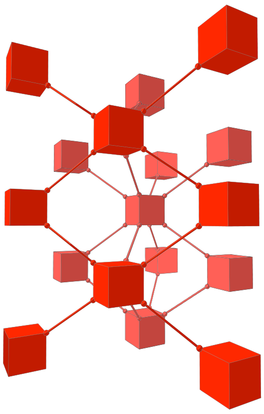
> *In telecommunications, a circuit switching network is one that establishes a dedicated circuit (or channel) between nodes and terminals before the users may communicate. Each circuit that is dedicated cannot be used by other callers until the circuit is released and a new connection is set up. Even if no actual communication is taking place in a dedicated circuit then, that channel still remains unavailable to other users. Channels that are available for new calls to be set up are said to be idle.*



Basically, in circuit switching communications, a channel is established between two end points. In order to establish this channel, the "network operator" has to create a specific end-to-end pipe to carry the information.

The introduction of digital communication and in particular of packet switching has radically changed the situation [3]:

> *Packet switching is a communications paradigm in which packets (units of information carriage) are routed between nodes over data links shared with other traffic. This contrasts with the other principal paradigm, circuit switching, which sets up a dedicated connection between the two nodes for their exclusive use for the duration of the communication. Packet switching is used to optimize the use of the channel capacity available in a network, to minimize the transmission latency (i.e. the time it takes for data to pass across the network), and to increase robustness of communication.*



In practice, information is converted in a stream of bits. This stream is divided in a number o packets that are sent independently from each other from source to destination. Packets can even follow different routes, depending on the state of the network.

Packet switching is the heart of Internet. It was originally introduced to optimize the communication among computers. Eventually, it has had a much wider and radical effect: *with the introduction of packet switching, the network has become a general-purpose transport means for bunches of bits. The network has little – if any – clue about the nature and meaning of the information it is transmitting*.

An essential characteristics of packet switching is that it inherently deliver packets according to a best effort policy: delivery time and even ordering of packets are not guaranteed a priori [5]:

> *Best effort delivery describes a network service in which the network does not provide any guarantees that data is delivered or that a user is given a guaranteed quality of service level or a certain priority. In a best effort network all users obtain best effort service, meaning that they obtain unspecified variable bit rate and delivery time, depending on the current traffic load. By removing features such as recovery of lost or corrupted data and preallocation of resources, the network operates more efficiently, and the network nodes are inexpensive.*

In reality, Internet has been enriched with protocols and layers (such as MPLS) that provide means to enforce specific levels of *quality of service (QoS)*. Still, it is essential to keep in mind the nature and characteristics of the basic approach used in Internet, best effort, since they have a number of important and strategic consequences.

Seven Major Changes

In parallel with the advent of Internet, there have been seven other essential revolutions:

1. *Everything is digital*. The impressive achievements of Digital Signal Processing (DSP) techniques have made it possible to transform any information we produce into a stream of bits. Music, video, still images, TV shows: anything can be digitalized, distributed, and exploited through digital networks and a variety of digital devices (computers, PDA, mobile camera phones, MP3 players, …).
2. *Memories are amazingly powerful*. The capacity of solid state memories have improved by orders of magnitude. Moreover, it is possible to store information even when the memory chip is not powered. Finally, the physical size and memory cards and their consumption profiles have improved dramatically. Similarly, disk technology has evolved significantly, making it possible to have terabytes of data on very small devices.
3. *Computing units are smaller, more powerful, and consume less energy*. Moreover, the possibility of combining silicon, indium, and gallium arsenide will enable the integration of optoelectronics and computing capabilities in a single chip.
4. *Communication means are pervasive*. The amazing development of wireless and wireline transmission technology has made available a number of different means to interconnect everything. In particular, the adoption of DWDM (Dense Wavelength Division Multiplexing) has made it possible to dramatically increase the bandwidth of existing optical networks. At the same time, xDSL techniques (Digital Subscriber Lines) has enabled broadband transport over conventional copper wires. Wireless technologies such as WiFi, WiMax, and UMTS have brought IP connectivity to mobile devices; they also hold the promise to significantly reduce digital divide. Finally, the advent of new short-range techniques such as ZigBee is enabling new and challenging scenarios in personal area and wireless sensors networks.
5. *Sensors are everywhere*. Nowadays, it is possible to collect information about any phenomena and events characterizing or occurring in our environment.
6. *New materials, new devices, new metaphors*. There is continuous flow of innovations and advances related to new material, new devices, and new metaphors (e.g., iPod control wheel). They have made it possible to create completely new concepts and products. For instance, ultra wide resolution displays (8 megapixel) will push forward the frontier of visual interaction. At the same time, they will impose new and very stringent requirements on the bandwidth of telecommunication networks.
7. *The ubiquity and power of software*. The availability of cheap computing power, low-cost and capable memories, and ubiquitous connectivity makes it possible to embed elaboration capabilities everywhere. These capabilities are exploited through software applications and services that are able to provide any object with intelligence and context-specific features.

