A Network of Networks: Transit, Peering, and Exchange Points

Before the commercialization of the global Internet, network pioneers such as Prodigy, AOL and CompuServe created separate, private networks. However, a customer on one of these networks could only talk to others on the same network. Over time, users wanted to communicate across networks.

As public access to the "network of networks" -- now known as the Internet -- became more prevalent, two models for connecting emerged: transit and peering.

The global Internet is composed of interconnections between tens of thousands of separate Internet Service Provider (ISP) networks, which are divided into tiers depending on their size, extent, and the amount of traffic they carry.

TIER 1

Operate vast intercontinental and trans-oceanic networks of enormous capacity which function as the Internet's global backbone.

TIER 2

Operate national or regional networks with abundant capacity. They bridge the gap between the Tier 1 ISPs (the global Internet backbone) and Tier 3 networks.

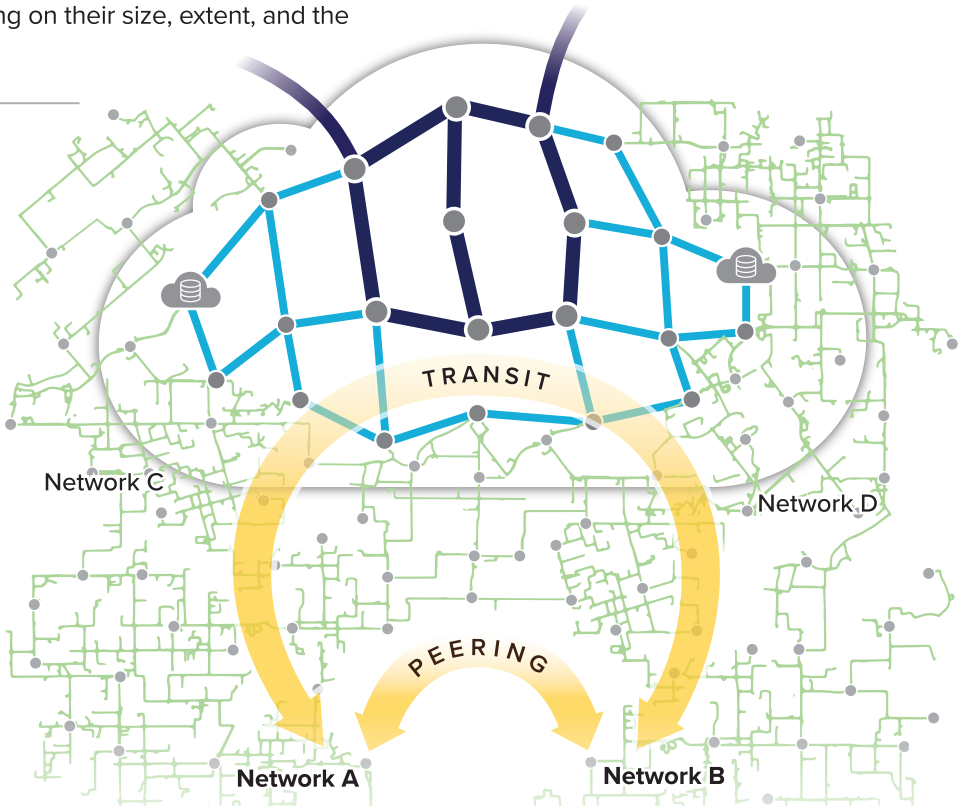
TIER 3

Sometimes called last-mile providers, these networks provide service to homes and businesses. They serve local regions and typically connect to a middle-mile network to reach a Tier 1 ISP.

CLOUD PROVIDER

While not ISPs, major cloud providers such as Microsoft, Google, Amazon Web Services, Netflix, and Apple also manage and operate their own network infrastructure.

When networks provide transit, they typically charge based on traffic volume for this service. This can make traffic exchange expensive, especially since global Internet traffic continues to increase at a compounded annual rate of 30%.*



Networks A and B, shown here, are each connected to the Internet and can exchange traffic via ***transit*** – in other words over another network or series of networks (Networks C and D) that they both connect to, as intermediary links.

However, Networks A and B may decide to connect directly to each other and share traffic without transiting other networks – ***peering***. Peering can be paid or ***settlement-free,*** and may involve an informal understanding or a written contract.

Whether two networks engage in a peering relationship depends on many factors, including whether the networks are in the same tier, how much traffic each carries, whether they are commercial or nonprofit, or how many customers each serves. For example, CENIC pursues peering relationships with other networks including major cloud providers, allowing their data to travel directly to the millions of Californians that use CENIC's infrastructure and avoiding transit expenses and delays, vital for access to critical data and content, updates, and computing resources.

* "Internet Traffic and Capacity Remain Brisk," TeleGeography.com Blog, September 13, 2022.

Building a Network of Networks: Internet eXchange Points

Interconnections between networks take place at Internet eXchange Points (IXPs), extremely large facilities heavily provisioned with rack space, bandwidth, and power where the world's networks physically meet to connect to one another for mutual benefits. IXPs are the high-tech "farmers' markets" that create the vibrant, commerce-based ecosystem of network connections – transit and peering, paid and settlement-free – comprising the Internet as we know it.

