



The Architecture of Modern Telecommunications & What it Says about Competition

Telecommunications Law 2016

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What Has Changed Since 1996

- Broadband Internet access service has replaced local phone service as the must have communication connection for homes and businesses.
- States are no longer the primary regulator of local communications service. The FCC has preempted states, but abdicates any role.
- WiFi has replaced wires as the basic means of connecting end user devices to the communications network.
- Bundled service by a single provider has replaced separate phone, Internet access, and cable service providers. Bundling is being extended to commercial mobile service as well.

What Has Not Changed Since 1996

- Digital ones and zeros enable voice, video and data on same network.
- The physics of wired versus wireless communications.
- Ubiquitous broadband communication will continue to depend on wired infrastructure to reach almost every home and business.
- Deployment of infrastructure is costly and time consuming.
- Markets do not support deployment of infrastructure absent a monopoly service or very high demand.
- Infrastructure owners will not grant access absent rules requiring it.
- Physical network connections remain a key competitive bottleneck.

State Role Significantly Reduced Since 1996

- Incumbent industry players will continue to seek ways to exclude State commissions from regulating communications services.
- The present push to replace copper loops with 4G or 5G wireless continues that effort.
- Section 332(c) in general pre-empts States, and expedited wireless tower siting procedures make facility deployment easier.
- FCC removal of any pro-competitive requirements – resale, access to network elements, state arbitration – for VoIP and broadband Internet access service also pre-empted States.

Going Forward – What Role for States?

- In 2015 the FCC finally acknowledged the emperor was wearing no clothes – that “broadband Internet access service” does nothing more than transmit user data and thus is a “telecommunications service.”
- At the same time the FCC again pre-empted States and abdicated.
- The question is what role do States want to play in communications?
- Broadband Internet access service depends on local infrastructure.
- Broadband Internet access service is an essential service like power, water and sewer; but unlike those services it is not State regulated.
- Broadband Internet access service is also needed for NG-911.

The 1996 Act Addressed Broadband

- New legislation is not needed to re-invigorate the State role.
- The 1996 Act provides a well-balanced Federal-State scheme.
- If the States want to play a role then they need to communicate that to Congress, the Trump Administration and the FCC.
- If allowed to implement what Congress provided in the 1996 Act the States could ensure universal broadband Internet access and increase competition, bringing consumers lower prices and greater innovation.
- States could also accelerate the transition to NG-911.
- Virtual reality will overwhelm wireless, increasing consumer anger.

Broadband as Telecom Service

- If broadband Internet access service remains a “telecommunications service” then the 1996 Act provides explicit authority.
- Definition of “interstate communications” excludes local BIAS.
- Definition of “local exchange service” can include wireless BIAS.
- Definition of “telecommunications service” is technology neutral.
- Definition of “telephone exchange service” covers BIAS.
- Sections 214 and 254 can extend BIAS to rural and unserved areas.
- Section 332(c) permits State regulation of replacement service.
- Sections 251 through 253 provide rules for enhancing competition.

BIAS as “Information Service”

- Even if the Trump Administration successfully reverses the FCC’s 2015 re-classification, Congress gave States the opportunity to have a role regulating broadband Internet access service.
- Nothing in the Communications Act says that an “information service” offered to the public is not a “common carrier” service.
- States would have to make a fact based determination, but there is no legal bar. States have long regulated local common carriage.
- In addition, if the FCC is upheld on its claim that section 706 of the Telecommunications Act is a Congressional grant of authority, then States could use section 706(a) to regulate BIAS as well.

The Myth

- One searches the Communications Act in vain for a prohibition on common carrier regulation of “information service.”
- Congress had the opportunity to include a prohibition in 1996 but did not do so. This was no oversight – Congress did so for broadcasters in 1934, cable service in 1984 and private mobile service in 1993.
- Language prohibiting regulation of the Internet was included in the House bill, but the language was not adopted in conference.
- Congress never said “information service” and “telecommunications service” are mutually exclusive. The FCC did, but 47 CFR 64.702 shows the FCC is wrong – the two are in fact mutually **dependent**.

Information Service Pre-1996 Act

- In 1995 "information service" or "enhanced services" could only be offered to the public over a regulated "telecommunications service" or "basic service."
- The FCC's enhanced service rule applied to all carriers – both the Bells and new competitors, including cable systems offering telecommunications.
- 47 CFR 64.702(a) defined an "enhanced service" as "services, **offered over common carrier transmission facilities** used in interstate communications, which employ computer processing applications that act on the format, content, code, protocol or similar aspects of the subscriber's transmitted information; provide the subscriber additional, different, or restructured information; or involve subscriber interaction with stored information. **Enhanced services are not regulated under Title II of the Act.**"

Information Service Post 1996 Act

- Congress defined “information service” and added it to the Act.
- In new section 230 Congress said it was their intent “to **preserve the vibrant and competitive free market that presently exists** for the Internet and other interactive computer services, unfettered by Federal or State regulation.”
- To “preserve” the unregulated Internet, Congress left intact the Commission’s “enhanced service” regulation at 47 CFR 64.702.
- That regulation requires use of **regulated** transmission facilities in order for an information service not to be regulated.

Conclusion

- The IP Transition, like the digital transition before it, took much longer than Congress expected.
- New legislation is not likely to be the answer. The 1996 Act took six years of intense Congressional debate.
- 20 years after the 1996 Act industry continues to successfully argue that “new” technology makes the 1996 Act outdated, and they would do the same with any new law.
- States that want universal broadband, innovation and lower prices for their citizens should take new approaches to apply the existing law and lobby Congress and the new Administration to support them.



The Architecture of Modern Telecommunications & What it Says about Competition

The New Telecommunications Network: Competitive Environment

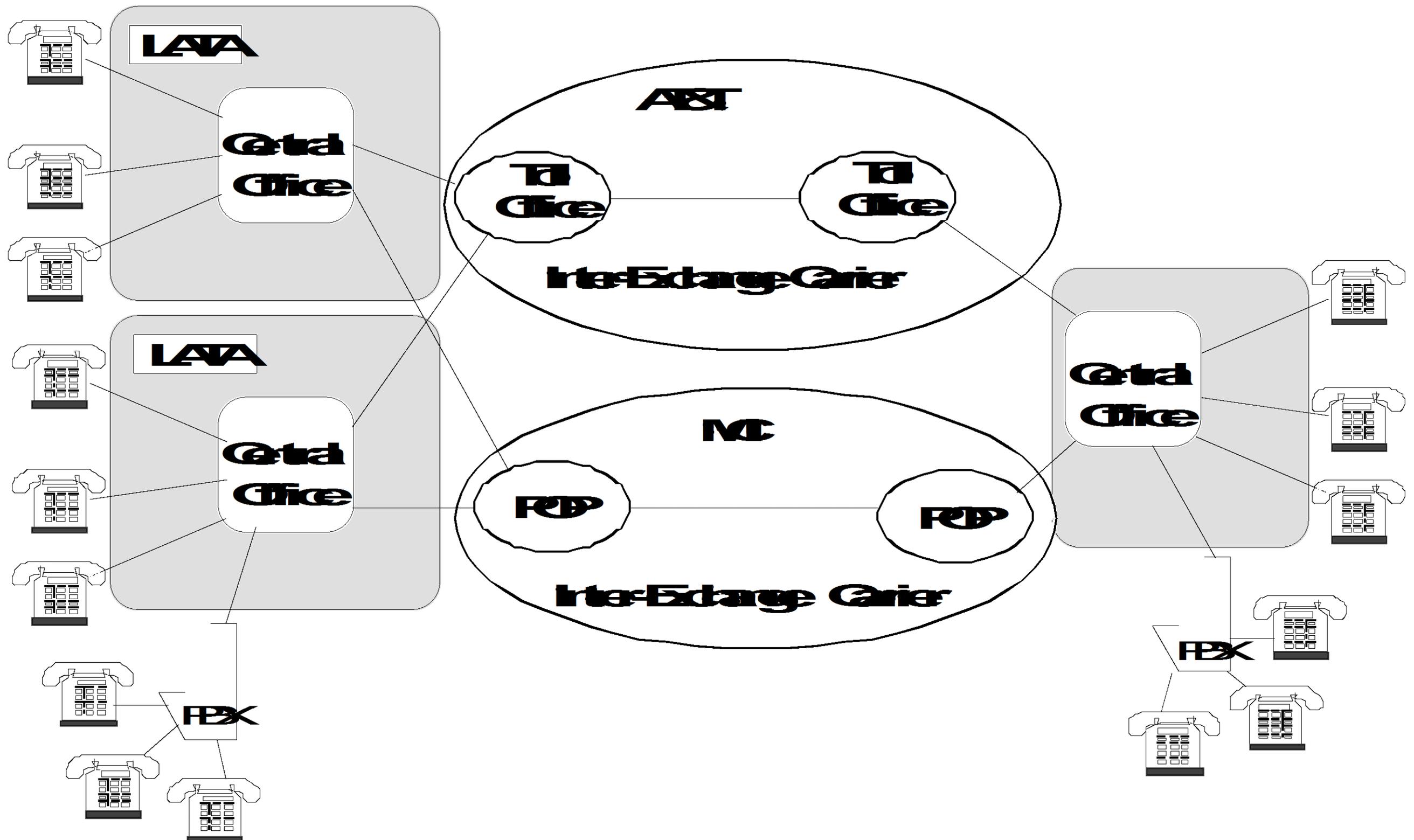
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TELEPHONE NETWORK