It is therefore possible to build and deploy small, intelligent, and mobile devices that are able to receive, create, manipulate, and transmit huge amounts of digital information produced not only by humans and conventional computers, but also by real world "things". It is the *Age of Pervasive ICT*, also called the age of m2m (machine-to-machine). These intelligent devices are the entry points of a *new* *generation of applications and services, totally integrated through the Internet.*

Summing up, it means that *it is possible to store information everywhere,to distribute computing power in any object we use in our life, with a permanent connection to a unified, worldwide digital telecommunication network.*

The Nature of Modern Telecom Channels

The study of the strategic aspects of modern telecommunication technologies requires to carefully distinguish the different types of communication channels that are on the market nowadays:

- *Unicast channels.* The make it possible to operate point-to-point communications.
- *Multicast channels.* They make it possible to distribute information from one source to a selected number of destinations.
- *Broadcast channels.* They make it possible to distribute information to all the destinations in a specific area.

This classification is extremely important since the nature of the communication channels impacts on the feasibility and cost-effectiveness of a specific service or products.

For instance, GSM and UMTS are unicast channels. Distributing a digital television signal through - say - UMTS to all the devices in a specific area is extremely complex, as it is necessary to establish and feed a separate communication channel for each destination. Conversely, DVB-H is a broadcast channel that makes it possible to feed all the devices in a geographical area very easily.

The situation changes radically when considering the creation and operation of interactive services. To feed each destination with the specific information required by the user, in a broadcast-based scenario it is necessary to send all the information to everybody, and let the destination select "its own" data. In a unicast channel, this can be easily implemented, as it is the intrinsic operational model of the channel itself.

Another important classification concerns the directionality of a communication channel. GSM, UMTS, and any wireline telephone-based protocol (e.g., ADSL) are bidirectional: each end-point can seamless send and receive information. All the DVB-based infrastructures (satellite, terrestrial, and mobile) do not have a return channel: they are unidirectional (they might have it, but in practice don't). This means that they can receive information, but cannot transmit data, unless an additional return channel is provided (typically, a unicast channel such as UMTS).

These classifications and observations can be easily related and applied to some of the phenomena we observe in the market. Those who try to use an inherently unicast channel for broadcasting real-time TV are facing complex technical challenges, as in the case of IPTV. Symmetrically, those who want to develop interactive services using broadcasting channels (such as DVB-T) are realizing that their infrastructure suffers from severe structural limitations.

Reasonably, the telecom infrastructure of the future will be developed using a combination of different technologies. Nevertheless, the coexistence of a multiplicity of technologies will not change the overall scenario that is being proposed in this paper. Before analyzing it in more detail, however, it is essential to briefly discuss the types and characteristics of modern applications and services nowadays available on Internet.

Applications

Initially, it was only email e generic web navigation. Nowadays, brands such as Google, YouTube, Skype, Second Life, MySpace, and eBay are a key constituent of our daily life. They have changed the way we perceived the net and also specific market sectors. In some cases, they have created new business areas and models. Let's consider the main characteristics of these new services through some significant examples.

Skype

Skype is a popular VoIP service offering also videoconferencing. It is a great example of the *possibilities offered by a best-effort network* in providing services that were previously offered through circuit switching. Basically, the computing power of terminals (i.e., the CPU of computers and PDAs) makes it possible to code and decode voice and video in a very efficient way. This limits the amount of data sent over the Internet. At the same time, the growing capacity of the net offers a viable alternative to complex QoS mechanisms and dedicated channels: it is cheaper and simpler to increase net capacity and speed!

