Update on Net Neutrality

Lexington Computer and Technology Group
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Topics

- How the Commercial Internet is Constructed
  - Local vs. National ISPs
  - Tier 1 vs. Tier 2/3 ISPs, inter-ISP Peering, and Regulation
  - How you connect in
  - Where the content resides
- Review of Net Neutrality & Who Pays What
- Small Aside on How TCP Fills Available Bandwidth and Fairness
- How ISPs Can Enforce Network Non-Neutrality
- Effects of Network Non-Neutrality
- ISP Capital Expenditures & Peering (Netflix – Comcast Example)
- Comments on:
  - Hiawatha Bray article comparing Net Neutrality to Y2K
  - Net Neutrality in India

Regulation

- Companies that offer wireline telephone voice services are highly regulated by the FCC as Common Carriers (universal service, CALEA, …)
- Television cable operators are primarily regulated by local jurisdictions
- Wireless carriers are less regulated than wireline carriers, but radio spectrum is shared resource and some bands are auctioned by FCC
- Satellite operators have to coordinate their spectrum use with terrestrial wireless operators and obtain US Landing Rights from FCC and orbital slots from the ITU
- Internet Service Providers have been classified as Information Services and are much less regulated

How the Internet is Constructed: Local vs. National ISPs

- Local wireline ISPs (cable or telco) – usually a monopoly or duopoly due to huge investment in "last mile" local wiring or fiber
  - Examples: Boston, Lexington & Randolph, VT
- National inter-city fiber backbones (primarily wholesale "carrier's carrier')
  - Level 3 and Cogent (some local fiber also sell to business & data centers
- Some Local ISPs (Comcast, Verizon, AT&T, Sprint) are also National ISPs
- Mobile (Cellular) Carriers as ISPs (some local, some national – roaming)
  - Some competition in urban and suburban areas between mobile Internet carriers
  - Wireless bandwidth is a very limited precious shared resource
- National Satellite ISPs (ViaSat Exede and HughesNet)

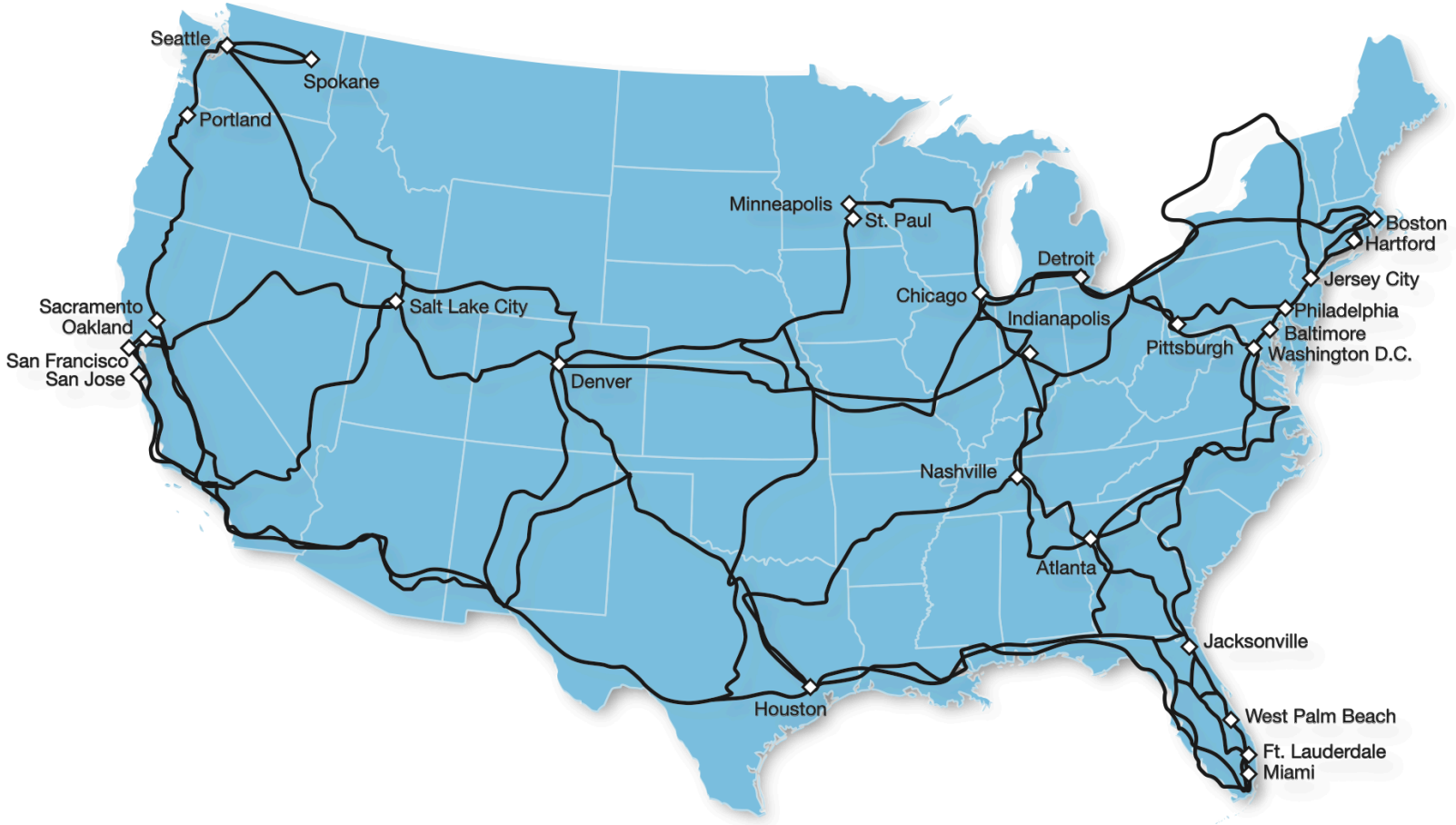
How the Internet is Constructed: Tier 1 vs. Tier 2/3, and Peering

- National Tier 1 ISPs interconnect via free private peering
  - Approximately equal size in terms of # of customers and infrastructure reach and that they are exchanging roughly equivalent amount of traffic
- Smaller Tier 2/3 Regional ISPs buy IP Transit from Tier 1s
- Large data providers (Internet web destinations – eg. Google, Amazon, Microsoft, Facebook) have their own private data networks and tend to interconnect with Tier 1 ISPs via private peering