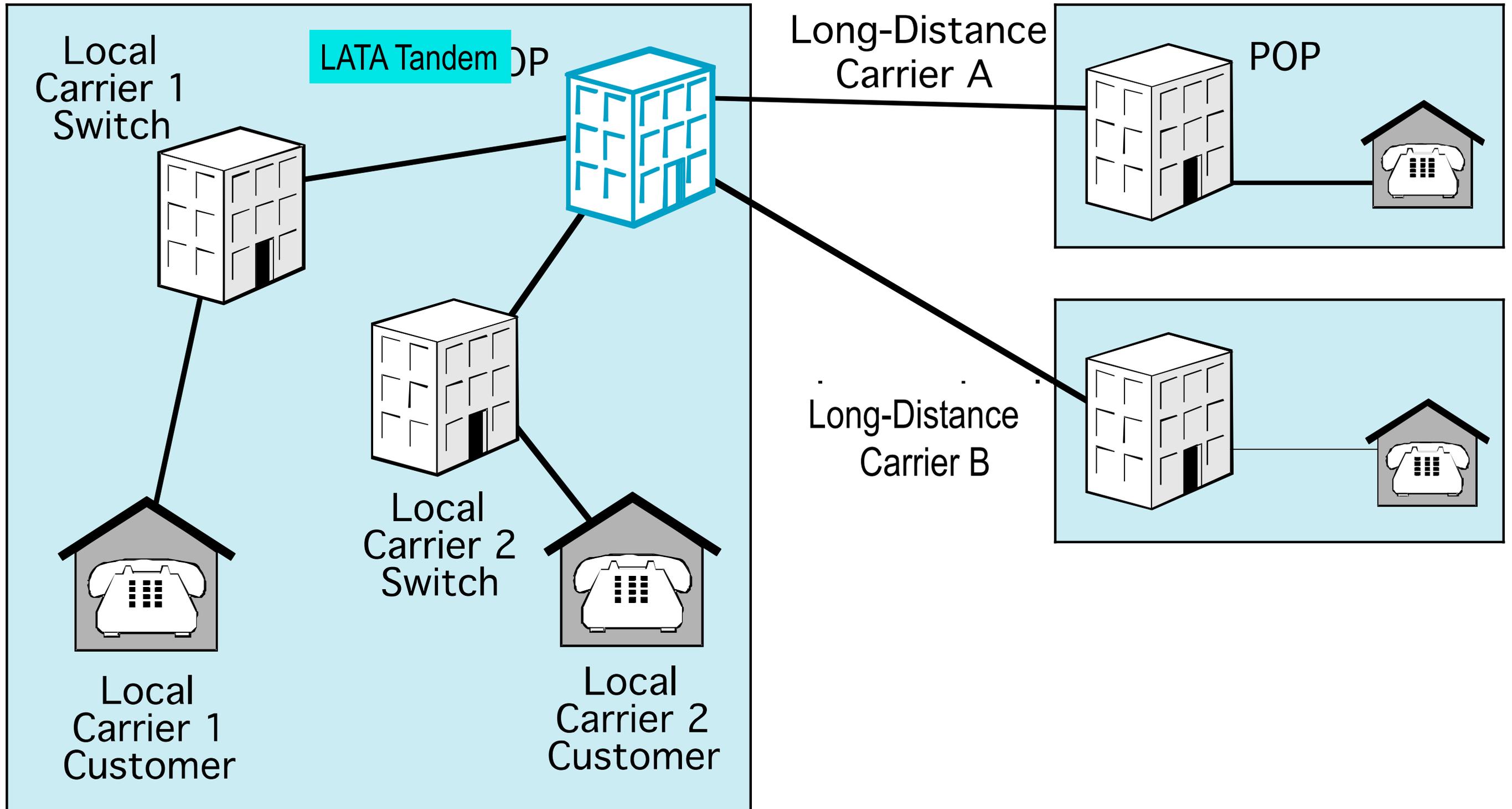
At the Time of the Telecom Act of '96



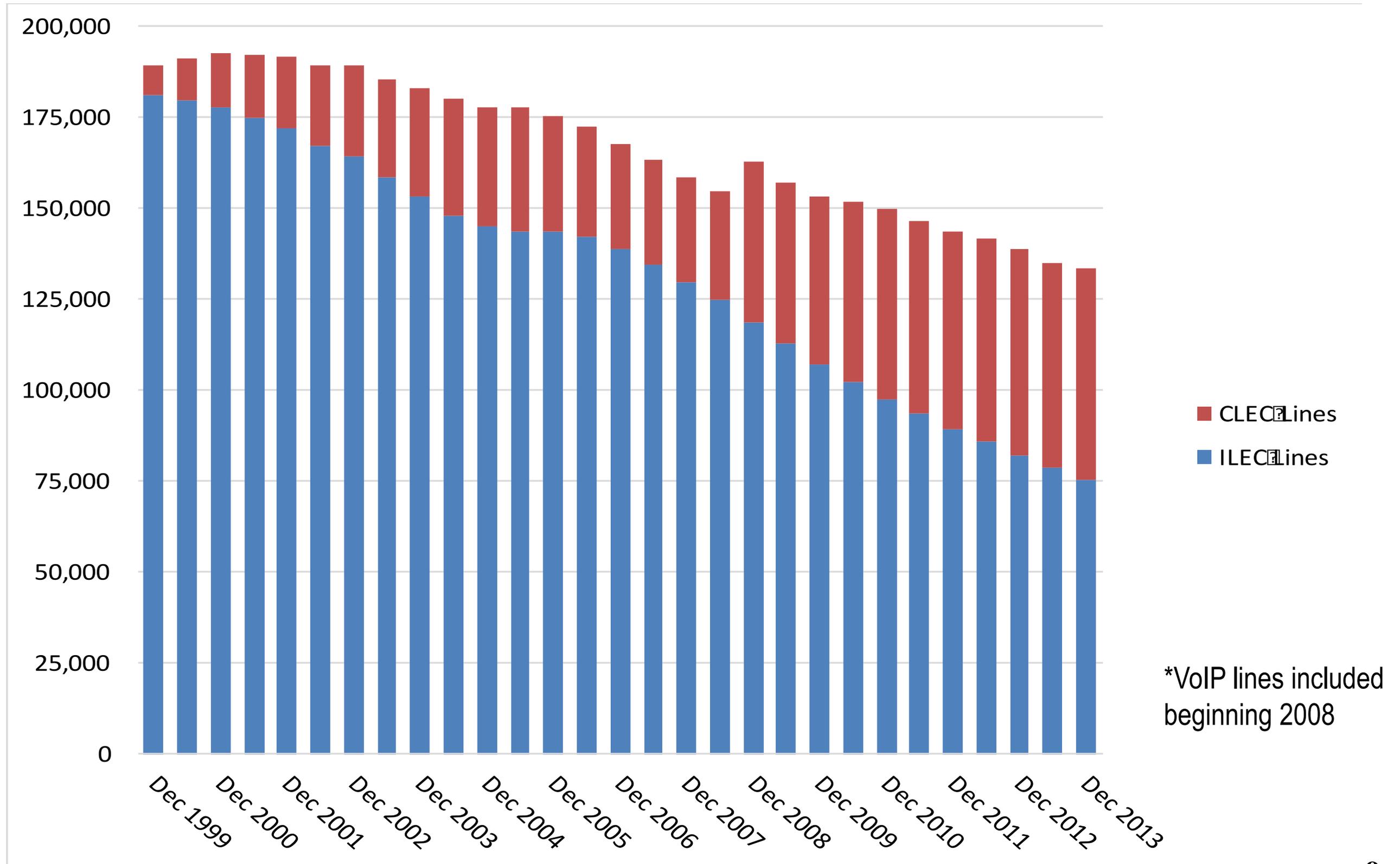
Competition in Both Local and InterExchange

Local Access and Transport Area (LATA)

Other Local Area

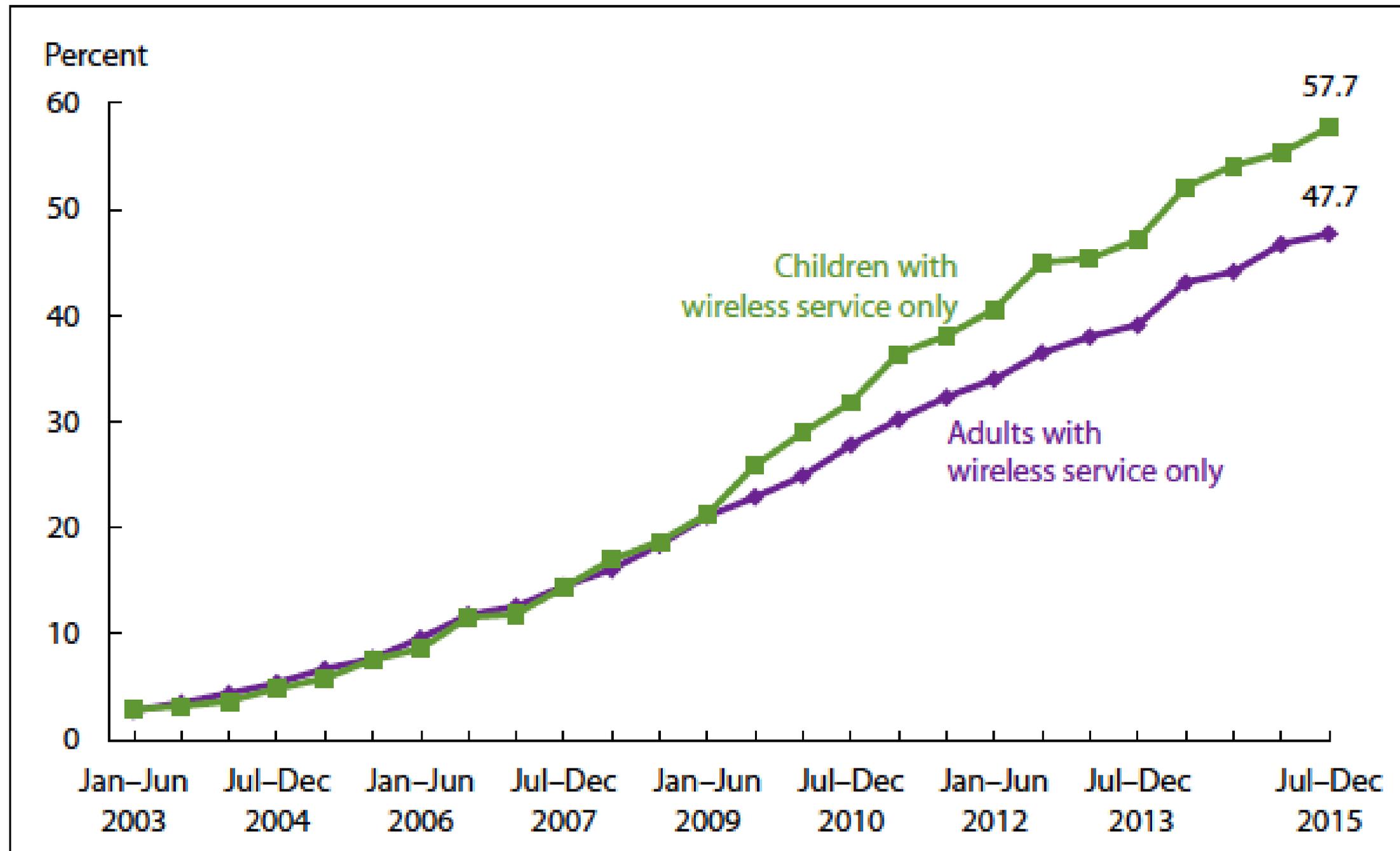


Decline of Switched Wireline and Growth of non-ILEC Competiton



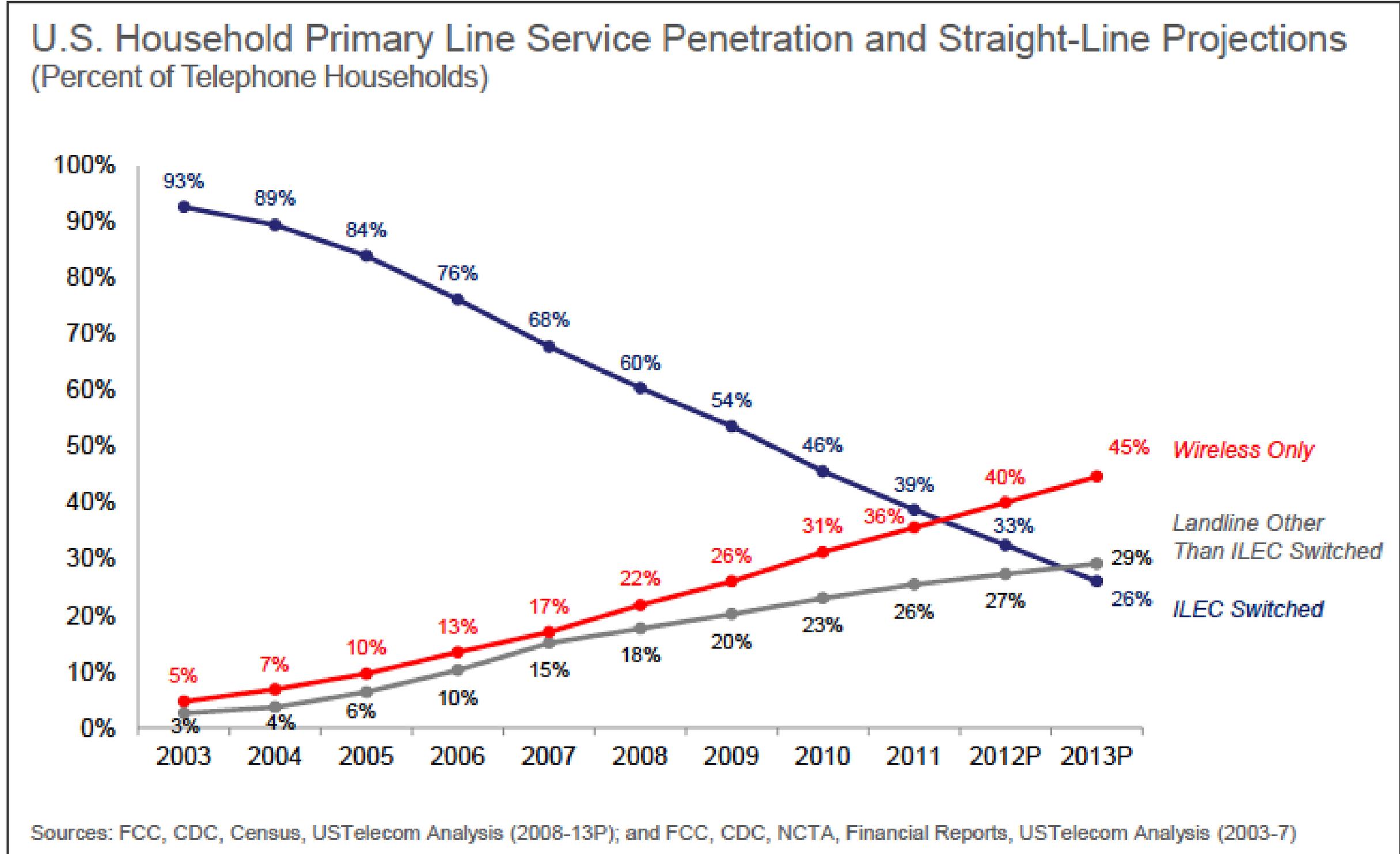
Rise of Wireless Competition

Figure. Percentages of adults and children living in households with only wireless telephone service: United States, 2003–2015



