# IP Interconnection

- The Big Internet is a collection of many independent networks, called Autonomous Systems
- An Autonomous System (AS) is a network administered independently from other Autonomous Systems
- An AS can be connected to:
  - Final users
  - Web sites and, generally, service providers
  - Other ASs

From: Gianfranco Ciccarella, Daniele Roffinella, “Interconnessione IP: il perche' e il come di un cambiamento”. Notiziario Tecnico Telecom Italia, 1/2013, pp. 44-56

# IP Interconnection

- Usually, IP packets cross multiple Autonomous Systems while they travel from the source to their destination
- The business relations among interconnected Autonomous Systems define the possible “IP interconnection models”

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# The IP transit interconnection model

- The *IP transit service* is a payed service offered by the administrator of a *transit* Autonomous System (the *transit operator*)
- The IP transit service guarantees the possibility of reaching any IP address in the world
- The service is provided, by the transit operator, both through its network and through other interconnected Autonomous Systems
- Usually, the IP transit service is used by *domestic operators* (for instance, the national telcos) to let their customers reaching any destination in the world
- The operator using an IP transit service pays the transit operator

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# The IP peering interconnection model

- The IP peering contract can be either free or payed (the cost of the payed peering is normally smaller than the cost of the transit service)
- IP peering contracts are usually made between operators with similar size (peers), when both of them can gain some profit from the interconnection of their networks
- The peering contract allows the clients of one peer reaching the clients of the other peers, with a smaller cost than transit
- When traffic is balanced, the peering service is normally free
- However, if traffic is unbalanced, the peer requi9ring more traffic pays the other peer

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# The IP peering interconnection model

- Note that the IP peering service is not transitive, meaning that only packets originated in one peer and destined to the other interconnected peer can cross a peering interface

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# Traffic management

- Usually IP traffic crossing an interconnection interface is treated as Best Effort
- There are no guarantees about packet loss, delay, duplications, and sequence
- Managed services, as opposed to Best Effort, provide a different treatment of packets, for example based on the type of service that packets carry
- Managed services are less frequent than Best Effort services
- In all cases, interconnection contracts are agreed between two operators

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# Tier1 operators

- A Tier1 operator can reach all the IP addresses in the world without buying IP transit services, but using its network and IP peering with other Autonomous Systems


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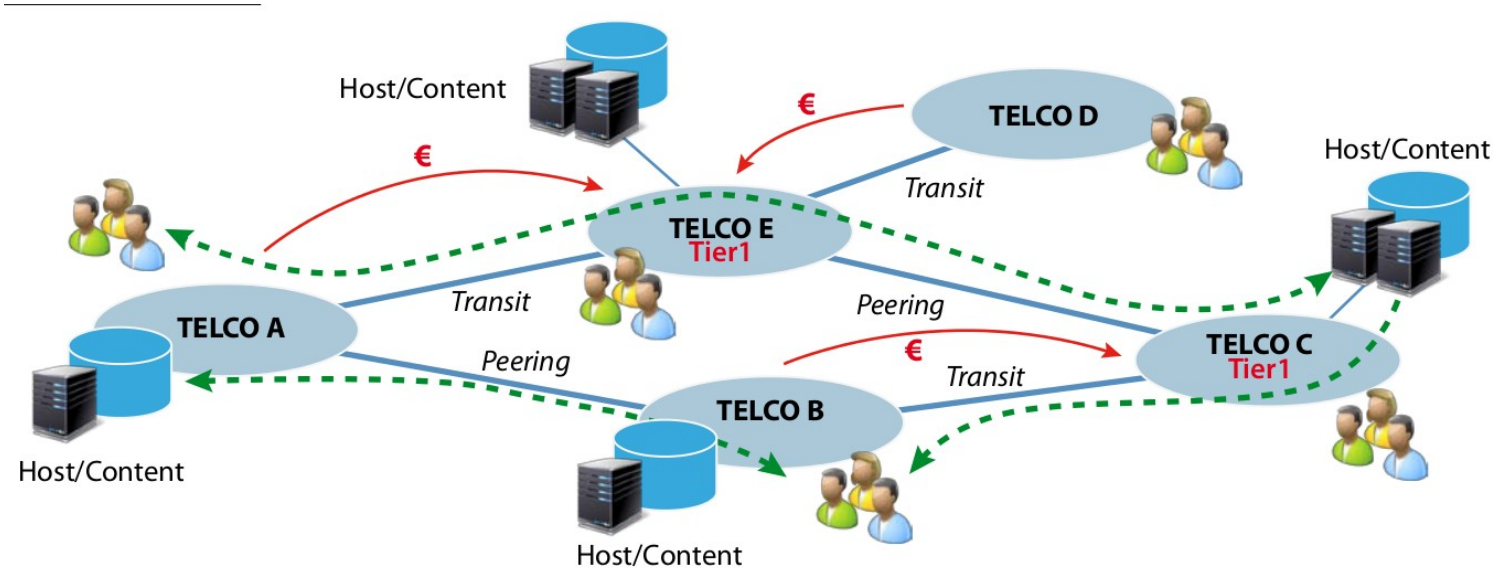
# Peering and transit