In California, the largest IXPs are in Los Angeles and the San Francisco Bay Area. All major international carriers connect to each other and other networks at these facilities. The more large networks use a given IXP, the more other networks, including middle and last-mile providers, will want to use that IXP.

New Regional Internet eXchange Points: How & Why

While existing IXPs were crucial to the formation of the global Internet and remain essential, rural and remote areas are disadvantaged since even local traffic must travel back and forth to existing IXPs, and the resulting latency -- the traffic's travel time over the network -- impacts performance.

Establishing new regional IXPs can help alleviate these issues but can be challenging since a threshold number of carriers must participate before it becomes cost-effective. One way to attract carriers to a new regional IXP is for a middle-mile network operator to negotiate with large content providers to place content servers that enable the caching of high-demand content within the IXP.

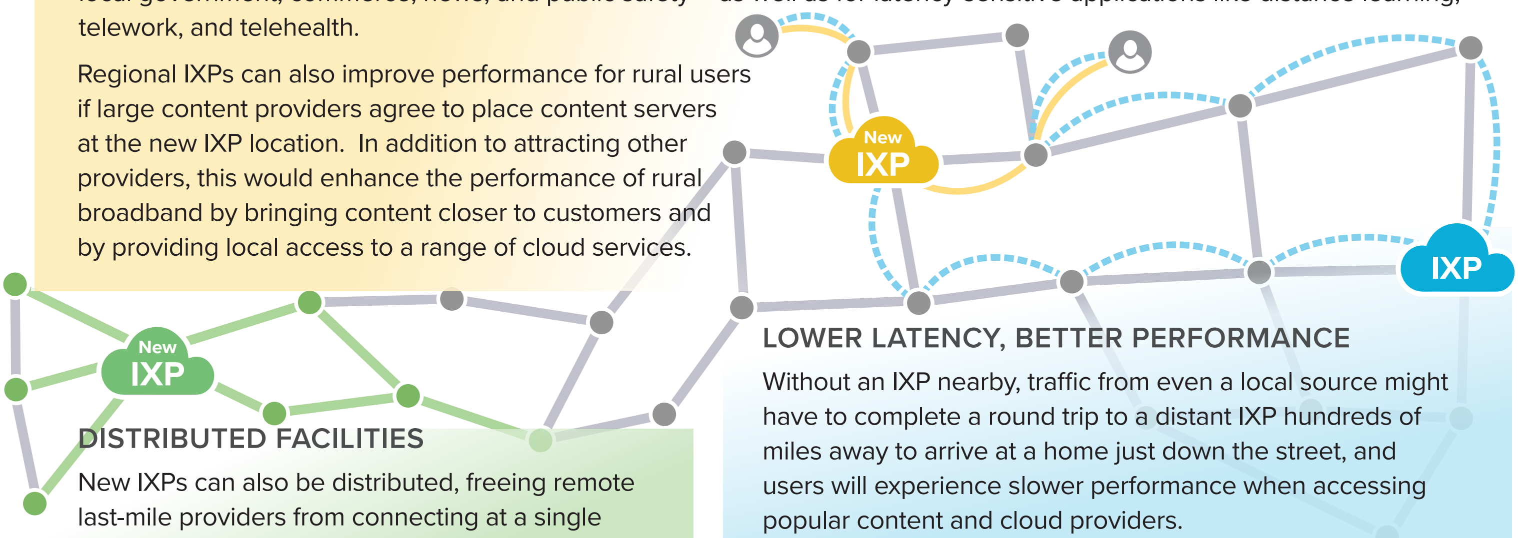
Since the major IXPs in California are all coastal, new exchange points in inland regions would improve network resilience and decrease costs of last-mile projects in these regions.

Three Major Benefits of Regional IXPs for Rural Communities

KEEPING LOCAL TRAFFIC LOCAL

With a regional IXP nearby, rural users would experience lower latency to and from local resources like school districts, local government, commerce, news, and public safety – as well as for latency-sensitive applications like distance learning, telework, and telehealth.

Regional IXPs can also improve performance for rural users if large content providers agree to place content servers at the new IXP location. In addition to attracting other providers, this would enhance the performance of rural broadband by bringing content closer to customers and by providing local access to a range of cloud services.



LOWER LATENCY, BETTER PERFORMANCE

Without an IXP nearby, traffic from even a local source might have to complete a round trip to a distant IXP hundreds of miles away to arrive at a home just down the street, and users will experience slower performance when accessing popular content and cloud providers.

DISTRIBUTED FACILITIES

New IXPs can also be distributed, freeing remote last-mile providers from connecting at a single distant facility. One example of such a distributed exchange is Pacific Wave, a project of CENIC and the Pacific Northwest Gigapop. Pacific Wave is a distributed peering facility that enables networks in East Asia, Southeast Asia, Oceania, and North America to interconnect. There are nodes for Pacific Wave interconnections in Los Angeles, Sunnyvale, Seattle, Chicago, Denver, Honolulu, Guam, and Tokyo.

By improving performance, regional IXPs could also make the middle-mile network more useful for Internet of Things (IoT) uses such as environmental sensors, transportation and logistics, and disaster warning and response.