A second key characteristic of Skype is that is based on a peer-to-peer (p2p) architecture. There are two basic paradigms used in p2p. In *pure p2p architectures*, the nodes (peers) of a network interact directly without any intermediation (as in Gnutella). In *hybrid p2p*, peers use a (conceptually) centralized directory to localize the counterpart it wants to talk to (as in Napster and Skype). Directories can be implemented according to different implementation strategies. Whatever implementation is chosen, *the directory service acts as an intermediary among users. In services based on circuit switching, this role role was played by the telecom operator.* Basically, Skype has acquired this role, while *the telecom operator has just to provide the pure transport service.*

This change has a *direct consequence on the business models of a company like Skype and of telecom operators.* With Skype, the notions of "phone calls" and "setup cost" disappear. A Skype user does not pay anything for a computer-to-computer call. Skype makes money by providing additional *premium services* such as redirections of calls to mobile phones or conventional phones. Also the notion of "telephone number" tends to disappear: each customer has a *userID* that is stored in the directory and is used to identify and connect users wherever they are located in the network.

From the telecom operator's viewpoint, the advent of services such as Skype means that customers are interested in paying for a *flat, ubiquitous, and fast IP connection to the Internet*, but they want to be free to choose among the services from any other company "working on the net". As in the case of low-cost airlines, *the customer pays the pure cost of "transportation" to one company (the low-cost airline or the telecom operator), while interacts with many other vendors (possibly and hopefully offering competing services) for any other need or request.*

Google

Google is the mastermind of the Internet. It is a huge profit-maker and, most important, it is becoming the central node of many new services and products. Why?

Google exploits two key strategies. First, *it uses the web technology as the execution environment on the customer's device*: any computer, mobile phone or PDA connected to the Internet and with a browser can use Google services, without installing any other specific application. Second, *Google collects and store in its infrastructure a huge amount of data that is used to offer new and advanced services to its customers.* This information is much richer and more sophisticated than the data traditionally collected by telecom operators.

Google's business model is very simple: they make money through advertising. As in the case of Skype, a telecom operator is requested to offer raw IP connectivity. Once again, there is a sort of separation between the company in charge of offering the basic transportation service (the telecom operator) and the company who exploits this capability to provide customers with advanced services.

MySpace and Flickr

MySpace offers its customers the ability of creating their *spaces* on the Internet where they can store information, music, data. People can meet in spaces, exchange information, create communities.

Flickr is a service offered by Yahoo (the main alternative to Google) and makes it possible for a user to store his/her pictures and images on the web.

MySpace and Flickr are typical example of services exploiting the notion of *user-generated contents*. They leverage the customers' ability and desire to create information and to share it with friends and even unknown people over the Internet. Their business model exploits a *combination of advertising and premium services*. For instance, in Flickr the user can store for free only a limited amount of images. He/she has to upgrade to the *pro service* in order to have a significantly larger amount of space and features.

Once again, the telecom operator is requested to offer raw IP transportation: *the service is offered by companies operating at a different level. Even more important, the same service can be offered by more than one company.* For instance, Picasa (Google) and Flickr (Yahoo) offer similar services. Interesting enough, the leader of the market is Flickr and not Picasa, notwithstanding Google being the undisputed leader in its business sector.

Mashups

A mashup is "a web application that combines data from more than one source into a single integrated tool; an example is the use of cartographic data from Google Maps to add location information to real-estate data from Craigslist, thereby creating a new and distinct web service that was not originally provided by either source." Mashup is an extremely powerful concept, as it exploits the notions of modularity and dynamic composition of services to enable the creation of an unlimited range of new applications. Of course, this is only possible if there is an open, efficient, and ubiquitous IP connectivity.

A Final Consideration

The examples discussed so far have clearly demonstrated that the evolution of network technology has induced a change in the structure of the market. The availability of a ubiquitous IP infrastructure and powerful devices and terminals make it possible for anybody to develop new products and services. *The telecom operator is no longer the deus ex-machina of the net*. Unless the net is transformed into something substantially different from the Internet we are used to deal with.

There are two main consequences of the new structure of the telecom market:

1. *Anybody can invent and propose new services, not just telecom operators.* This explains the incredible number of new services that are appearing on the market. In practice, this market structure is a powerful enabler for innovating ideas.
2. *The main interest of a telecom operator is (or should be) to saturate its infrastructure with loads of bits*, independently of their nature and originators.

These observations and the examples proposed so far represents the basic elements that make it possible to describe in more abstract terms the giant paradigm shift we are observing in the telecom market.