- Usually a Tier1 operator establishes peering interconnections with other Tier1 operators
- Then, the Tier1 operator sells transit services to non-Tier1 operators

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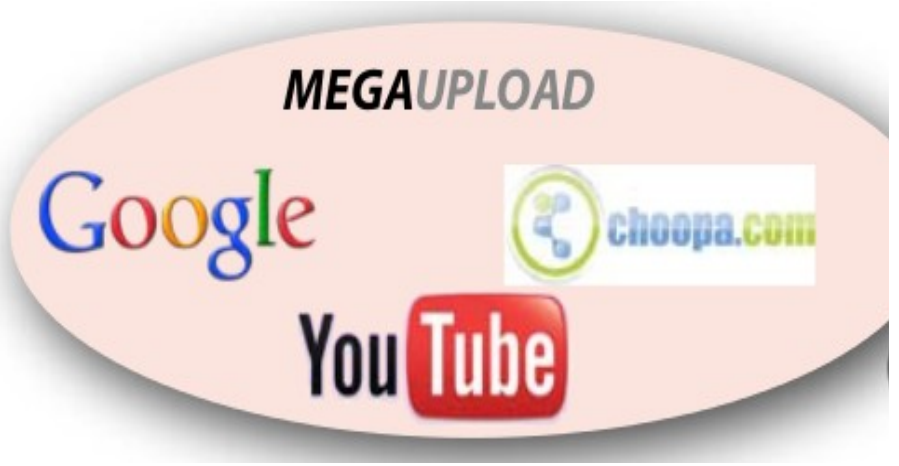
# Over The Top (OTT) providers

- In year 2001 the total IP traffic in the world was 1 Exabyte/year, while in year 2004 it reached 1 Exabyte/month; in 2007, it was about 1 Exabyte/week; in year 2013, it was about 1 Exabyte/day
- This dramatic increase has been partly due to the new Over The Top (OTT) providers and Content Providers (CP)
- OTT providers and Content Providers don't have a network: they provide services and they reach people and businesses in the world through the interconnection system

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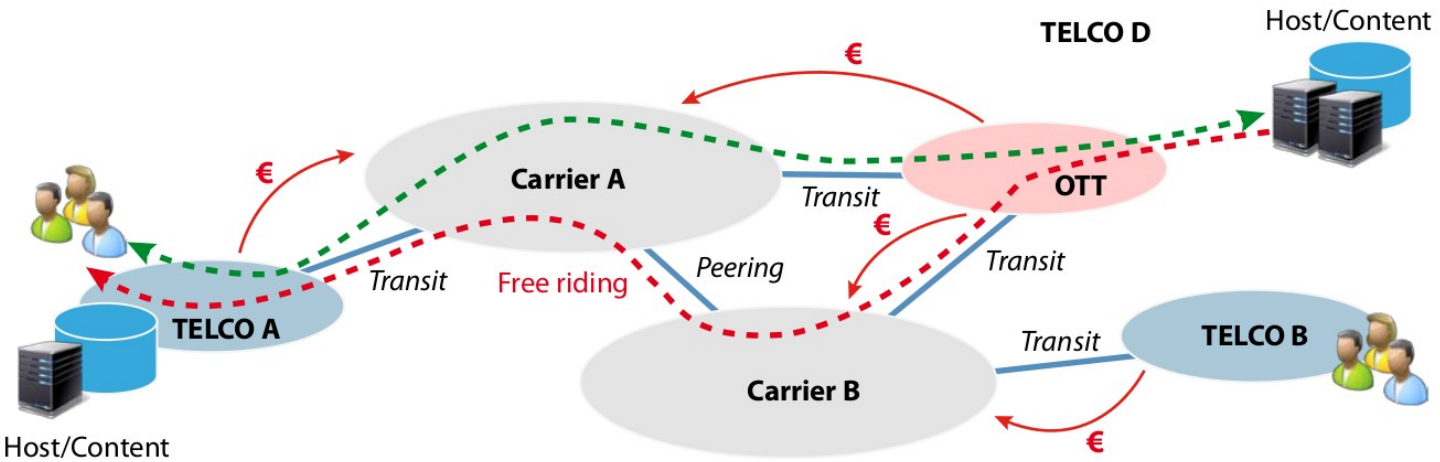
# Telcos