NOTE: Adults are aged 18 and over; children are under age 18.
DATA SOURCE: NCHS, National Health Interview Survey.

Chart 1: ILEC Switched vs. Wireless-Only and Interconnected VoIP Households¹



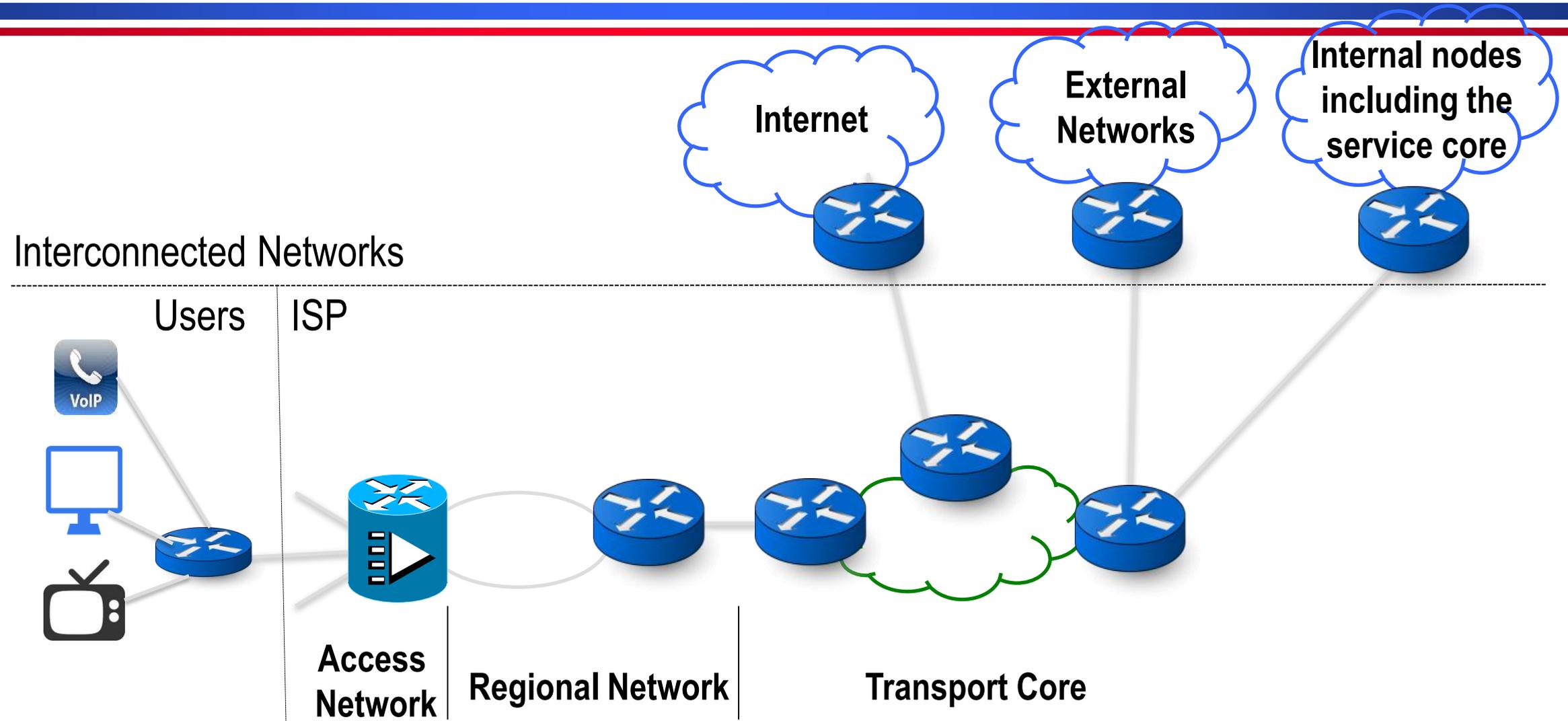
¹ In this chart, the ILEC Switched category includes all non-cable, non-ILEC switched services, on the assumption that they are resold ILEC switched services. ILEC VoIP lines are included in the Landline Other Than ILEC Switched category.

Source: <http://www.ustelecom.org/sites/default/files/documents/111813-voice-comp-research-brief.pdf>

From Circuit Switching to Packet Switching

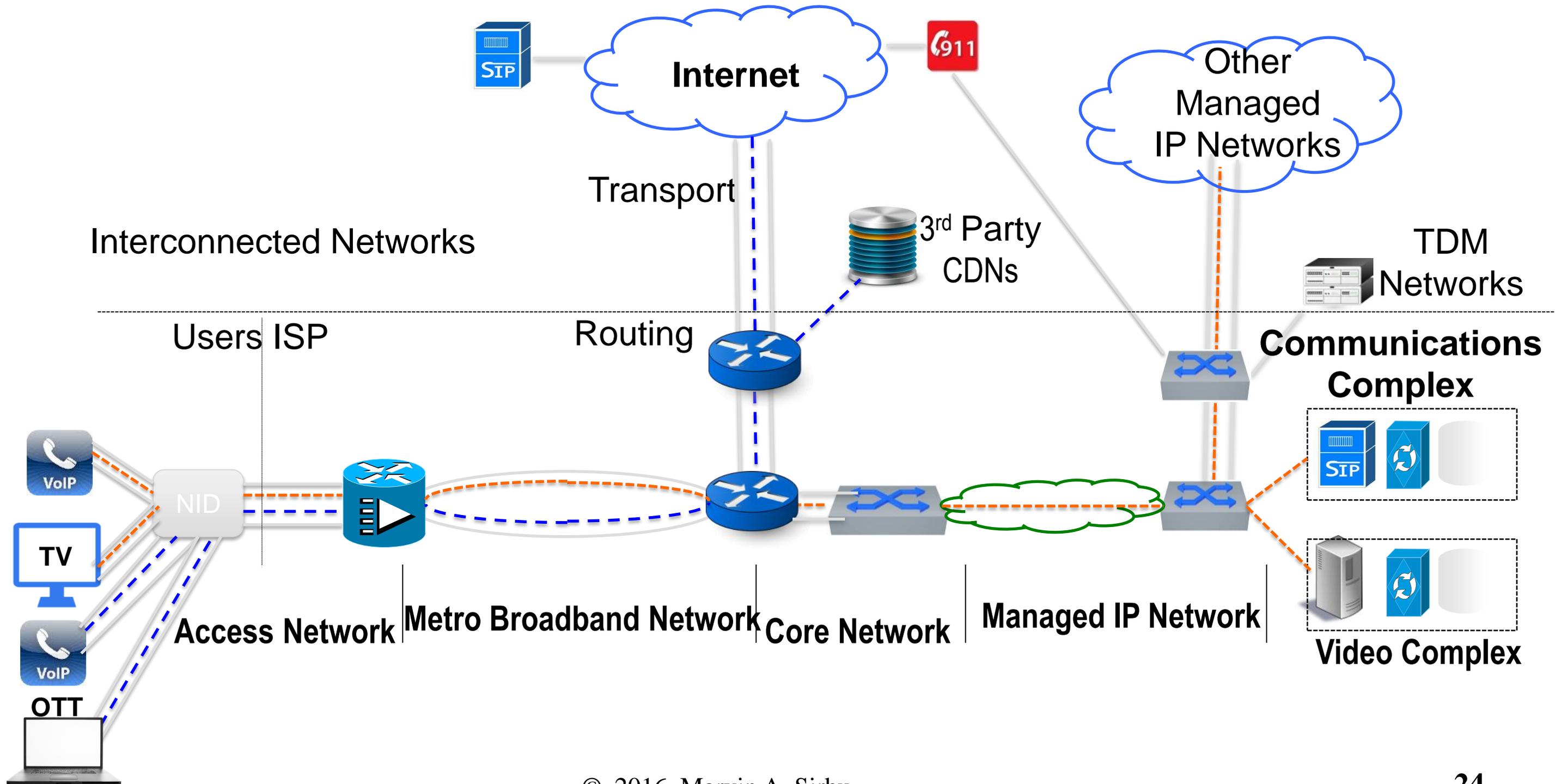
- **Circuit switched voice networks designed to provide a fixed, guaranteed amount of capacity (enough for one voice conversation) between origin and destination for the duration of a call**
 - 64 kbps for a voice call
- **Data communication is bursty**
 - Packets from many users interleaved over high speed links in the data network
 - Users send a variable amount of data per unit time depending upon how many packets
 - Content of the packets (application) determined by the endpoints
- **Today's Network Architectures are designed around packet switching**
- **Carriers' packet platform provides both public (Internet) and private ("Managed") packet switched services**
 - SDN and NFV will make it easier to proliferate new managed services