A Paradigm Shift

For telecom operators, the incredible changes, innovations, and opportunities discussed so far represent an amazing opportunity and a nightmare at the same time. If every object can be transformed into a connected device, the number of potential users of telecommunication network explodes.

At the same time, however, the nature and structure of Internet induce a radical change in the organization of the market, and in the role and business models of telecom operators.

The conventional telecommunication market was based on the notion of *intelligent network* (see Figure 1): all the services were provided through specific features that were part of the network infrastructure, while terminals (such as POTS - Plain Old Telephone Service) were "stupid" (i.e., they were just able to accomplish very simple and fixed operations: basically, to dial numbers).

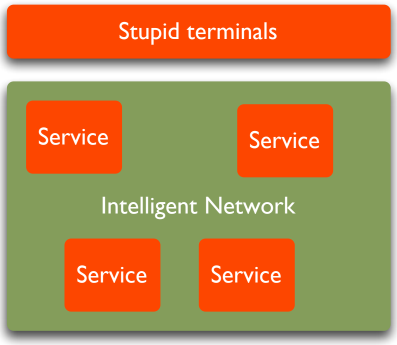


Figure 1:The intelligent network.

Conversely, Internet is "stupid", as it has just to deliver packets efficiently from a source to a destination, as David Isenberg wrote in a famous essay ten years ago *[4]*. All the "intelligence" is in the devices, i.e., in the software applications on users' terminal: they know the meaning of the bits transmitted and received (see Figure 2). This does not mean that a "stupid network" is easy to build. The network is "stupid" at the external pins, if considered as a black box. Actually, the "stuff" inside the box is extremely complex.

Figure 2:The stupid network.

In general, the key beneficial effect of the introduction of the Internet (and packet switching) is that it is possible to decouple the problems related to the construction of a reliable and effective network from those related to the creation of innovative services and applications. This has made it possible to exploit the huge potential of innovators and developers operating at "network borders." *Anybody can be an innovator, even if he/she does not have any "control" over the network.* Anybody can create new services and compete.

These observations lead to two important questions:

1. *Can a network operator compete with the universe of service providers?* The answer is no, as it is impossible for a single company to compete with the rest of the society. Google, MySpace, Skype, YouTube, and Flickr were not invented by telecom operators: *they were created by people and companies who exploited the raw features of the network to enable new services and models.*
2. *Is it reasonable and convenient to revert to a scenario where the telecom operator is also the service provider?* This situation is often referred as a *walled garden*, where the same company offers a close and integrated (vertical) stack of service. Indeed, *Internet is inducing a different segmentation of the market that is difficult to block or substantially change*. Moreover, from the viewpoint of customers and of the society in general, *this new scenario is much more convenient and able to stimulate innovations and the creation of new services.*

A New Market Structure

Internet is inducing the emergence of a new market (see Figure 3) that is substantially different from what we were used to have in the past decades.

The first and most important difference is the *distinction between IP Transport Providers and Service Providers*. An IP Transport Provider has the goal and mission to provide customers with ubiquitous and seamless access to Internet through the IP protocol. Service Providers offer application services (VoIP, video, social networking, search, news, …).

IP Transport Providers exploits a number of different physical communication infrastructures based on a variety of wireless and wireline technology. Actually, IP Transport Providers' customers are not interested in the specific technology being used, as long as IP connectivity is available wherever he/she goes and the bandwidth is large enough to satisfy his/her communication needs. This introduces the concept of *vertical roaming among different technologies*.

Physical infrastructures can be owned and managed by a IP Transport Operator or by separate companies. Indeed, as most physical infrastructure are often difficult to replicate, *they are increasingly considered natural monopolies*. This require rules and control authorities that ensure a fair and non-discriminatory access to such infrastructures by all IP Transport Providers.

Since users want seamless access to IP network, an IP Transport Provider has to establish suitable *horizontal roaming agreements* to ensure IP coverage even when the customer is in an area not directly covered by its services.