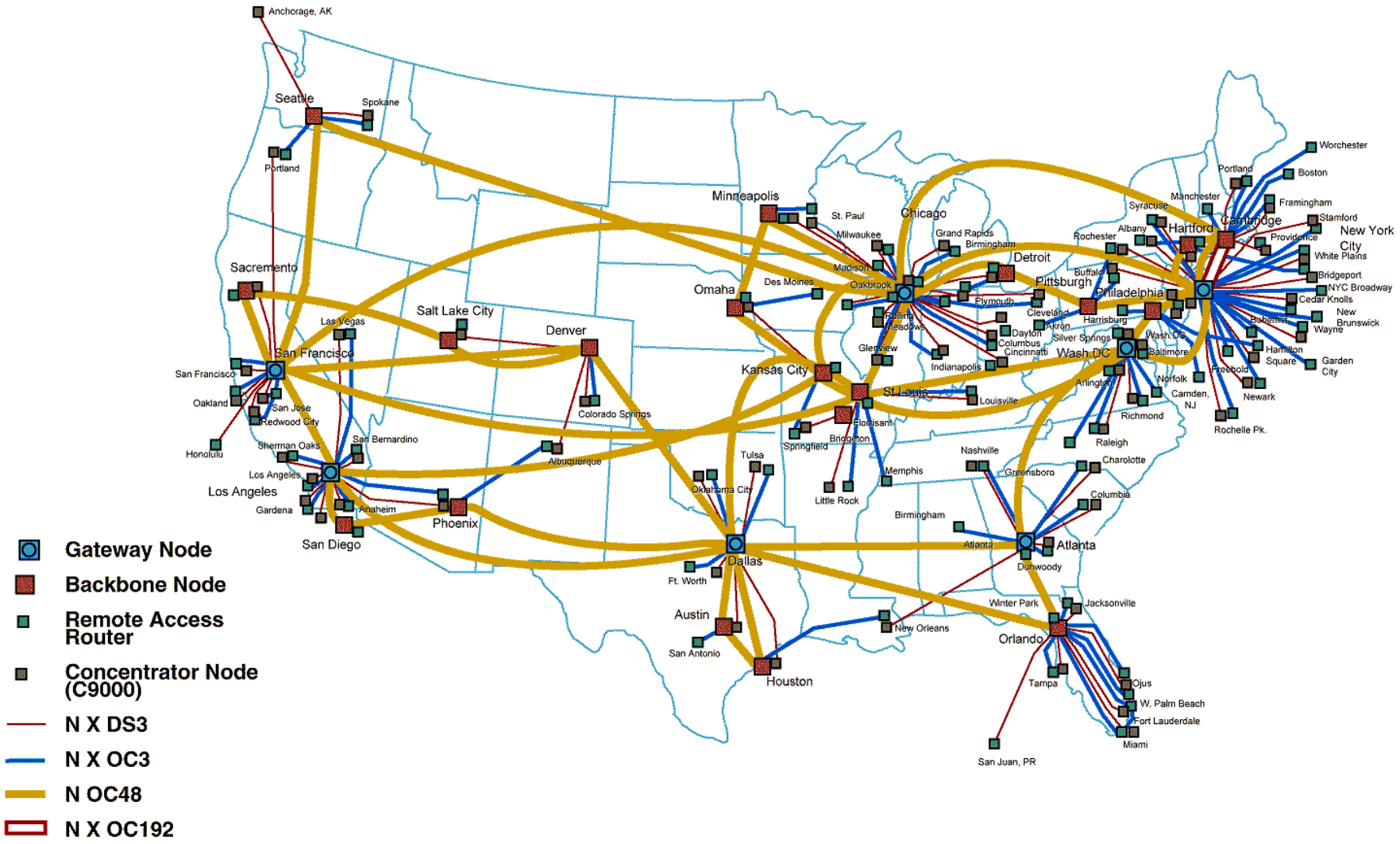
Comcast US Network Map

COMCAST'S EXTENSIVE NATIONWIDE FIBER OPTIC NETWORK

THE LARGEST FACILITIES-BASED, LAST MILE ALTERNATIVE TO THE PHONE COMPANY IN THE UNITED STATES.