- Telcos receive traffic generated by OTT/CP, either from transit interconnections (payed for by Telcos) or through peering (they don't get payed because usually it is free)
- With reference to the figure, in either cases TelcoA doesn't get payed (unless a payed peering has been set up); to the contrary, it pays in the case of transit (green path)

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# Content Delivery Networks (CDN)

- A Content Delivery Network cashes contents in such a way that users have a significant chance of getting the required content from an intermediate cache, and not from the original source of the content
- This speeds up the delivery of contents and, in turn, it increases the users' satisfaction
- The time required for the delivery of a content (e.g., a web page) is critical: studies from Google and Bing show that by increasing the download time by 1 second, the user satisfaction drop is about 16%, the number of visited pages decreases (about 11%) and the conversion of a click into a profitable action (e.g. a purchase) decreases (about 7%)

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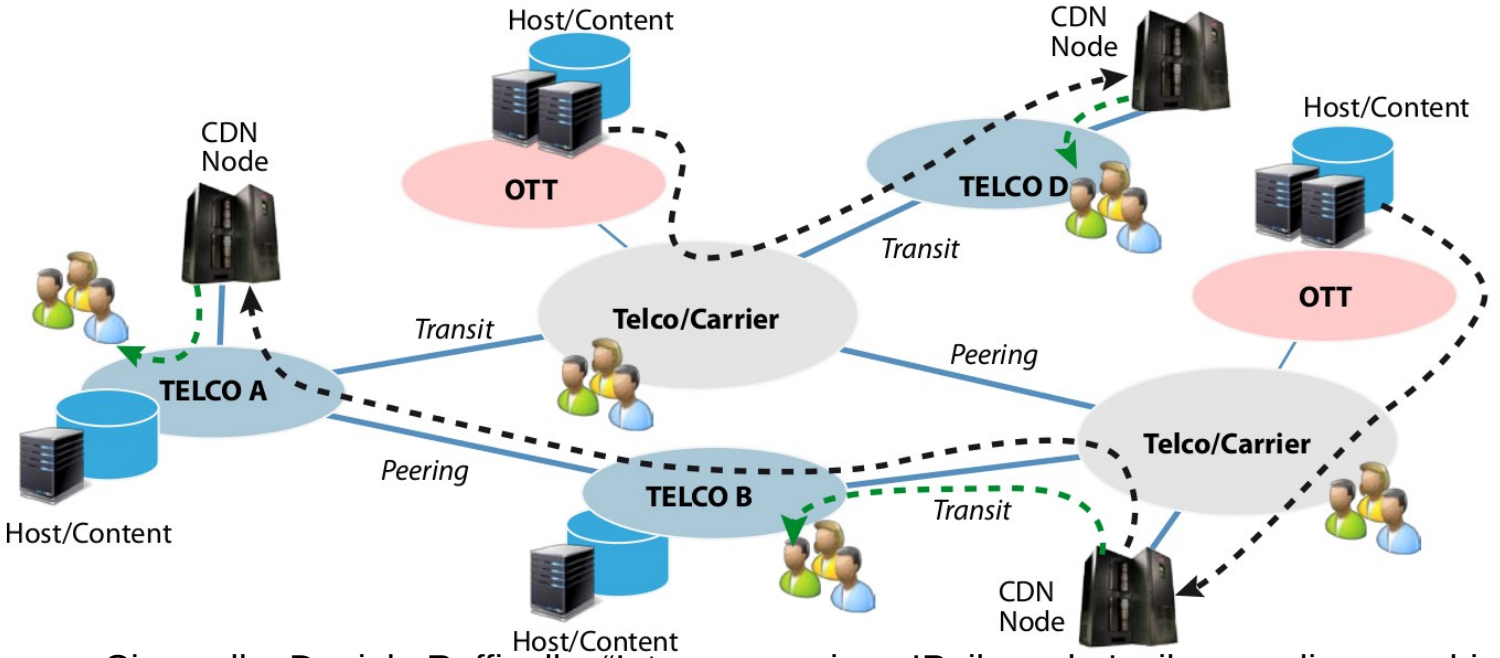
# Content Delivery Networks