Reference Architecture for A Modern Packet Switched Network Operator



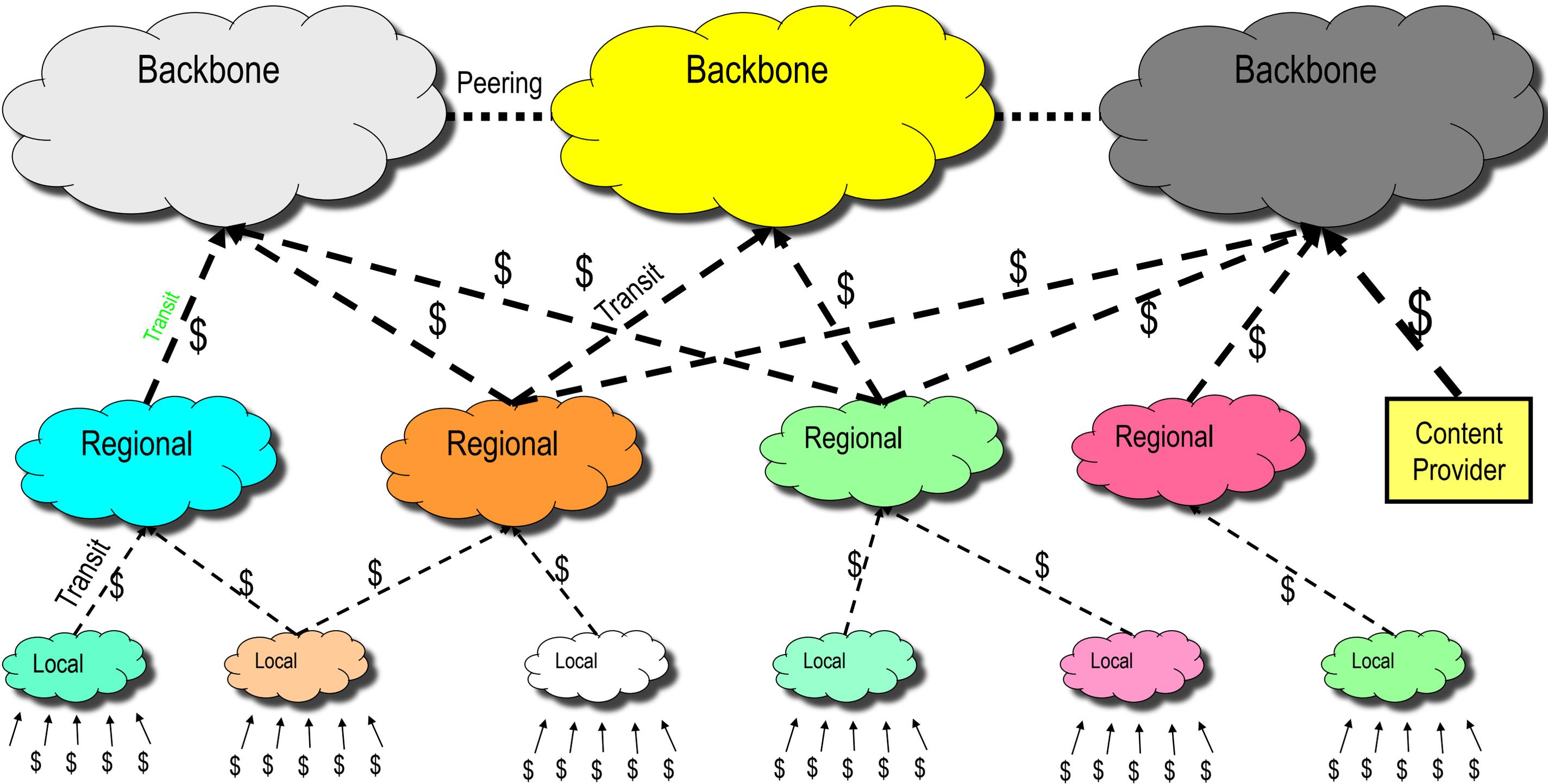
- **Access network** – connects the user to the regional network
- **Regional network** – connects the access network to the transport core
- **Transport core** – connects the regional network to the Internet, the service core and other internal and external networks
- **Internal nodes** – other nodes within the network including the service core which enables communications and/or linear video service
- **Internet** – connections to other ISPs that enables the user to access Internet services
- **External networks** – communications and video networks; CDNs

Modern Packet Infrastructure Carries Both Internet and Private Packet Traffic

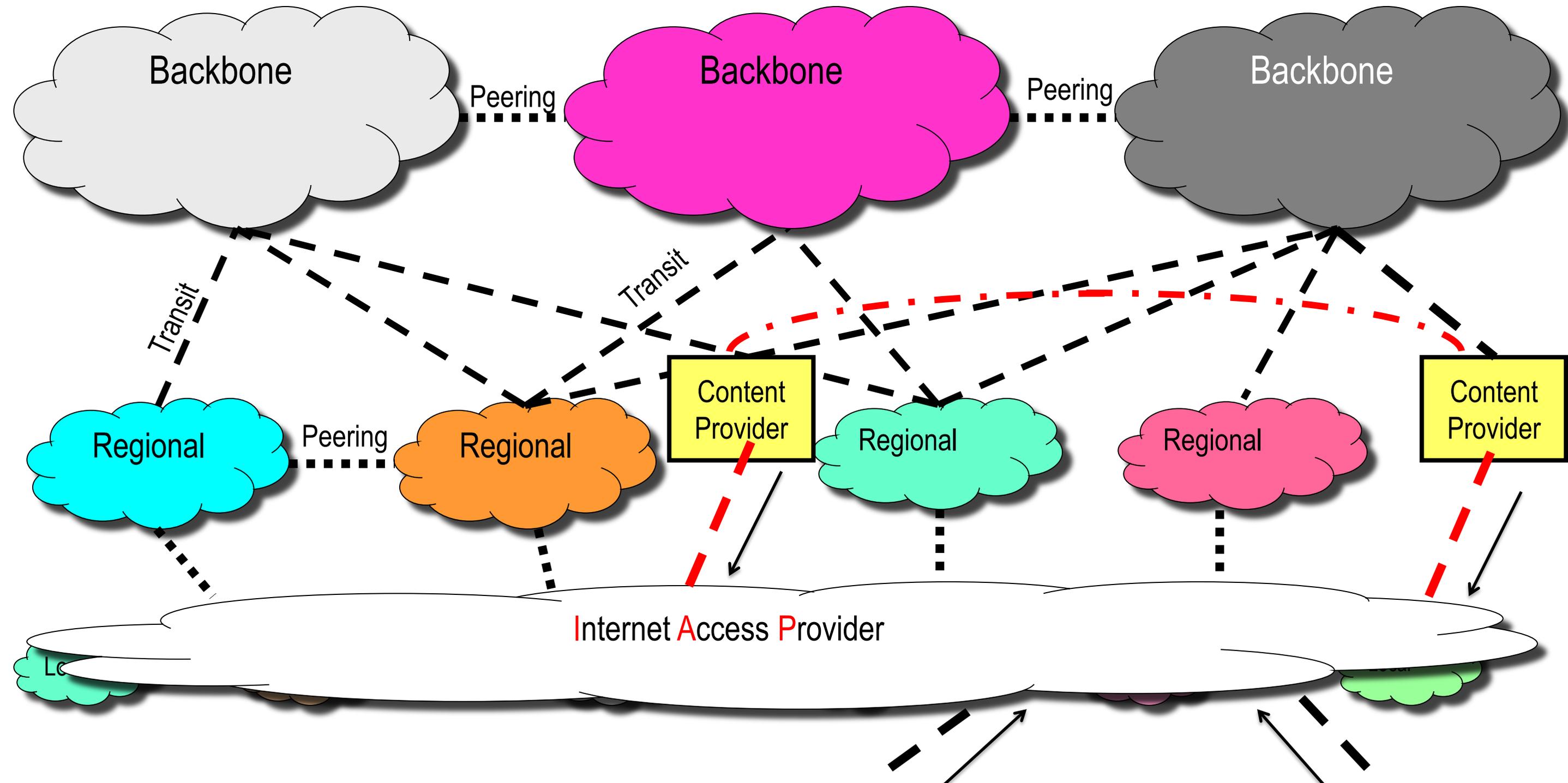


- **Data servers attached to the metro or transport core provide services and management**
 - VoIP call setup servers
 - Video storage and delivery servers
 - Email servers
- **Growth of 3rd party Content Delivery Networks**
 - Serve content from close to end user
 - Attach directly to metro or transport core
 - Serving own content (Netflix, Apple) or others' content (Akamai, Limelight, Amazon)
 - Streaming video dominates Internet traffic

ISP Interconnection Circa 1990

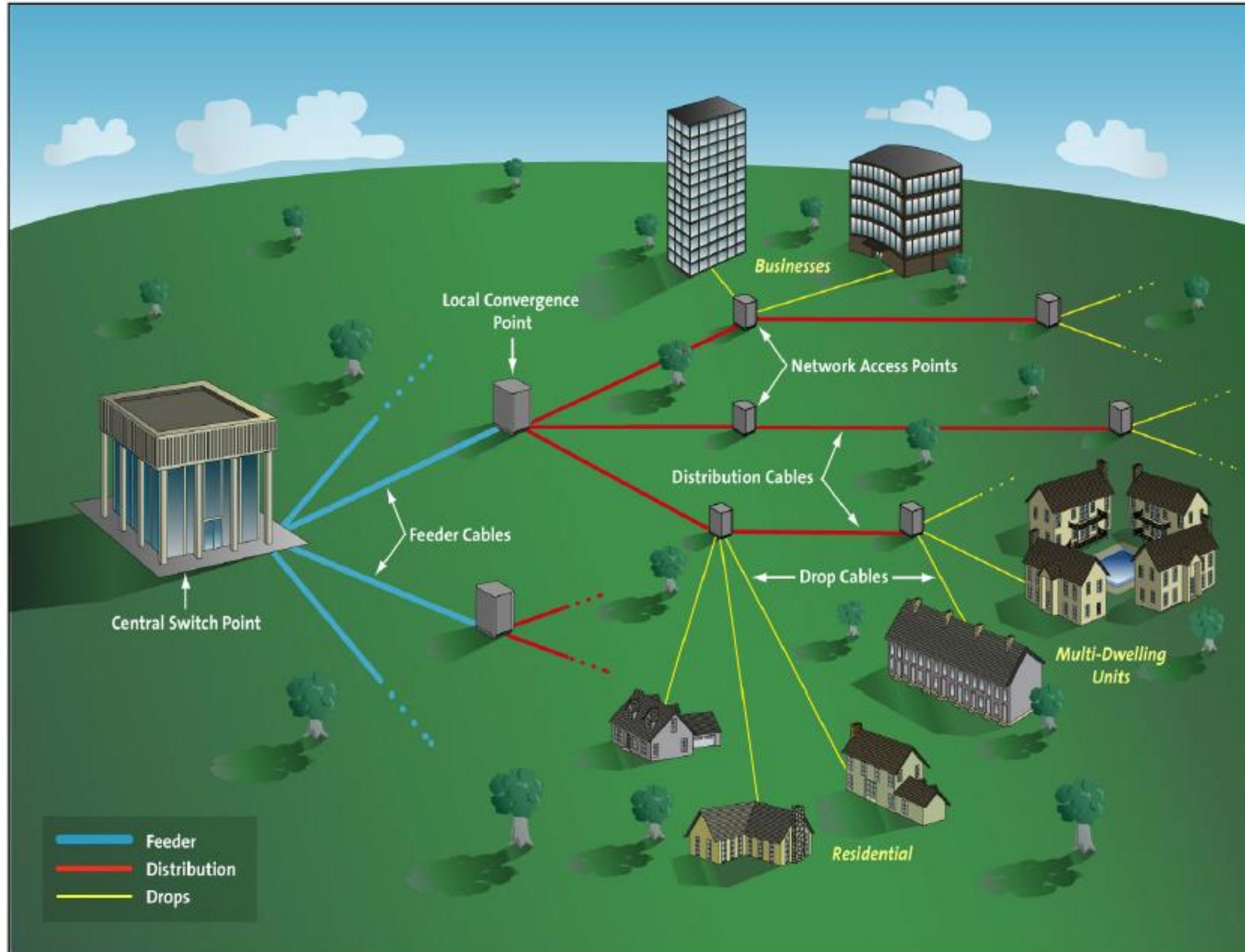


ISPs in 2016



Edge networks (access and content provider) build national networks, bypassing backbones. Reduced role of Tier 1; Video from CDNs dominates traffic