Summing up, the market is moving *from vertical segmentation (walled garden), in which each telecom operator offered the entire stack of services, to horizontal segmentation with different players at each level of the stack*. The main actors of this new market can be described as follows:

- *Physical Infrastructure Operators (or carriers' carriers)*. They own and/or manage a physical infrastructure, such as a metropolitan fiber network (e.g., MetroWeb in Milano) or a wireless GSM/UMTS network (e.g., Ericsson for H3G).
- *IP Transport Providers (or IP carriers)*. They offer IP connectivity exploiting one or more wireless and wireline

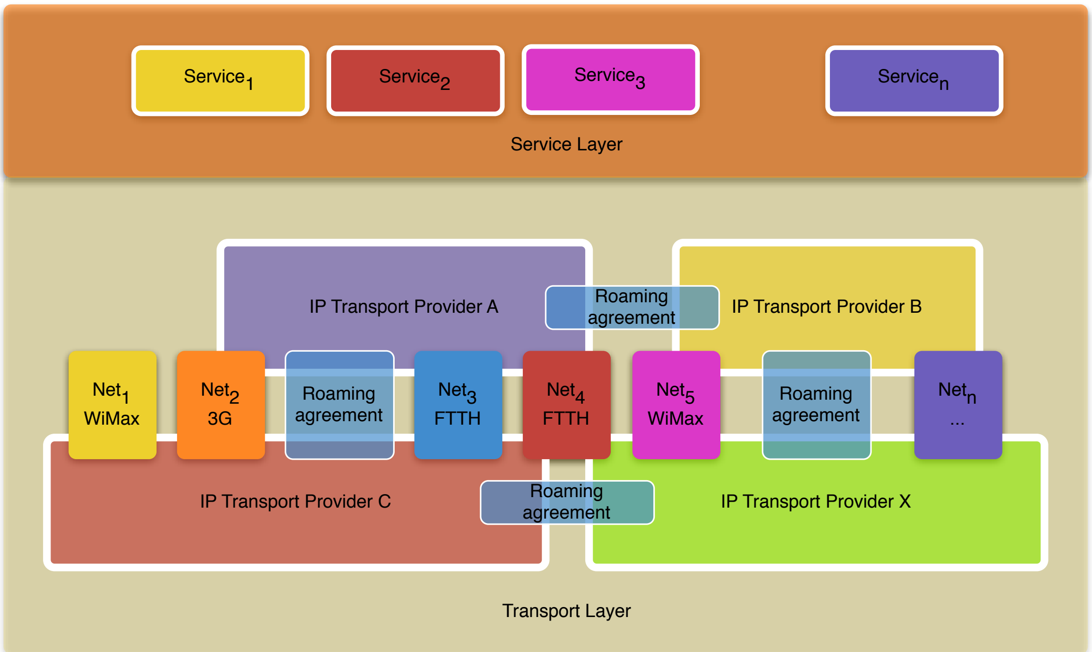


Figure 3: Structure of the market.

physical infrastructures. They can have roaming agreement to offer IP connectivity through other IP Transport Providers in areas that they do not cover directly. A typical example of service offered by an IP Transport Provider is a "naked ADSL", i.e., pure IP connectivity (usually based on a flat rate) without any other additional application service (in particular, no voice calls).

- *Service Providers.* They offer application services to customers. Typical examples are Skype, Google, and YouTube. These services can be offered through any IP network, regardless of its nature (wireless or wireline).

The above scenario tends to limit the role of the classical telecom operator, as its goal is "simply" to transport IP packets. Indeed, IP Transport Providers can also offer a number of services directly related to their contractual relationship with the customer. For instance, cellular phones have SIM cards that uniquely identify a customer. SIMs can be used to provide a unified payment service: the IP Transport Provider directly charges the customer for the activities it carries out over the net.

Certainly, nowadays many telecom operators (such as Vodafone or Telecom Italia/TIM) operate at all three levels of the stack, in a vertically segmented market. However, the horizontal segmented scenario discussed so far can be already observed in several contexts. For instance, the Italian mobile operator 3 exploits a UMTS network developed and operated by Ericsson. Vodafone and other GSM network operators have signed agreements to host Mobile Virtual Network Operators (MVNOs) on their network. In these cases, Vodafone is acting as a Physical Infrastructure Operator selling bandwidth and network capacity to an IP Transport Provider (the MVNO).

Of course, this radical change of the market is complex and induces a number of critical problems and issues.