- Content Delivery Networks decrease significantly the length of the delivery paths and, in turn, traffic decreases
- As a consequence, interconnection costs decrease

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# Content Delivery Networks

- Content Delivery Networks are used for both bandwidth intensive and traditional services
  - Bandwidth intensive: video/audio streaming, cloud computing
  - Traditional: web browsing
- In both cases, speeding up the delivery of the content increases the users' satisfaction and revenues
- However, traditional interconnection models do not take into account the increased economic value of cached information

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# Critical issues of current interconnection models

- Telcos pay for transit, and usually their bill is proportional to the volume of exchanges traffic
- The fast growth of Internet traffic generates growing expenses for Telcos
  - For transit
  - Capex and Opex costs to increase the capacity of their network
- However, standard Internet access contracts for retail users are flat, that is, they do not depend on traffic
- In conclusion, costs grow much faster than revenues

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# Critical issues of current interconnection models

- In practice, the revenues of Domestic Telcos come mainly from the Internet access of their customers (flat rate)
- They do not get revenues from OTTs, CPs, CDNs
- However, OTTs, Cps, and CDNs generate the 80% of the traffic received by an average Telco's network ...
- … and they get large revenues from ads and from the services that they deliver
- That is, Telcos let OTTs, Cps and CDNs reach their customers, but they get hardly payed for this

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# Critical issues of current interconnection models

- There are many OTTs, but the market is in the hands of very few huge players (e.g. Google)
- Their business is based of a worldwide reach (provided also by Telcos) and revenues coming from ads and payed services
- The termination of traffic in the Domestic Telco's network is not payed (or payed very little money)
- Some of the services offered by OTTs compete with traditional Telcos' services (messaging, voice …)
- Basically, OTTs operate in *free-riding* mode, meaning that Telcos' revenues are not related to the business value of the traffic that they terminate

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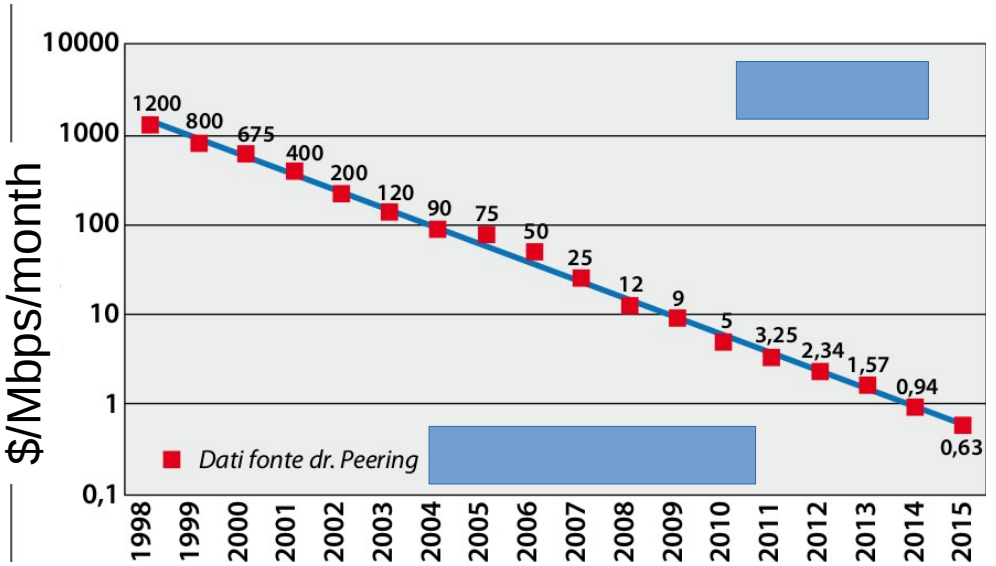
# Critical issues of current interconnection models