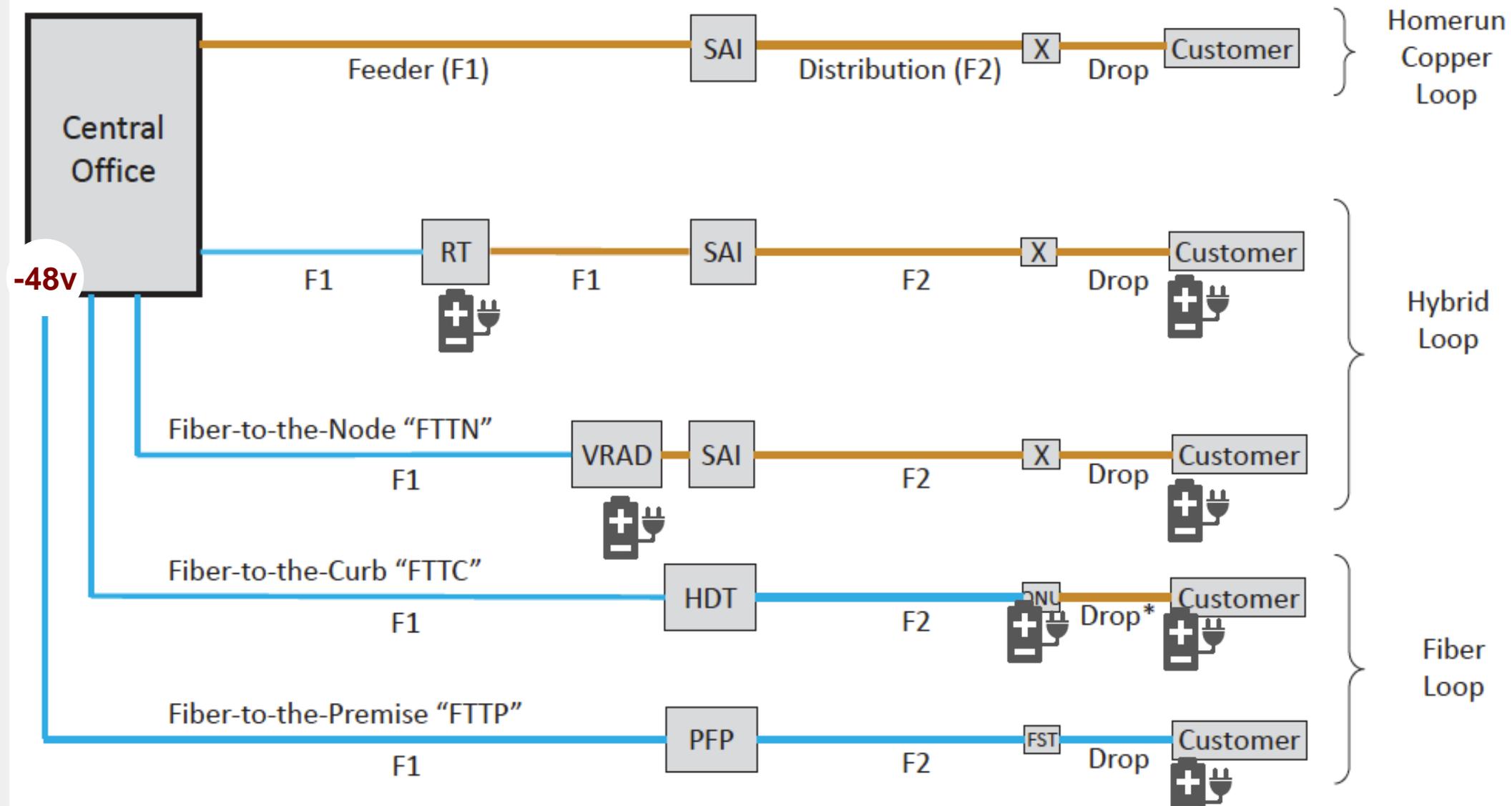
Elements in a Typical Wired Access Network



Physical Architecture

- **Feeder Cables**
 - Carries traffic serving multiple endpoints from an “office” to a neighborhood (local convergence point, LCP, or serving area interface, SAI)
- **Distribution Cables**
 - Carry traffic for one or more households from LCP to the curb (network access point)
- **Drop Cables (above ground) or service wire (underground)**
 - Carry traffic from curb to dwelling unit
- **Depending upon the architecture**
 - Cables may be fiber, twisted pair or coax
 - Local convergence point and/or network access point could host a patch panel, a DSLAM, an optical splitter, an Ethernet switch, or a fiber/coax interface.
- **As bitrates increase, fiber must be pushed further into neighborhoods**

Telco Architectures offered today



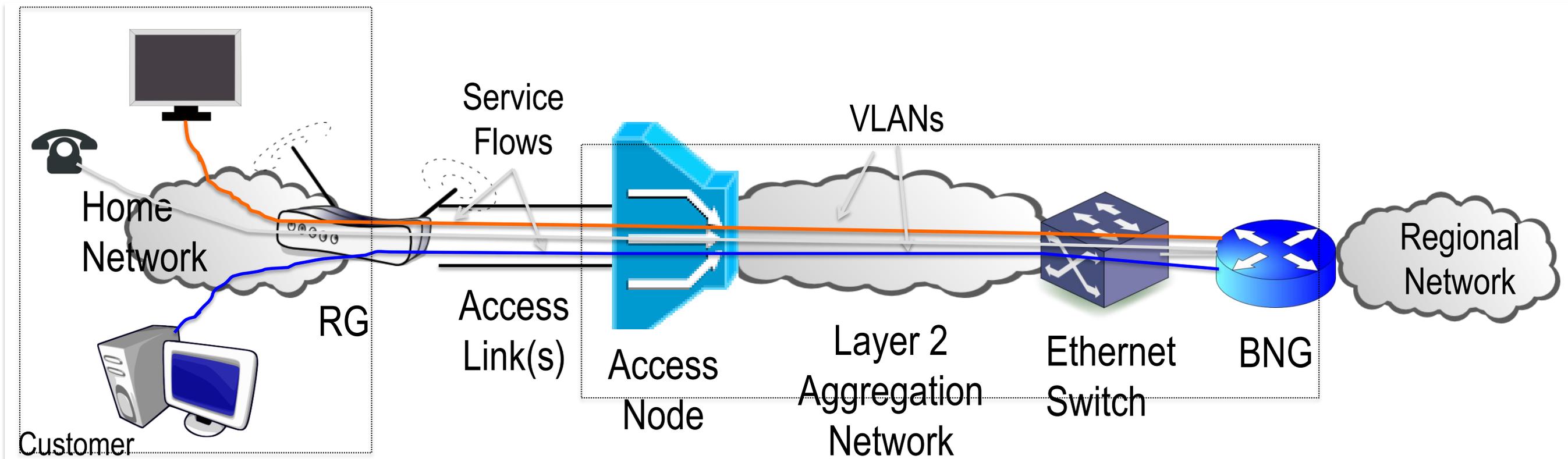
— Copper
— Fiber

SAI = Serving Area Interface
X = Serving Terminal
RT = Remote Terminal

VRAD = Video Ready Access Device
HDT = Host Digital Terminal
ONU = Optical Network Unit
PFP = Primary Flex Point
FST = Fiber Serving Terminal
Drop* = FTTC copper drop < 500'

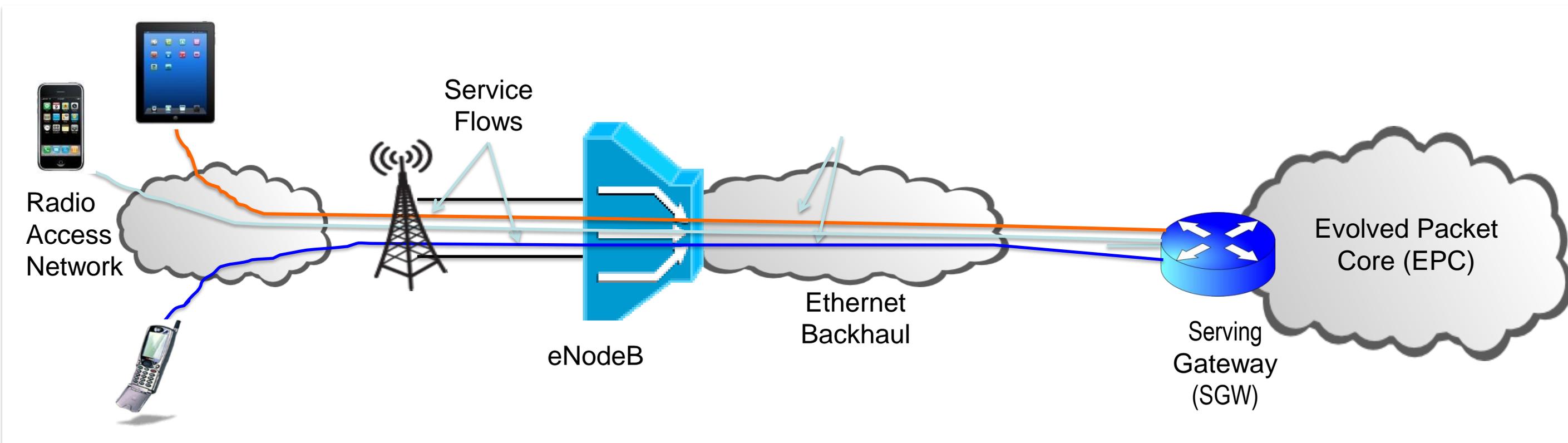


Logical Architecture - wired networks



- **Access network extends from Residential Gateway (RG) to Broadband Network Gateway (BNG)**
- **Access network accommodates separate flows for voice, video, Internet, etc.**
- **These flows may be given different Quality of Service treatment**
 - *“Specialized” or “Managed” Internet services*

Logical Architecture: Mobile Wireless LTE Network



- **Typically no residential gateway: transmission direct to end nodes**
 - RG may be used with Fixed Wireless service
- **Cellular base station (eNodeB) functions as the Access Node**
 - Wired backhaul to the packet core