First, *the business models of companies are forced to change significantly.*

- As for telecom operators (specifically those evolving into IP Transport Providers), they need to change the nature of their billing policies. So far, customers have been billed for the services they use. Nowadays, many operators are offering flat fares whose cost depends on the upload and download speeds of the lines used by customers. Alternatively, operators are also offering fares based on the volume of bits transmitted and received by the customer. *In general, as in the case of other utilities such as electric power or gas, Ip Transport Operators will charge customers based on the characteristics of the infrastructure they are accessing – and the volume of the information transmitted and received – rather than on the services they are using.* Of course, this is a radical change that will significantly impact business models, and companies' structure and organization.
- The business models of many Service Providers are centered on advertising. It is not just Google: Microsoft, for instance, plans to have about 25% of its revenues based on advertising. *The issue is critical as it is not clear at all whether or no the advertising investments will be able to sustain the growth of services and applications.*

A second problem concerns privacy. Services such as Google, eBay, and Amazon – just to name a few – collect and maintain huge amount of personal data. Telecom (in particular mobile) operators are able to trace customers' movements and personal communications. In general, our lives are more and more monitored and controlled without any guarantee that this information is not used for purposes that violate our right to privacy and even our own freedom.

A third critical problem problem is how to deal with companies that owns critical assets such as the physical infrastructures. They can offer services exploiting their knowledge and control of the infrastructure. Moreover they can discriminate other operators or introduce policies and constraints that limit the competition and stifle innovation. These considerations briefly sketch one of the main issue that is being discussed at political and industrial levels: *net neutrality*.

The Net Needs to Be Neutral

Telco operators are net neutrality main critics. They want to charge different prices depending on the services used by the customers (e.g., VoIP vs. conventional Internet access). Moreover, they tend to create *vertically integrated bundles of services*: basically, they offer IP connectivity along with traditional voice services (POTS), and innovative services such as VoIP and IPTV. By bundling and vertically integrating services, they want to be the main interface to the customer and control the services and related revenues: any company willing to sell a service will be somewhat forced to go through the telco operator.

The supporters of network neutrality claim that operators cannot offer services in competition with "external service providers", favoring some services and penalizing others. The key issue is "non discrimination", i.e., services should not be discriminated because of bundles or exclusive agreements with the telco operator.

Telecom operators assert that the investment in physical infrastructures cannot be covered by just selling IP connectivity to end-users. They needs to find additional revenues.

Actually, low-cost airlines have demonstrated that is possible to restructure a company and a business model in order to reduce costs and have a different revenue profile. Moreover, too often net neutrality is confused with "no charge" or "political fee". Indeed, an IP Transport Provider should charge a fee that is reasonable and related to the cost it is sustaining. Also, it is reasonable to assume (as it is today) that a user has pay in proportion to the speed of the connection he/she is requesting. Certainly, it is essential to address the issue in a convincing way, as *it will influence the development of the market and of the society in the next decades*.

Conclusions

The advent of Internet and packet switching is radically changing the telecom market. We are moving from vertical integration of services offered by a single operator, to horizontal separation in at least three categories of actors: Physical Infrastructure Operators, IP Transport Providers, and Service Providers. In practice, it is the same kind of transformation that we have seen in the computer market during the 80s and 90s with the advent of PCs and standard operating systems (i.e., Windows, MacOS, and Unix/Linux).

This transformation is far from being completed. Even more, there are trends and forces pushing in different directions and trying to perpetuate models of the past. Certainly, technology has a strong and direct influence on market structure. Moreover, the emerging market structure appears to be much more suited to promote innovation. Therefore, the undergoing changes will sooner or later consolidate into a new organization of the telecom sector. It's up to the current players to decide if they want to adapt to the new world or face the risk of extinction.

Acknowledgments

I wish to thank Elserino Piol, Franco Morganti, Riccardo Melen, Roberto Saracco, Carla Milani, Glauco Bigini, Flavio Giovanelli, Paolo Quaranta, Carlo Rogialli, Aldo Milan for their comments and support.

References

1. Wikipedia. See the corresponding pages for *Ocean liners*, *DC 8*, and *B707*. http://www.wikipedia.org.
2. Wikipedia. *Circuit switching*. http://www.wikipedia.org.
3. Wikipedia. *Packet switching*. http://www.wikipedia.org.
4. D. Isenberg. "Rise of the Stupid Network", http://www.rageboy.com/stupidnet.html. See also, D. Isenberg. "The dawn of the stupid network", http://www.isen.com/papers/Dawnstupid.html.
5. Wikipedia. Best effort delivery.