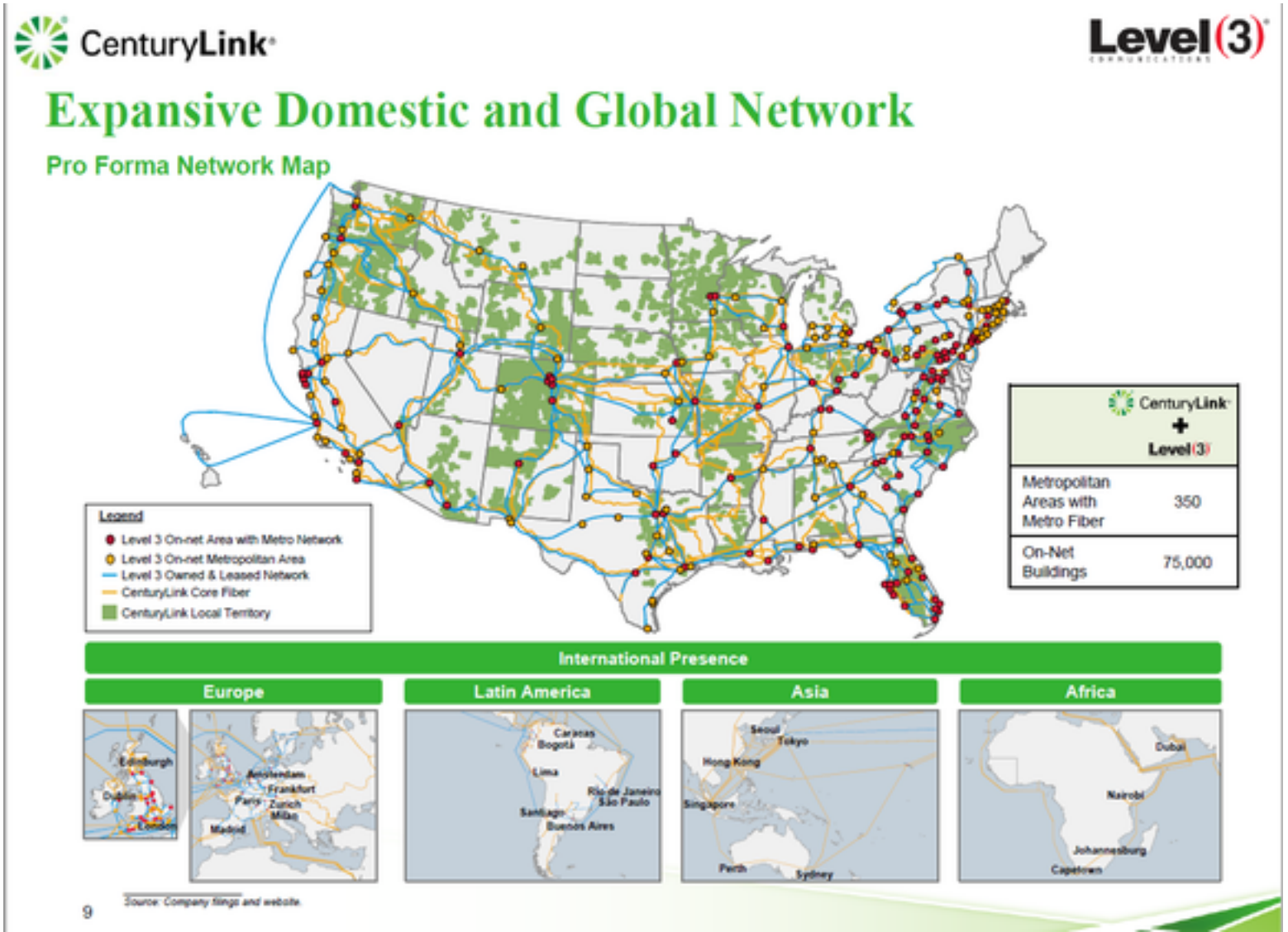


AT&T North America IP Backbone

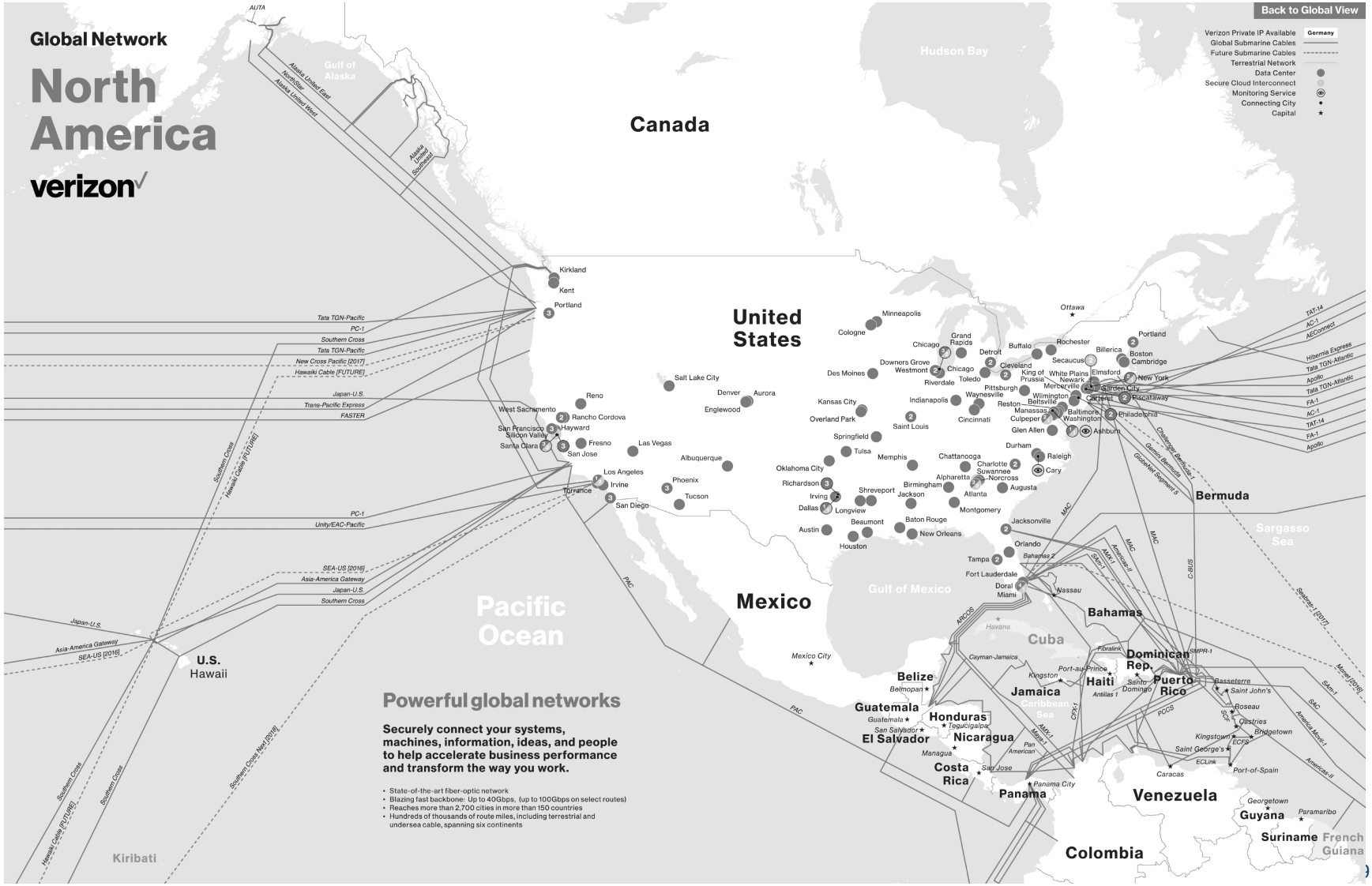


Note: map is not to scale.