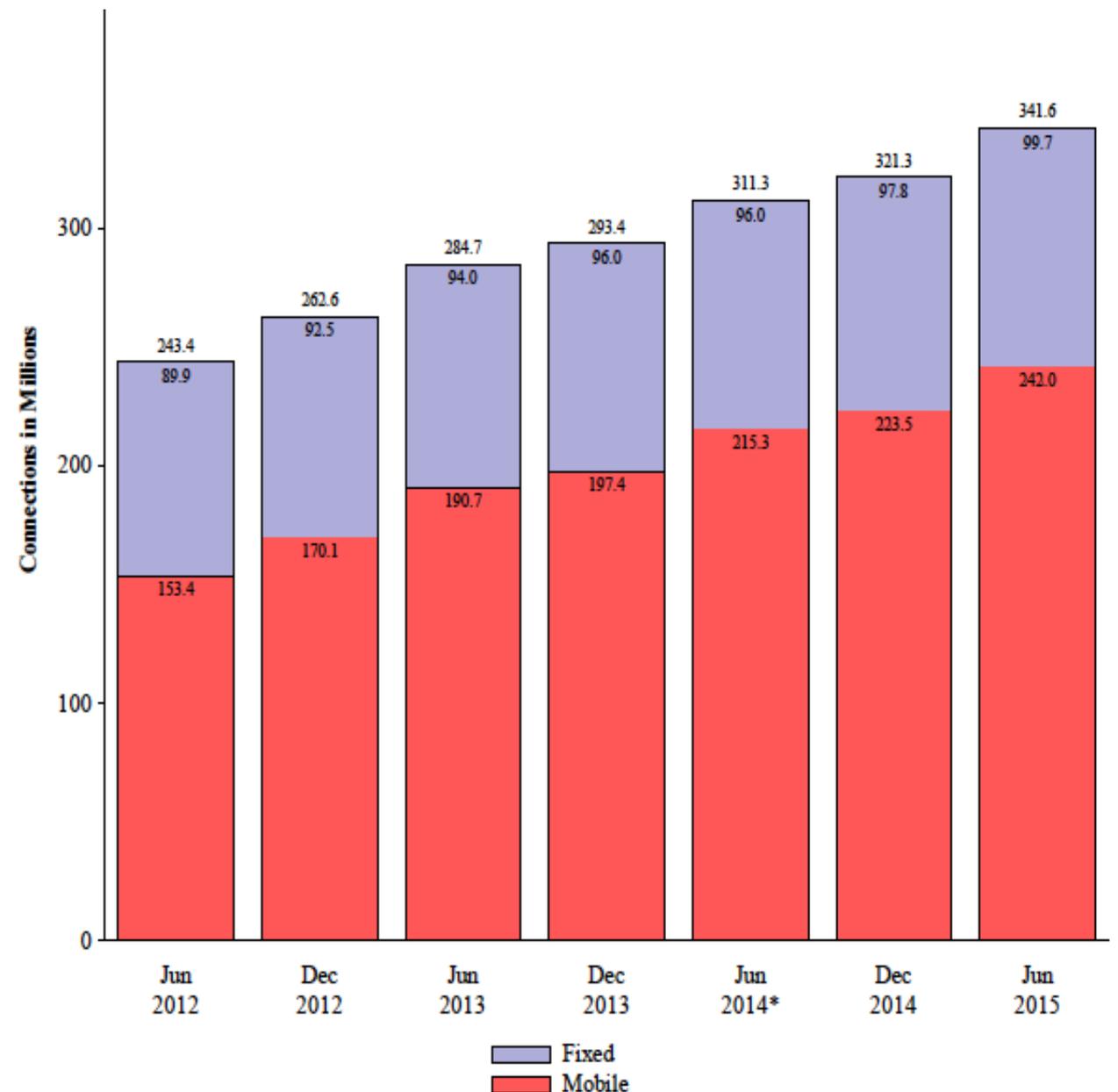
Three Distinct Transitions Underway

- **From Time Division Multiplexing (TDM) and circuit switching to packet switching and VoIP**
- **From SS7 to Session Initiation Protocol (SIP)**
- **From analog copper loops to broadband access over**
 - Copper (e.g. DSL)
 - Hybrid fiber/ copper (e.g. Fiber To The Neighborhood—FTTN, or Fiber To The Curb—FTTC)
 - Fiber To The Premise (FTTP)
 - Hybrid Fiber/Coax (HFC)
 - Wireless

Continuing Shift to Wireless

- **Voice traffic dominated by wireless today**
- **More broadband wireless subscriptions than fixed**
 - But only 22% (2014) of Internet traffic
- **More mobile screen time than PC-based**
 - *But*, a significant fraction is via WiFi and fixed access
- **Video viewing continues to be dominated by fixed access**

Fixed and Mobile Broadband Connections
2012-2015

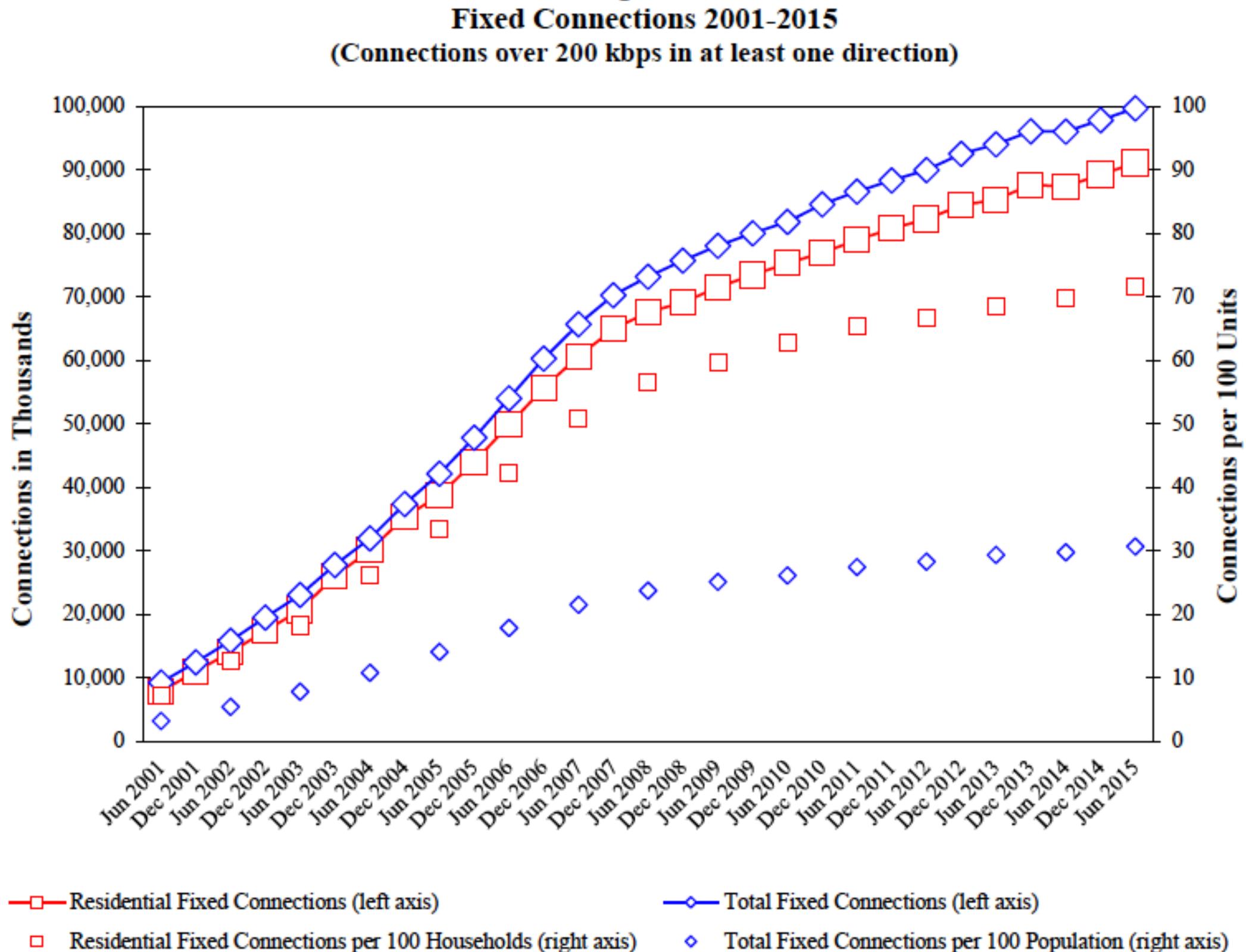


Source: FCC, *Internet Access Services: Status as of June, 2015*, Aug 2016

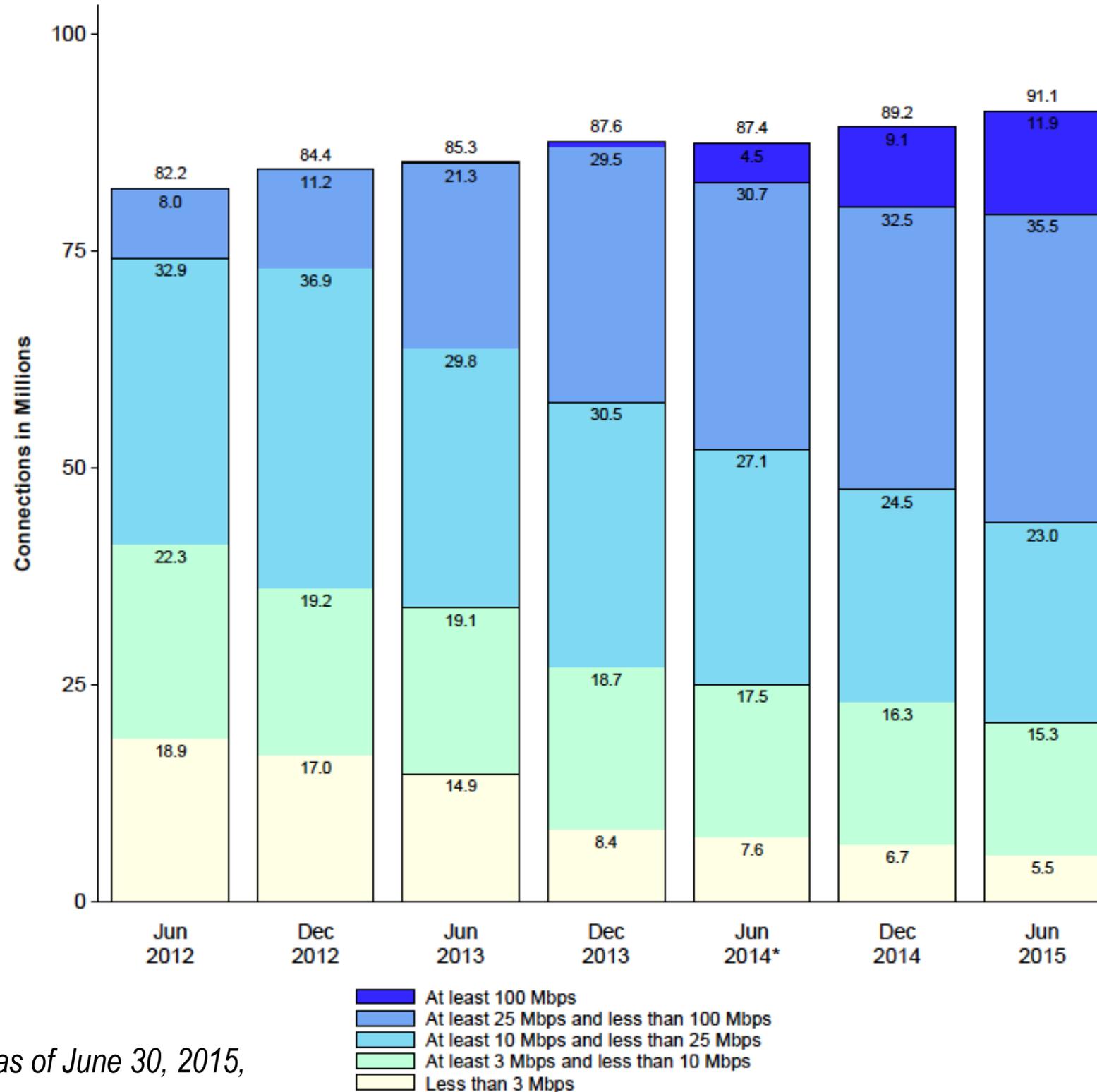
Policy Issues Raised by the Transition

- **Reliability and the demise of network-provided power for CPE**
- **Access to e911 and caller location**
- **Replacement of legacy TDM services**
- **Copper decommissioning**
- **Interconnection**
- **Rate center consolidation and the definition of “local calling areas”**
- **Universal service**