- A positive fact for Telcos is the sharp decrease of transit costs
- This partially compensates the traffic increase
- However, this does not solve the basic issue: Telcos are not payed enough for the service that they deliver to OTTs

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# Open issues

- Enabling the transport of IP traffic with quality of service through interconnection interfaces
- Allowing Telcos to get payed proportionally to the value of traffic, and not only by volumes

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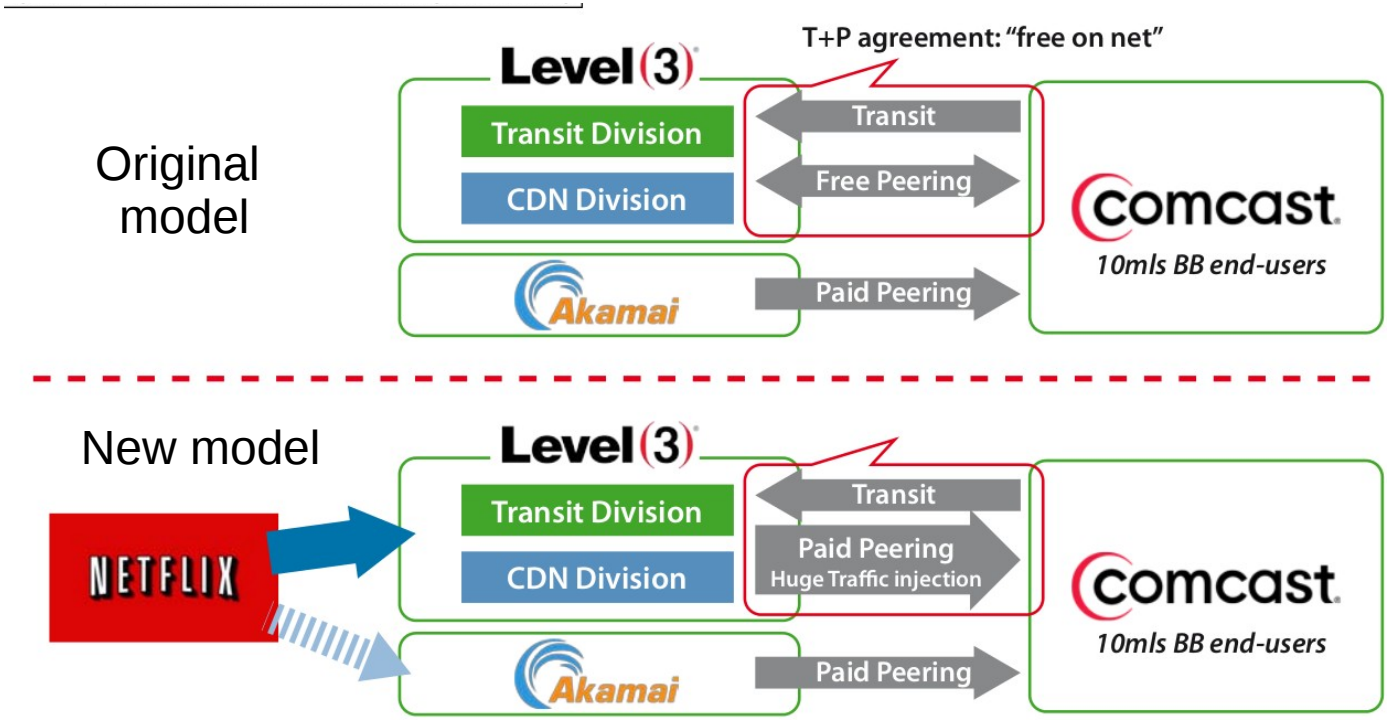
# An example

- Level3 (T1er1) and Comcast had a free-on-net (transit + free peering) interconnection contract
- Level3 could reach for free Comcast customers, and Comcast could reach for free the Big Internet
- Then, Netflix selected Level3 as CDN, and the traffic from Level3 into Comcast's network exploded
- Comcast had to transport huge volumes of traffic without getting any revenue for that

- The irony was that Netflix was a competitor of Comcast, and Comcast had to transport Netflix's traffic for free
- Comcast proposed a payed service, and Level3 refused
- Then (after a legal action) the new contract was signed, where Level3 has to pay Comcast for peering



# Where Telcos get their revenues from