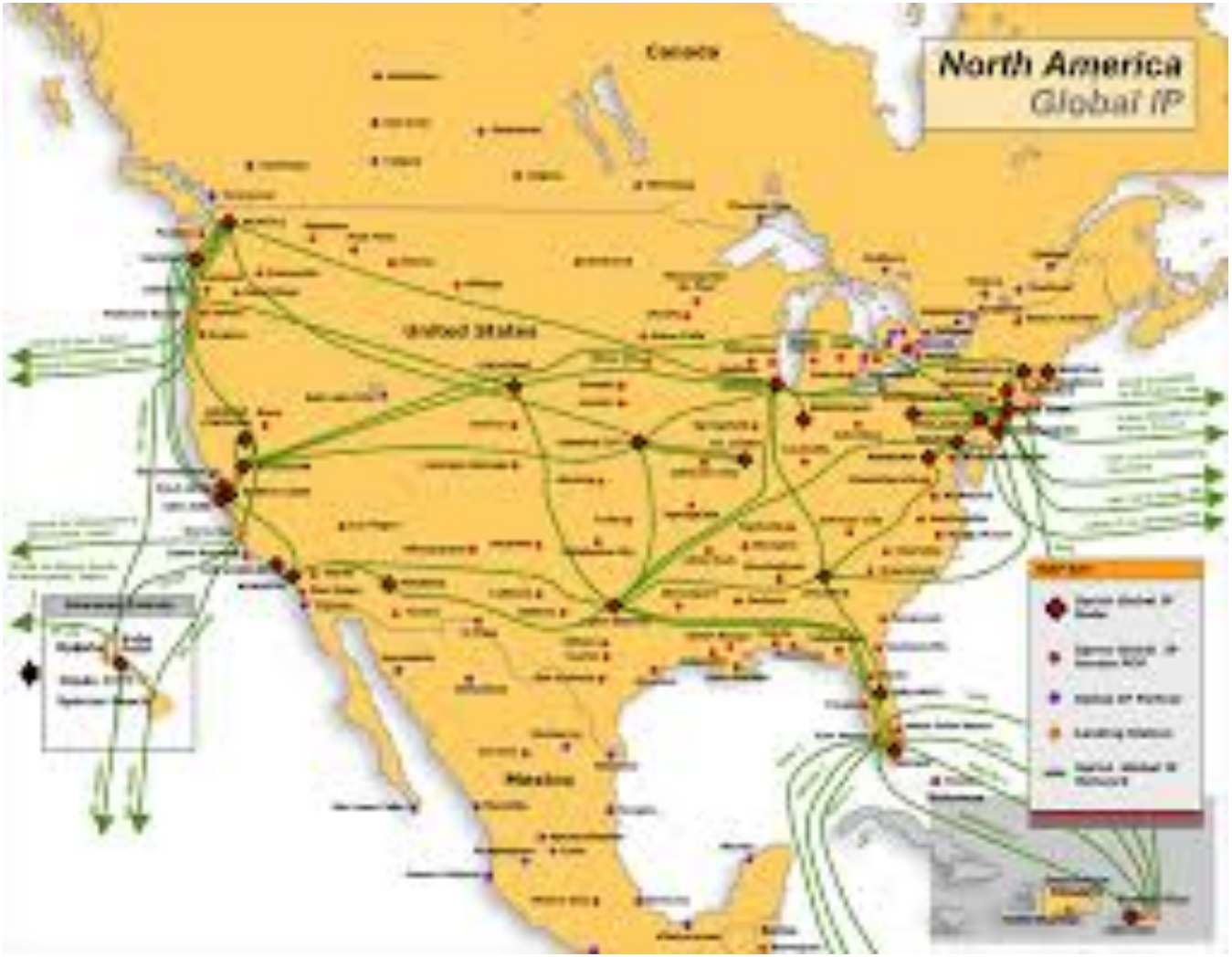
Level 3 + CenturyLink



Verizon North America Network



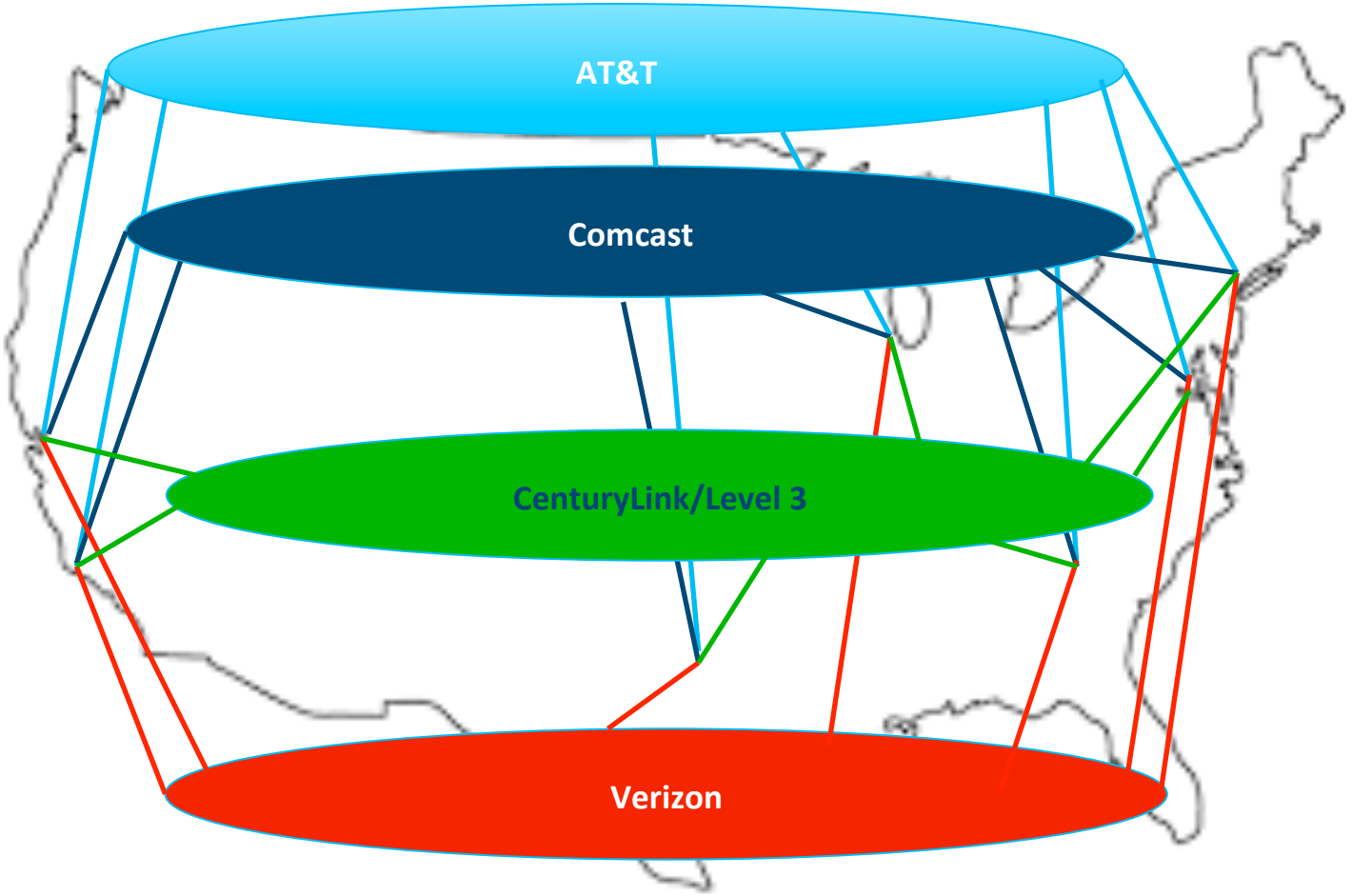
SprintLink



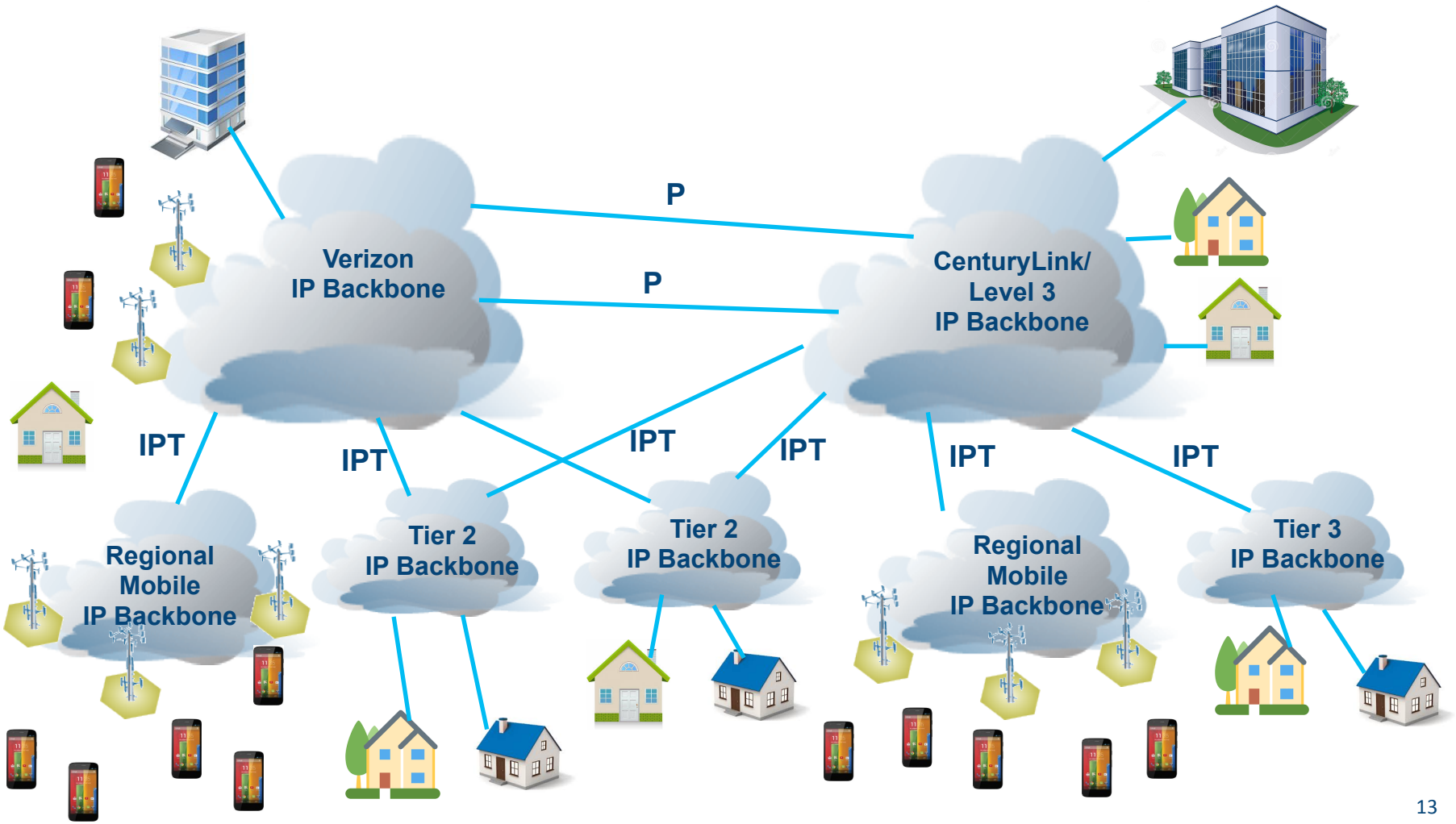
Issues Related to Peering

- Telephone carriers are highly regulated – ISPs much less so.
  - Individual calls are tracked and fees are paid to carriers for terminating calls on their network (settlement fees)
  - Sometimes calls to a cell phone in another country is more expensive that a call to a land line phone
- Large Tier 1 ISPs have established settlement-free interconnects between their networks in a few locations around the country in carrier-neutral facilities
  - New York, Washington, Atlanta, Miami (to get to Latin America), Chicago, Dallas, San Francisco and Los Angeles
  - Tier 1 ISPs are exchanging traffic that is approximately equal
  - Peering routers and interconnects typically sized to the volume of traffic exchanged
- "Hot Potato Routing" – get rid of traffic from your network as soon as you can
  - However, asymmetries can exist
  - Eyeballs vs. content: a few clicks in a browser (a few packets) can get back a movie (thousands or millions of packets)
- Carriers focused on capital expenses, especially revenue generating vs. not