U.S. Penetration of Fixed Broadband



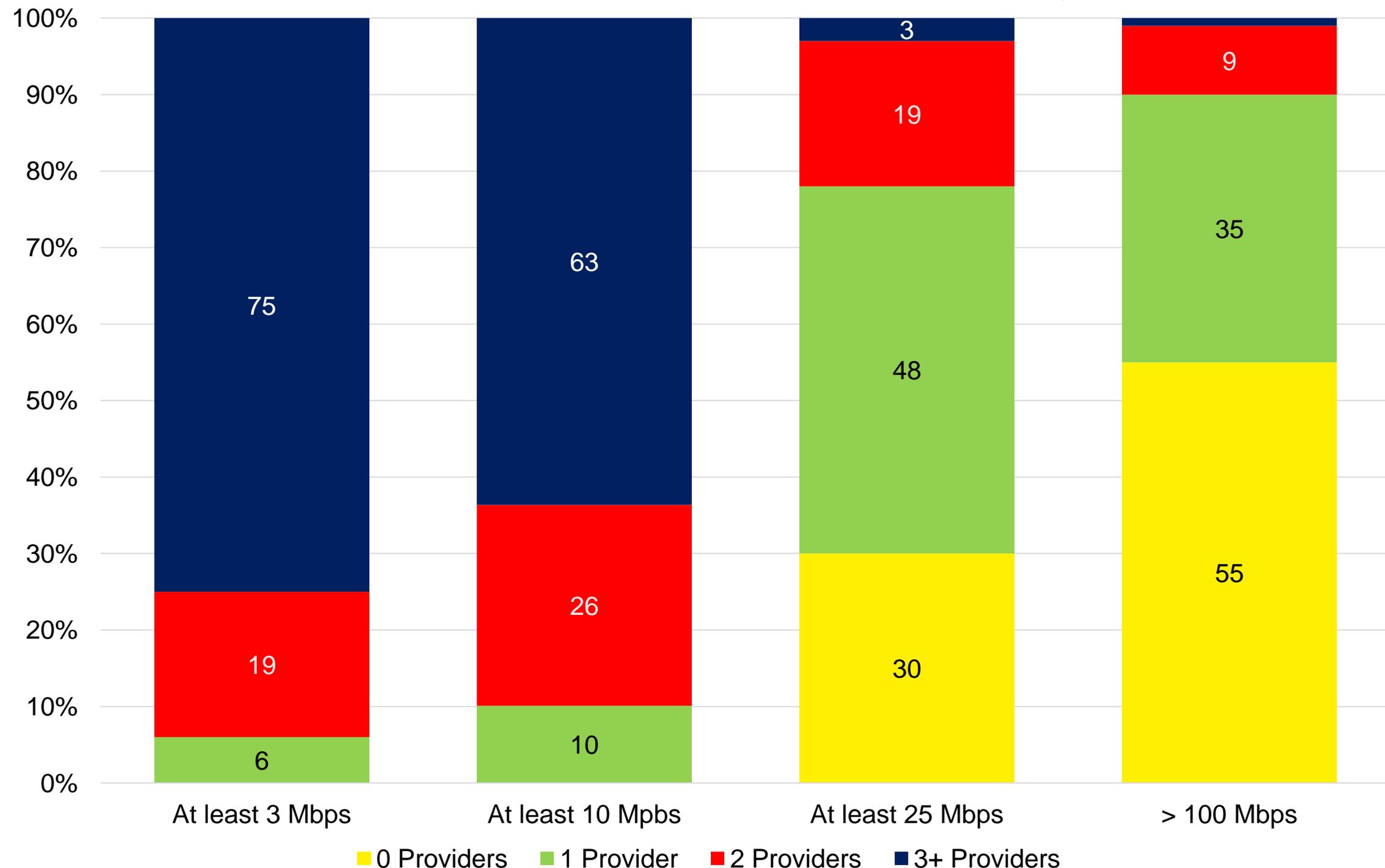
Residential Fixed Access Connections By Speed: 2012-2015



Source: FCC, *Internet Access Services as of June 30, 2015*,
Released August 2016

Limited Broadband Competition at Speeds of 25 Mbps and Above

Percentage of Developed Census Blocks Where Providers Reported Fixed* Broadband Residential Customers as of June, 2015



*includes satellite providers

Competition Issues in the New Network

- **Access competition**

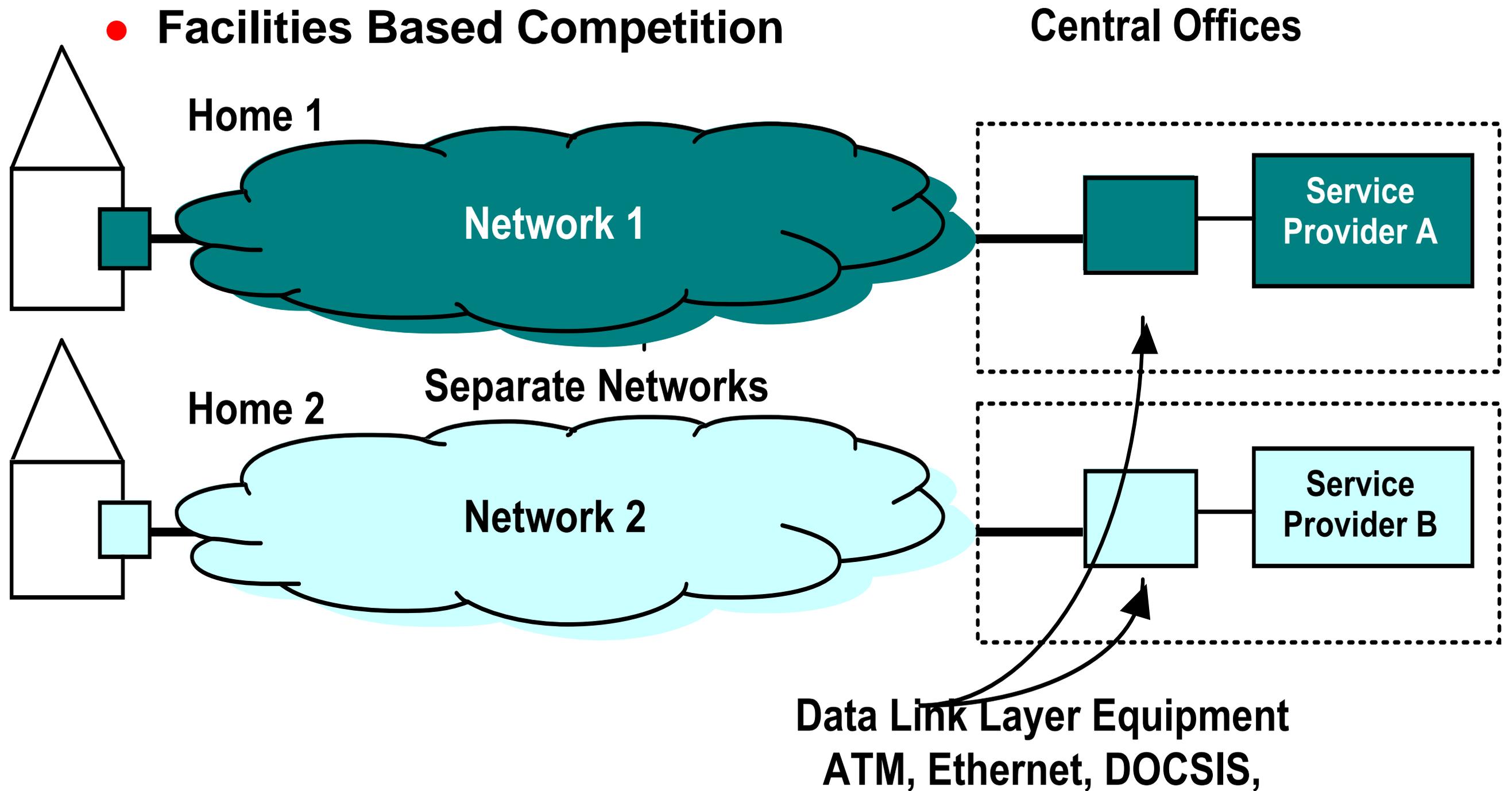
- Facilities-based or logical layer competition
- Economies of scale limits the viability of multiple fixed broadband providers in a region
 - In lower density areas only one wired network may be viable
 - Implications for competition in Business Data Services
- Can wireless compete effectively with wired?
 - Today's high volume-based charges make HD video unaffordable

- **Services competition**

- Services provided by access network owner over specialized logical channels on the access network
- Services provided "Over The Top" by unaffiliated service providers using the public Internet channel
- Level playing field for affiliated and unaffiliated service providers?

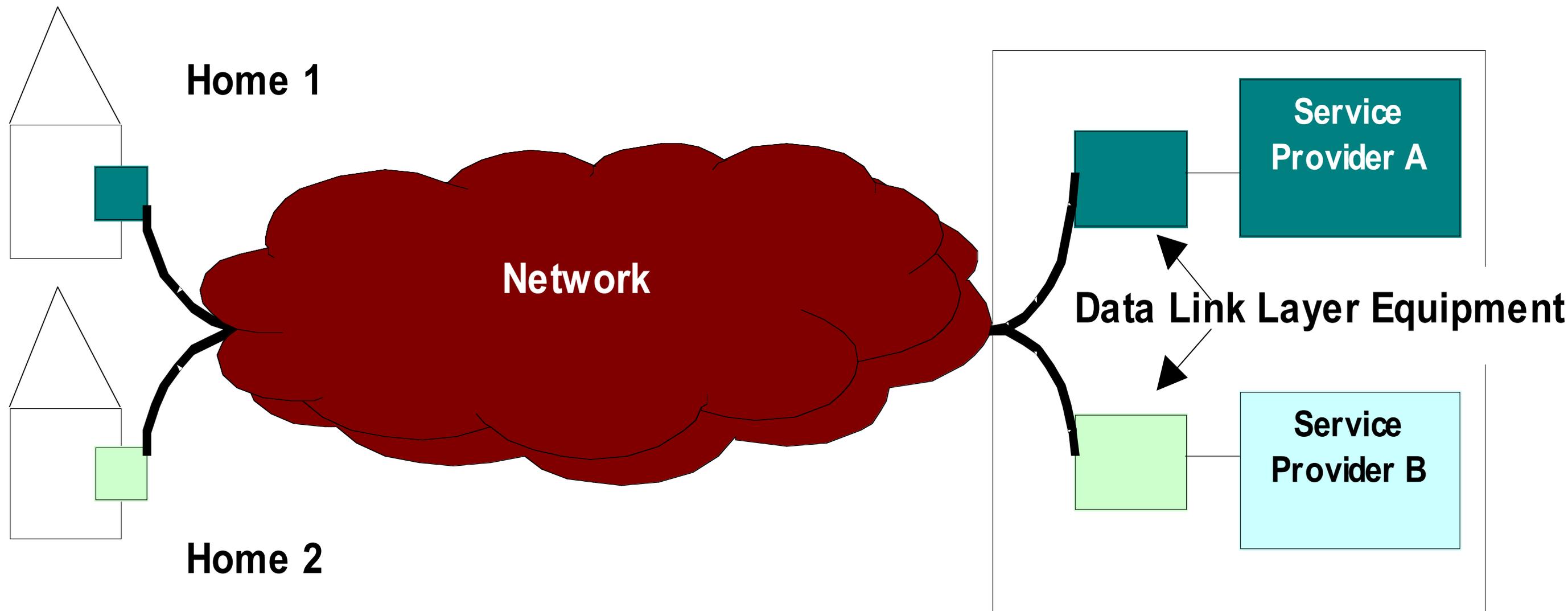
Models of Competition in Telecommunications

