【CN】Day6

Created	@May 19, 2022 9:29 AM
Class	
Type	
Materials	Network of Networks
Reviewed	☐

【Ch1】Computer Networks and the Internet

1.3.3 A Network of Networks

Network Structure 1

We saw earlier that end systems connect into the Internet via an access ISP. The access ISP can provide either wired or wireless connectivity, using an array of access technologies including DSL, cable, FTTH, Wi-Fi, and cellular.

But the access ISPs themselves must be interconnected, which is done by creating a network of networks.

Let’s now consider a series of structures that allow each ISP to connect with any other ISP.

Our first network structure, Network Structure 1, interconnects all of the access ISPs with a single global transit ISP.

Our (imaginary) global transit ISP is a network of routers and communication links that not only spans the globe, but also has at least one router near each of the hundreds of thousands of access ISPs. It would be very costly to build such a network, so it would charge each of the access ISPs for connectivity.

Since the access ISP pays the global transit ISP, the access ISP is said to be a customer and the global transit ISP is said to be a provider.

Network Structure 2

Now if some company builds and operates a global transit ISP that is profitable, then it is natural for other companies to build their own global transit ISPs and compete with the original global transit ISP.

This leads to Network Structure 2, which consists of the hundreds of thousands of access ISPs and multiple global transit ISPs. The access ISPs certainly prefer Network Structure 2 over Network Structure 1 since they can now choose among the competing global transit providers as a function of their pricing and services.

Note, however, the global transit ISPs themselves must be interconnected. Otherwise, access ISPs connected to one of the global transit providers would not be able to communicate with access ISPs connected to the other global transit providers.

In reality, although some ISPs do have impressive global coverage, no ISP has presence in each and every city in the world.

Instead, in any given region, there may be a regional ISP to which the access ISPs in the region connect. Each regional ISP then connects to tier-1 ISPs.

Tier-1 ISPs are similar to our (imaginary) global transit ISP; but tier-1 ISPs do not have a presence in every city in the world.

Network Structure 3

Not only are there multiple competing tier-1 ISPs, there may be multiple competing regional ISPs in a region. In such a hierarchy, each access ISP pays the regional ISP to which it connects, and each regional ISP pays the teir-1 ISP to which it connects.

Notice that tier-1 ISP do not pay anyone as they are at the top of the hierarchy. This is referred to as Network Structure 3.

Network Structure 4

To build a network that closely resembles today's Internet, we must add points of presence(PoPs), ulti-homing, peering, and Internet exchange points(IXPs) to the hierarchical Network Structure 3.

A PoP is simply a group of one or more routers(at the same location) in the provider's network where customer ISPs can connect into the provider ISP.

Any ISP(except for tier-1 ISP) may choose to multi-home, that is, to connect to two or more provider ISPs. For example, an access ISP may multi-home with two regional ISPs, or it may multi-home with two regional ISPs and also with a tier-1 ISP.

When an ISP multi-homes, it can continue to send and receive packets into the Internet even if one of its providers has a failure.

As we learned, customer ISPs pay their provider ISPs to obtain global Internet interconnectivity. To reduce the costs, a pair of nearby ISPs at the same level of the hierarchy can peer. That is, they can directly connect their networks together so that all the traffic between them passes over the direct connection rather than through upstream intermediaries.

We refer to this system as Network Structure 4.

Network Structure 5

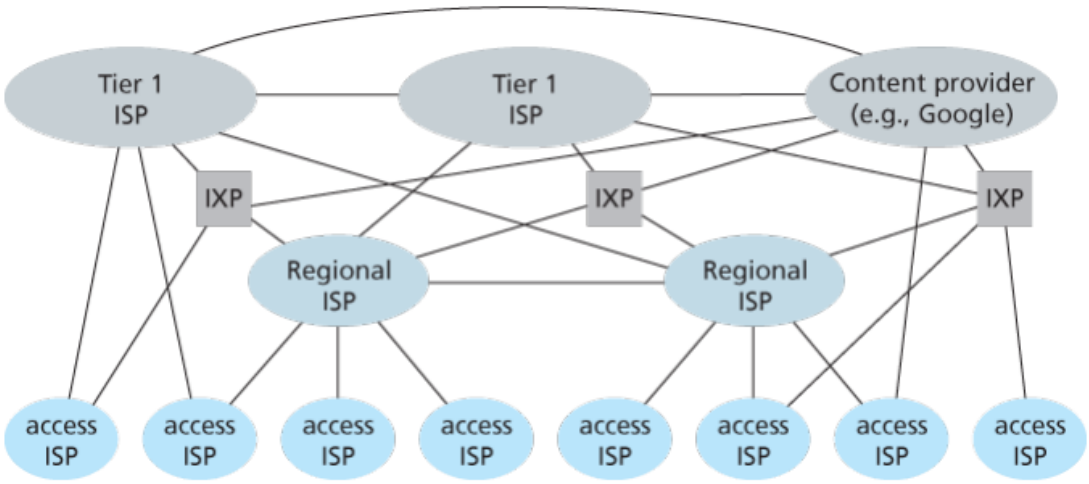

Figure 1.15 Interconnection of ISPs

Network Structure 5 builds on top of Network Structure 4 by adding content-provider networks. Google is currently one of the leading examples of such a content-provider network. It is estimated that Google has 50-100 data centers distributed across the globe.

The data centers are all interconnected via Google’s private TCP/IP network, which spans the entire globe but is separate from the public Internet.