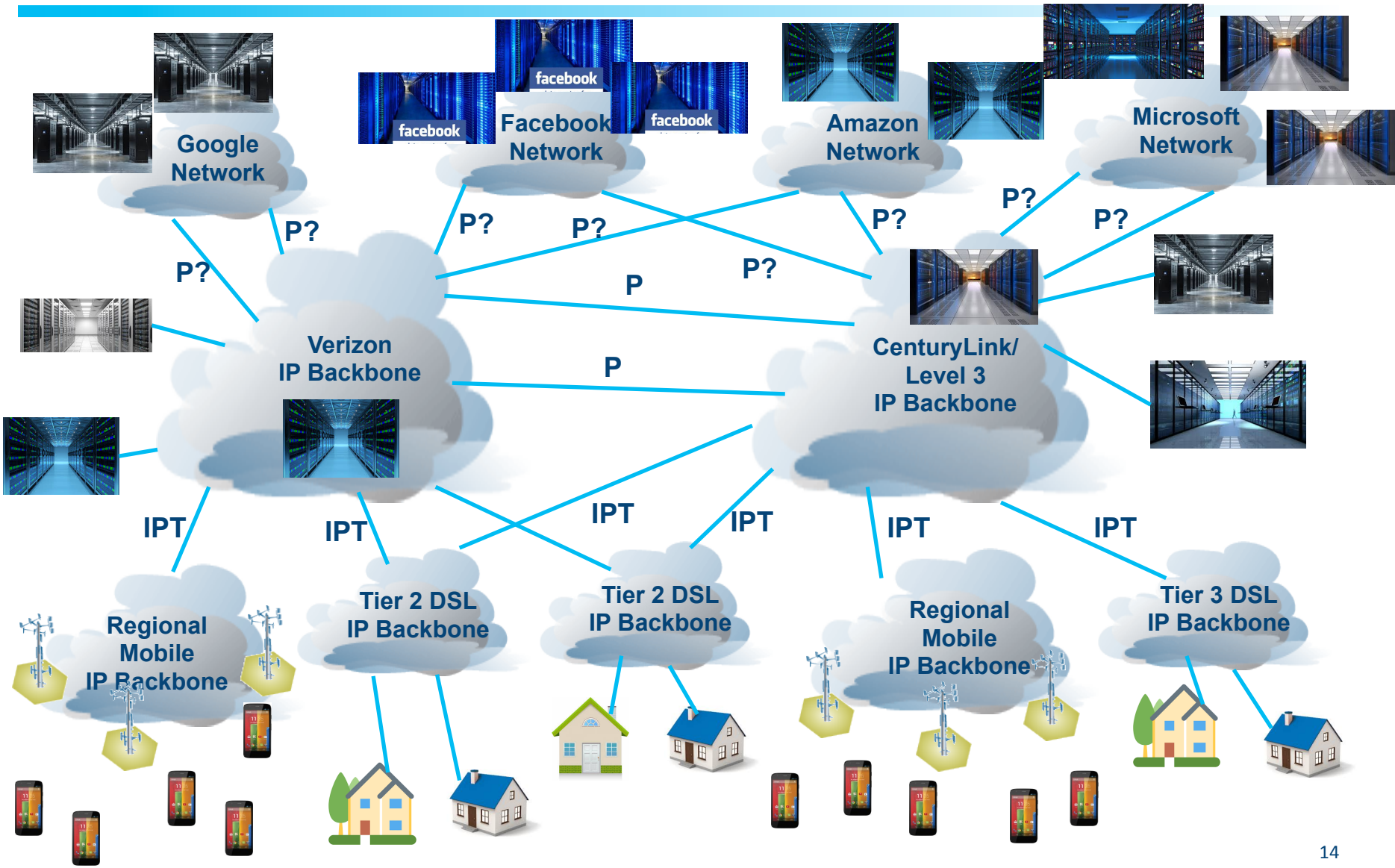
Tier 1 Inter-ISP Peering: Settlement-Free Private Interconnects



Smaller Tier 2 & Tier 3 Regional ISPs Buy IP Transit Service from the Larger Tier 1 ISPs



Data Centers and Data Center Networks May Buy IP Transit Service from the Larger Tier 1 ISPs



Now About Net Neutrality

Brief Review of What Net Neutrality Means

- Net Neutrality is a set of FCC rules aimed at Internet Service Providers (ISPs) issued in 2015 under Pres. Obama
- Forces ISPs to treat all content flowing through their networks equally
  - They can't slow down or inhibit any particular content.

- Without Net Neutrality, ISPs could create service tiers that treated various content sources differently
  - They can have fast lanes and slow lanes for different content depending on what the content provider was willing to pay them (or not).
  - This could harm small new innovative or controversial content providers by denying them access to the "public"

- Content Providers want Net Neutrality;
- ISPs: cable, wireline (fiber and DSL) and mobile carriers don't

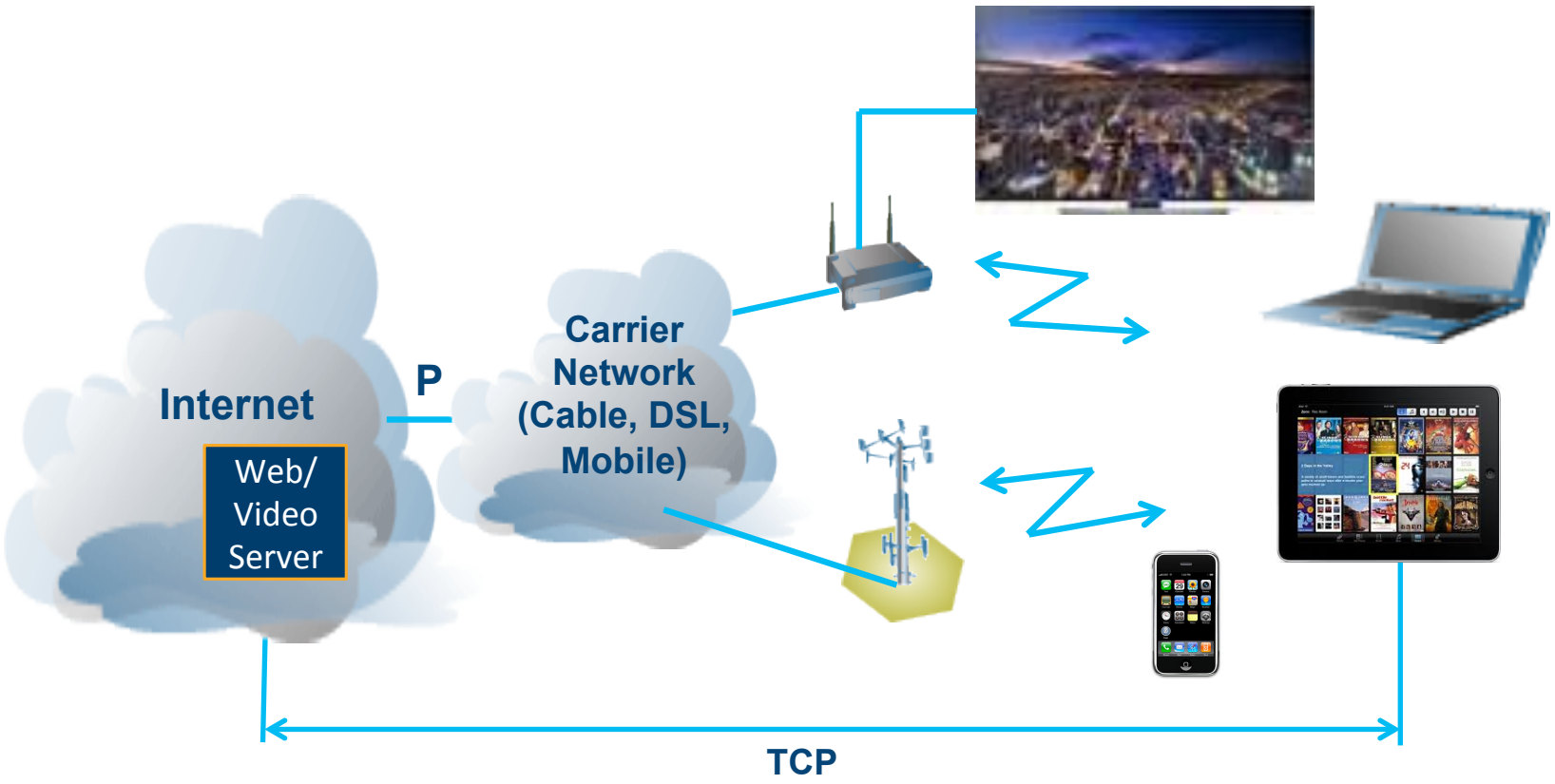
Who Pays What?
Today Under FCC Net Neutrality Rules