- **Facilities Based Competition**



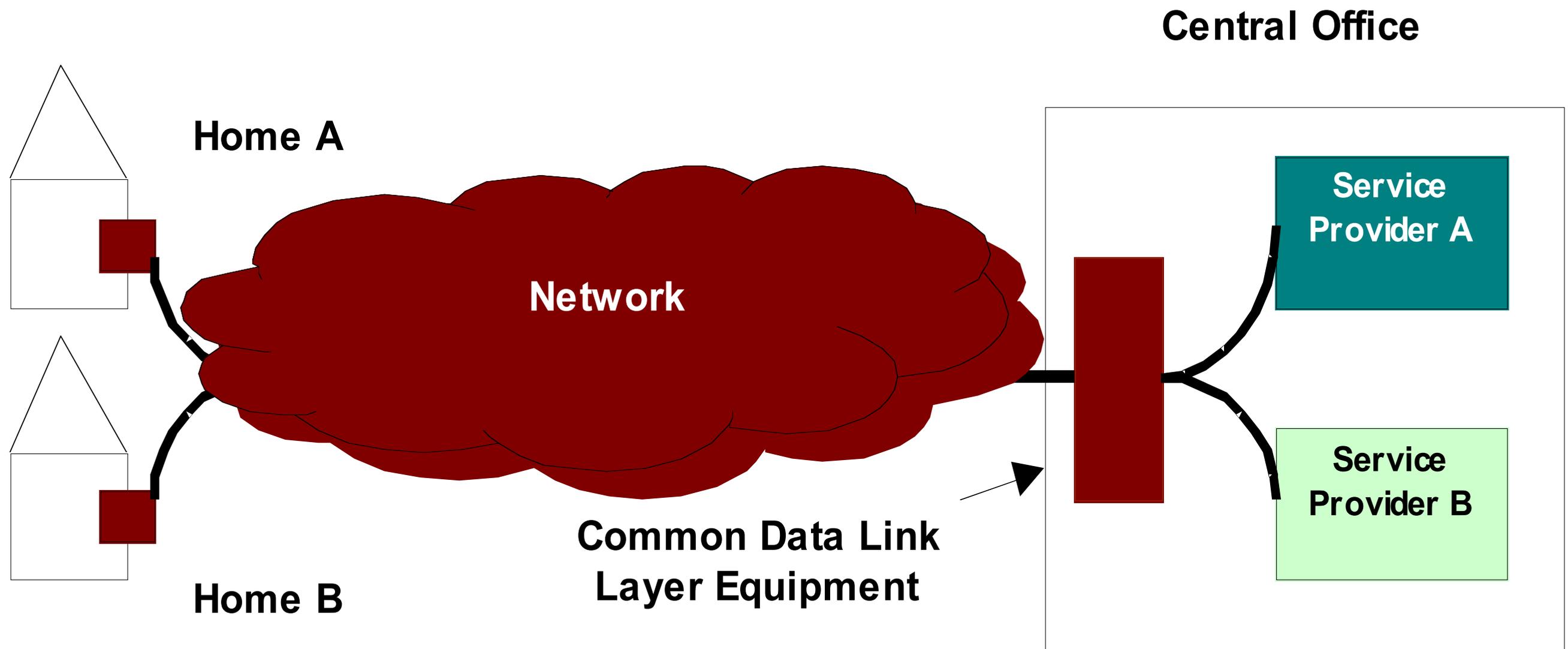
Models of Competition in Telecommunications

- **UNE Based Competition (made possible by Physical Plant Unbundling)**



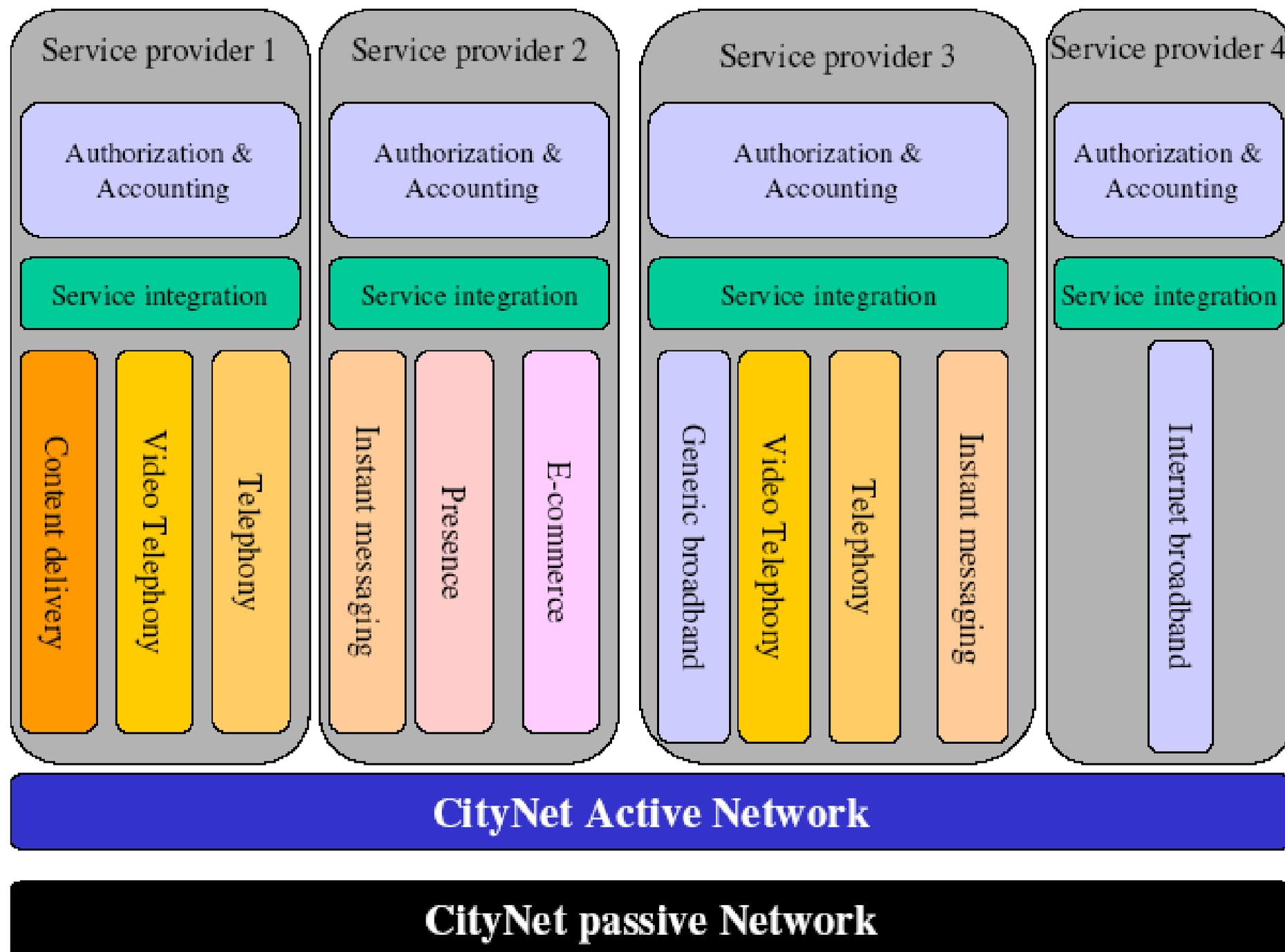
Models of Competition in Telecommunications

- **Open Access Based Competition (made possible by Logical Layer Unbundling)**



Broadband Infrastructure: The Role of Municipal Networks

- Can we decouple fiber and lower layer electronics (subnetwork) from higher layer services?
- Amsterdam Municipal Network Architecture

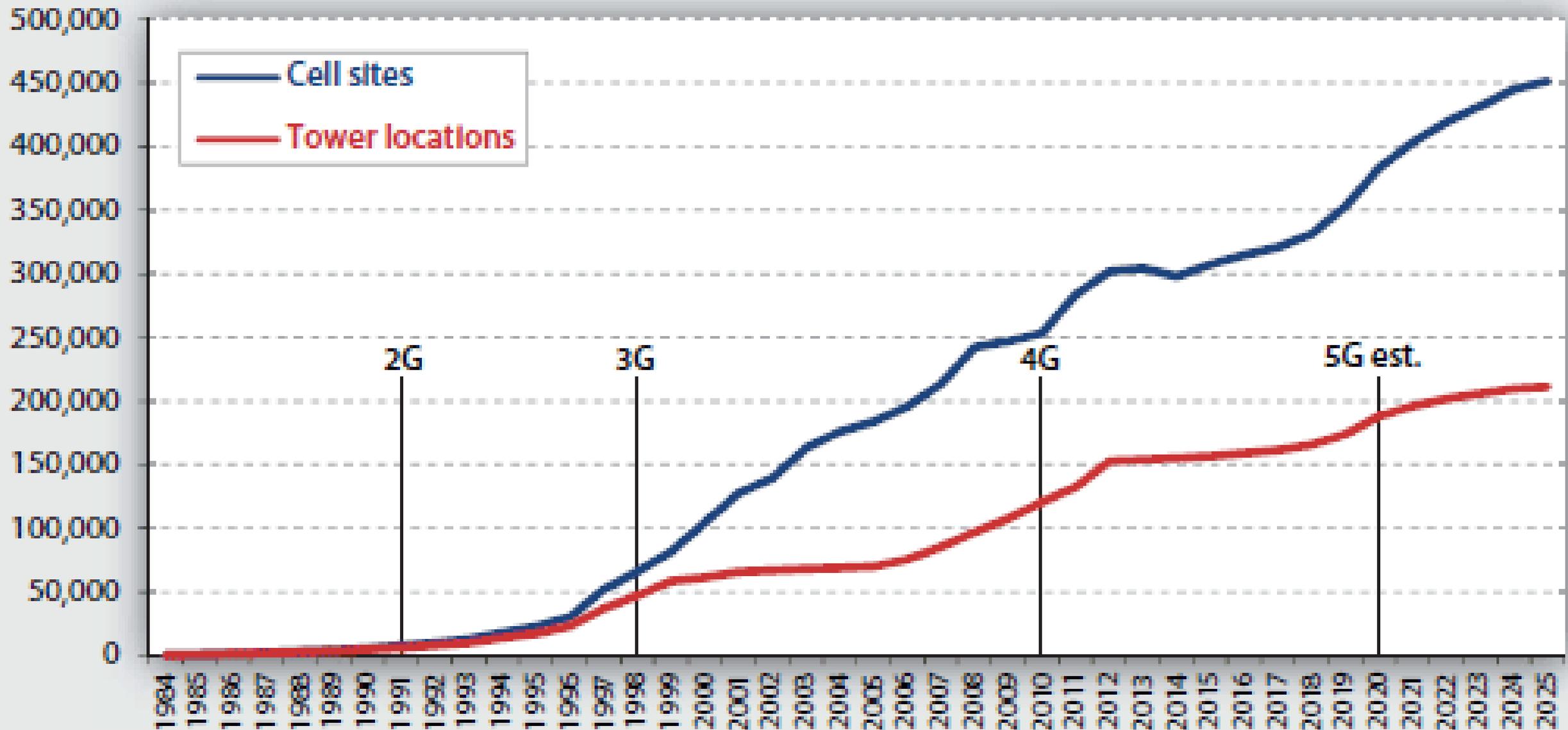


Competition Issues in Wireless

- **Mergers are reducing the number of wireless providers**
- **Services like Google Fi which provide MVNO service using multiple MNOs may heighten competition**
- **5G will require significant increase in number of cell sites.**
 - Increases economy of scale → further consolidation; or
 - Economic pressure for shared or carrier-neutral cell sites
 - Pressure to streamline local zoning procedures for siting cells
- **5G will require more fiber in the loop for backhaul**
- **5G speeds could make wireless a viable competitor with fixed wireline for the last 100 meters.**
 - Fiber to the Curb and wireless drops?

Projected Cell Site and Tower Growth: 50% Increase by 2025

U.S. wireless towers and sites, 1984-2025



A "tower" is a physical structure. A "cell site" refers to a carrier's equipment on a tower.
 Active towers. Includes poles, rooftops and DAS. Excludes Small Cells.
 Excludes broadcast-only sites and "available" locations without equipment like empty rooftops.
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Conclusions

- **Modern carriers provide packet switched platforms carrying both public and private services**
 - Voice, video, data all carried as packet traffic
- **Continued penetration of fiber in local loop for both fixed and wireless access**
- **Limited competition in broadband fixed access**
 - Varies with population density
 - Facilities based competition versus open access competition
- **Increasing displacement of fixed services by wireless**
- **Over The Top (OTT) services compete with carrier-owned managed services**
- **Maintaining public values in the transition to packet switched networks**



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