- ISPs can charge residential and business customers a monthly rate that depends on the access speed (typically Mbits/sec. or Gbits/sec.)
- With mobile services, the rate charged for data services is more dependent on monthly data usage cap (typically Mbytes per month, Gbytes/month or Unlimited)
- They can't charge consumers more for access to a particular web site or service
  - What about charging less?: T-Mobile's BingeOn video streaming service
- ISPs can charge web servers or data centers that connect to their network an access fee that depends on their 95th percentile peak data rate during a month.
  - They can give volume discounts to large sites or high volume users.

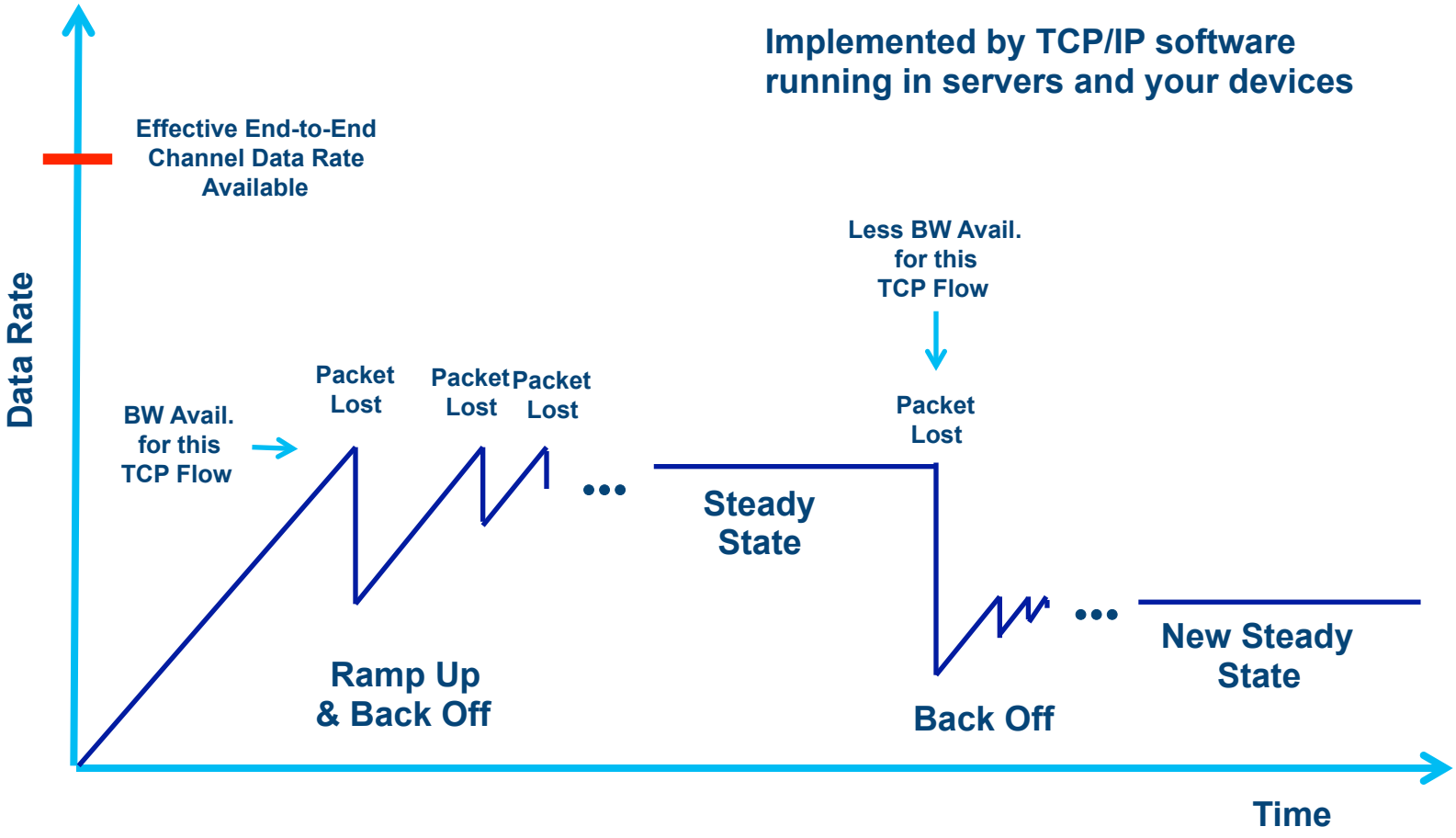
Who Pays What?
Without Net Neutrality

- ISPs could charge consumers more for access to certain web sites or services.
- They could create web service bundles like cable operators do for groups of channels.
- ISPs could block or slow down access to certain web sites or services unless they paid the ISP some sort of special access fee.
- The ISP could provide higher speed access (a fast lane) to web sites or services that paid them some sort of special access fee.
  - This higher speed access could also be provided to web sites or services that the ISP owned or controlled

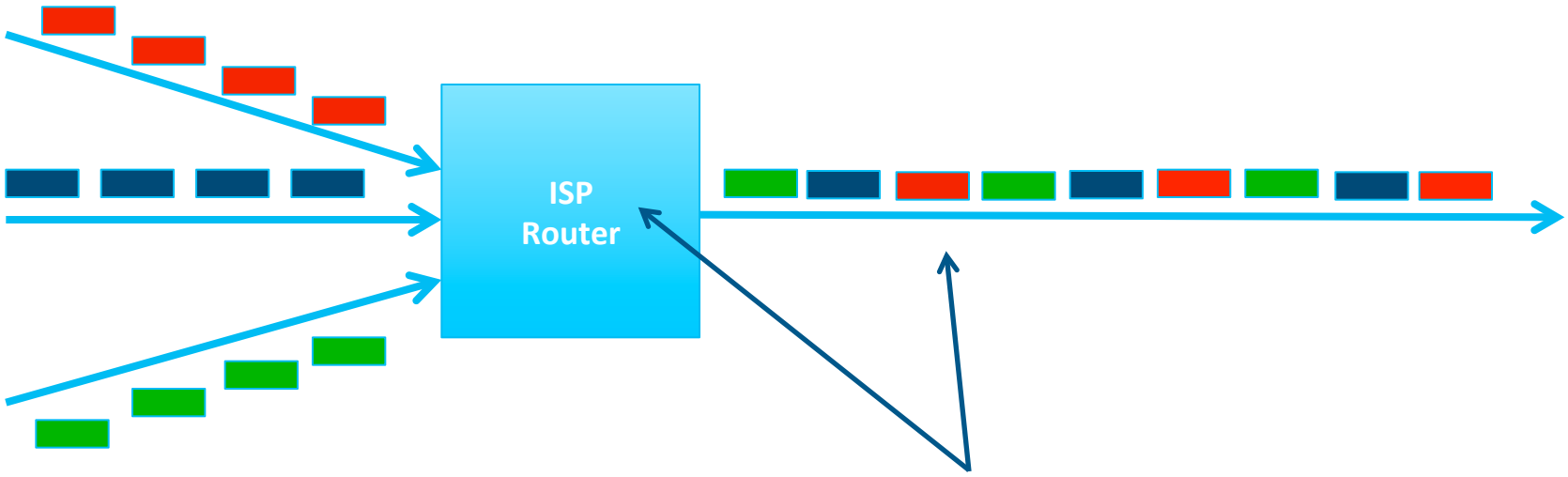
TCP – End-to-End Reliable Content Delivery



TCP End-to-End Flow & Congestion Control Sets the Content Delivery Data Rate and Ensures that Each TCP Connection Fairly Shares Available Bandwidth



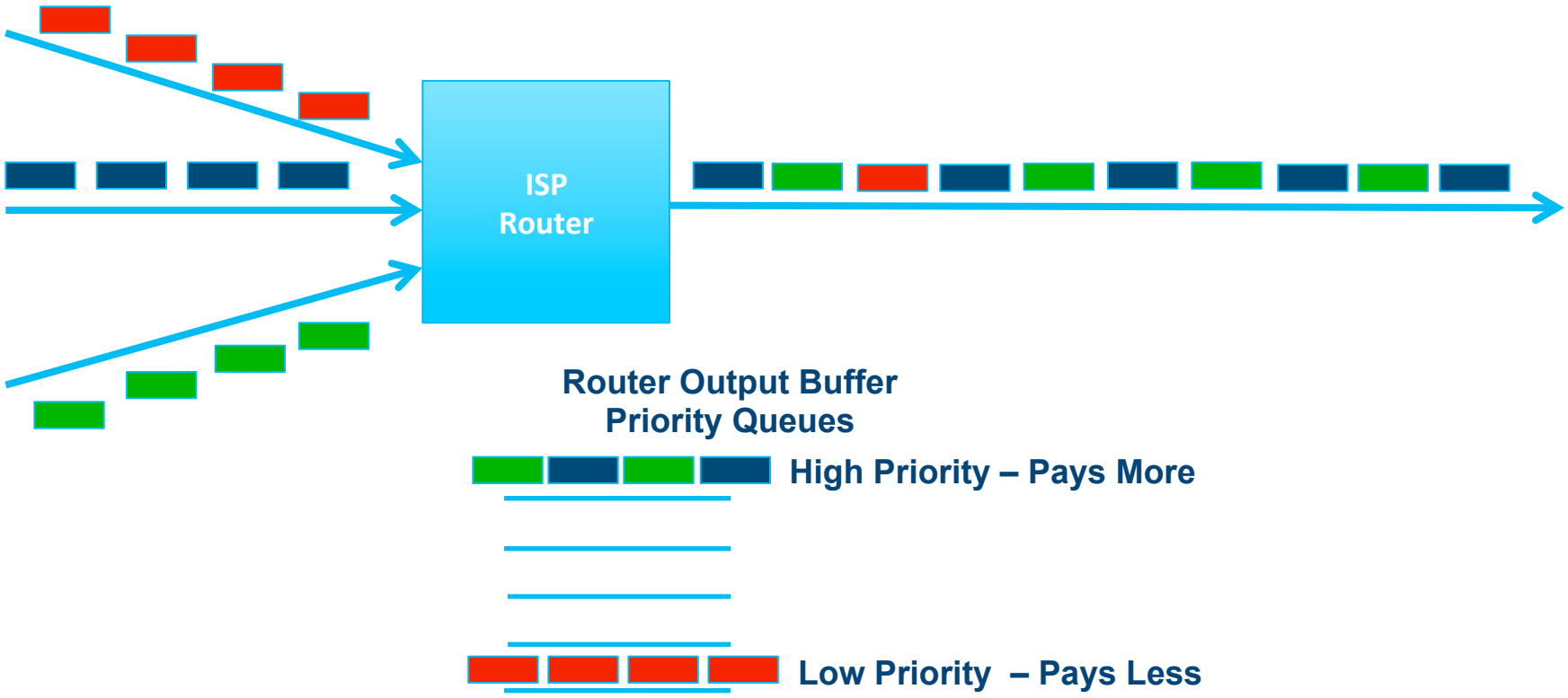
With Net Neutrality



Limited Resources:

- **Output buffer space**
- **Circuit bandwidth**
- **Allocated fairly across all traffic**

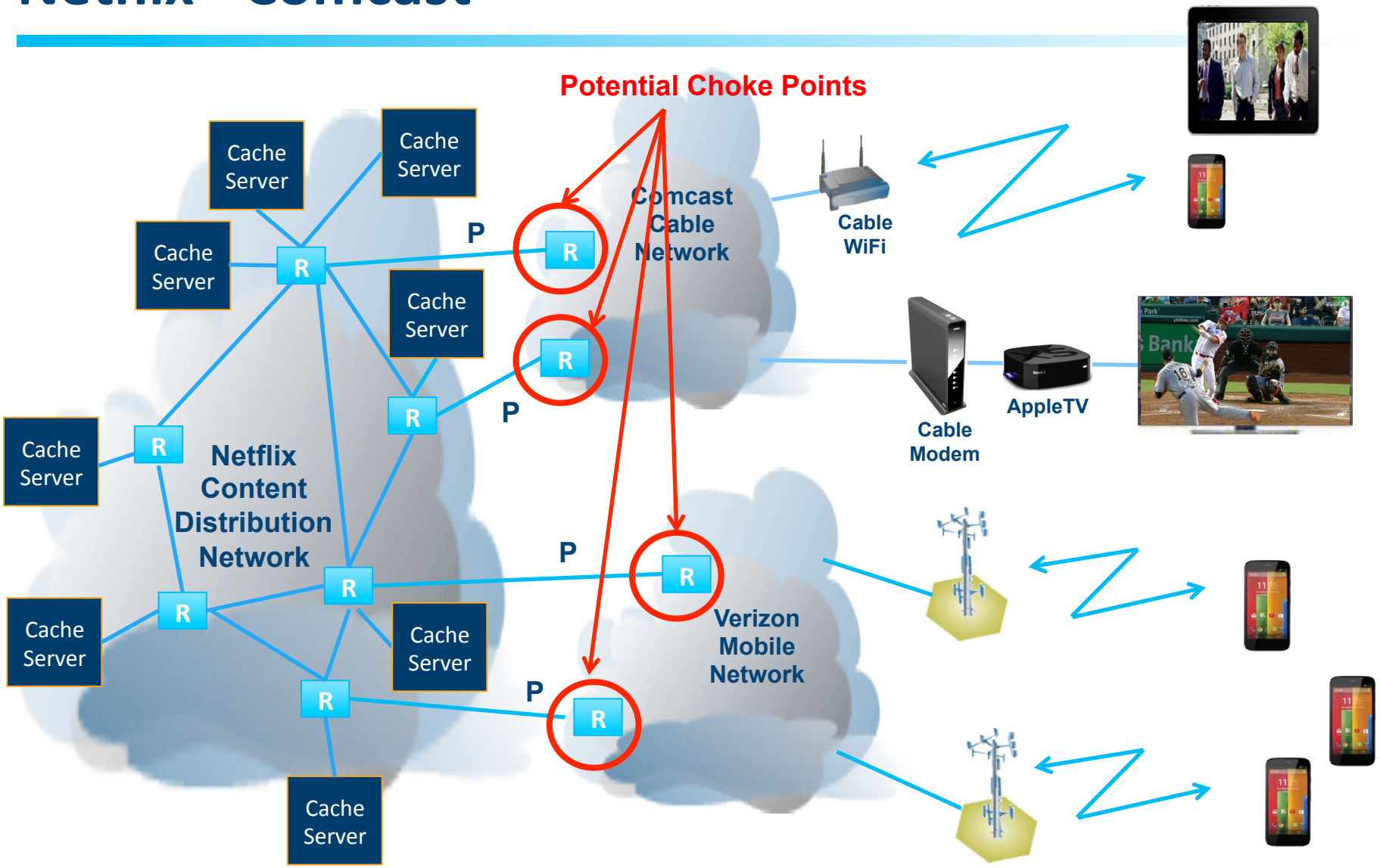
How ISPs Can Create Fast Lanes



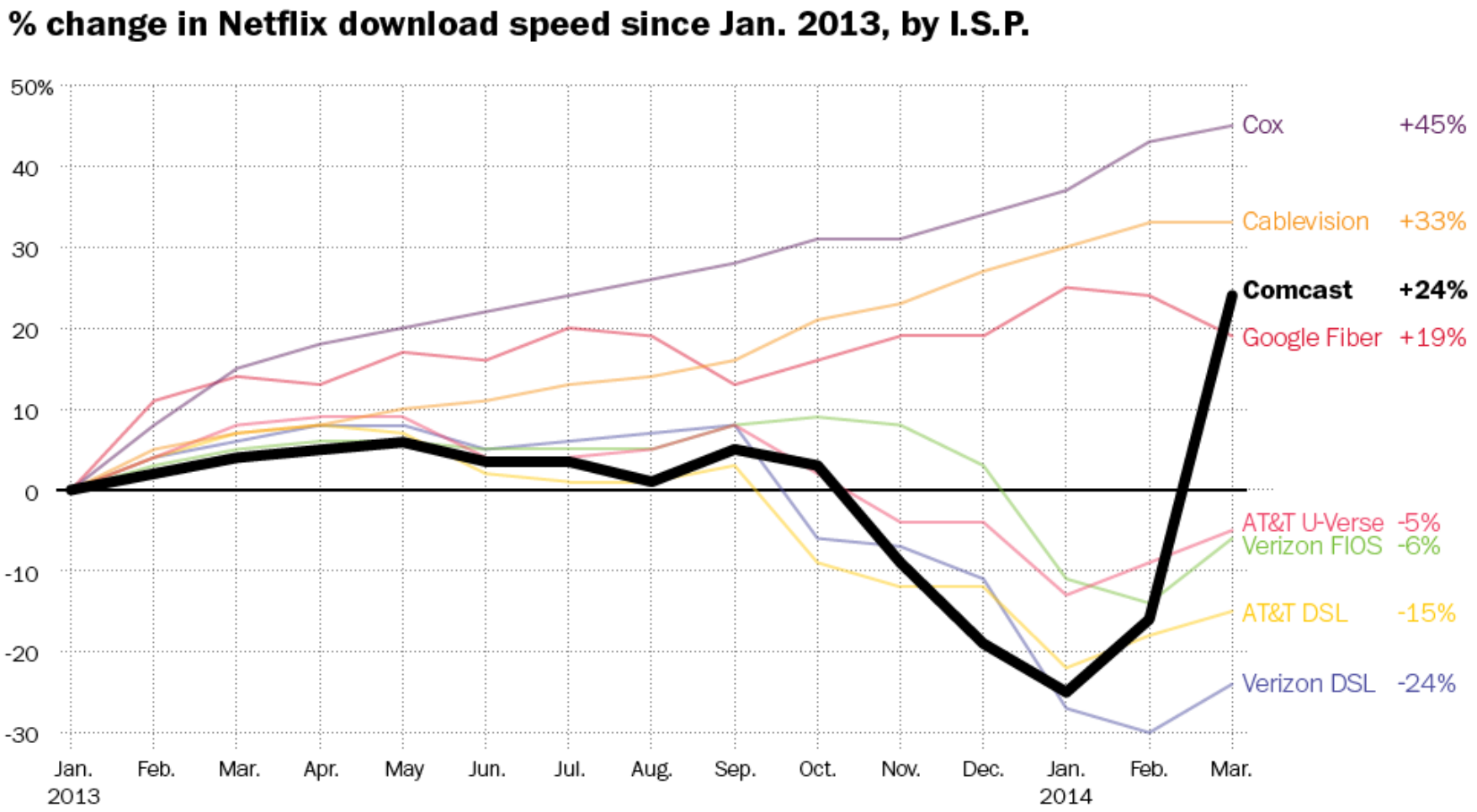
Slowing Down the Delivery of Content

Netflix Example Short – Buffering and Less than Standard Definition (640 x 480 Pixels)

Streaming Video Delivery Example: Netflix - Comcast



Netflix Reaches a Deal with Comcast



Netflix: Example Short – Full High Definition (1920 x 1080 Pixels)

Hiawatha Bray's 11/28/17 Boston Globe Article: Like Y2K, the Net Neutrality is Way Overhyped

- Y2K (rollover from Dec. 31, 1999 to Jan. 1, 2000) was overhyped at the time
  - Some very old systems did have dates coded with two digits and needed to be fixed (eg. The FAA 's IBM System/360 Air Traffic Control System)
  - Most modern Unix based systems did not have a problem (Jan. 19, 2038 problem)
- Fear of consumer backlash and in some locations real competition should prevent outrageous ISP behavior
  - Streaming video throughput problems in the past were fixed by payments
  - Starting in 2011, Verizon, AT&T and T-Mobile all blocked Google Wallet in favor of Softcard their payment system, until Google bought Softcard in 2015
  - There is not much competition in wireline last mile broadband ISPs and in some places there is none
- FTC should be able to handle cases of real content discrimination
  - FCC/FTC did fix some of these problems (Madison River Communications blocking VoIP) in the past:

Net Neutrality in India

- Facebook tried to offer Free Basics, free access to 38 web sites mediated by a Facebook app, in conjunction with Reliance Telecom
- Bharti/Airtel offered something similar with Airtel Zero
- Both services have been disallowed by Telecom Regulatory Authority of India (TRAI) (Indian equivalent of FCC)
- TRAI has now issued a set of Net Neutrality Guidelines:
  - No service provider can offer or charge discriminatory tariffs for data services on the basis of content.
  - No service provider shall enter into any arrangement, agreement or contract, by whatever name called, with any person, natural or legal, that the effect of discriminatory tariffs for data services being offered or charged by the service provider for the purpose of evading the prohibition in this regulation.
  - Reduced tariff for accessing or providing emergency services, or at times of public emergency has been permitted.
  - Financial disincentives for contravention of the regulation have also been specified.
  - TRAI may review these regulations after a period of two years.

Thanks For Listening!