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We are Broadband.

Here Comes the IP Transition – What's In It For You?

February 2017

U.S. Technology Transitions Policy Framework

- FCC, *Emerging Wireline Networks and Services NPRM* (FCC 14-185):

  o Technology transitions are already bringing innovation and improved communications services to the marketplace.

  o We are determined to ensure that the fundamental principles of competition, consumer protection, universal services, and public safety and national security are not lost merely because technology changes.

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Technology Transitions Are Well Underway

- The transitions underway are organic processes without a single starting or stopping point

- They include:
  - TDM-to-IP
  - Copper-to-Fiber/Hybrid Coax
  - Wired-to-Wireless

- Technology transitions and innovations have largely been consumer and business market-driven
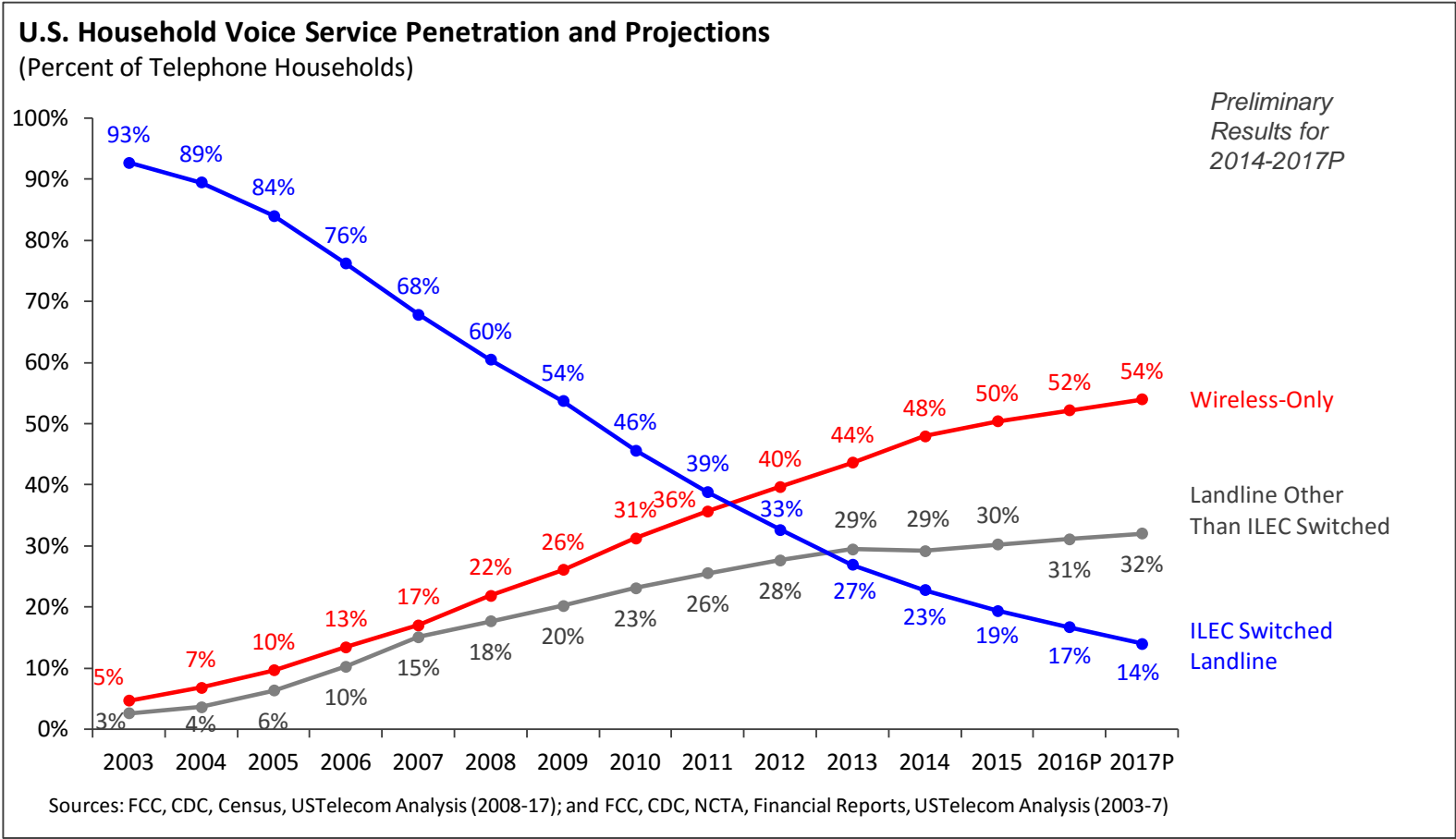
Aggressive Industry Investment Has Been A Driving Force
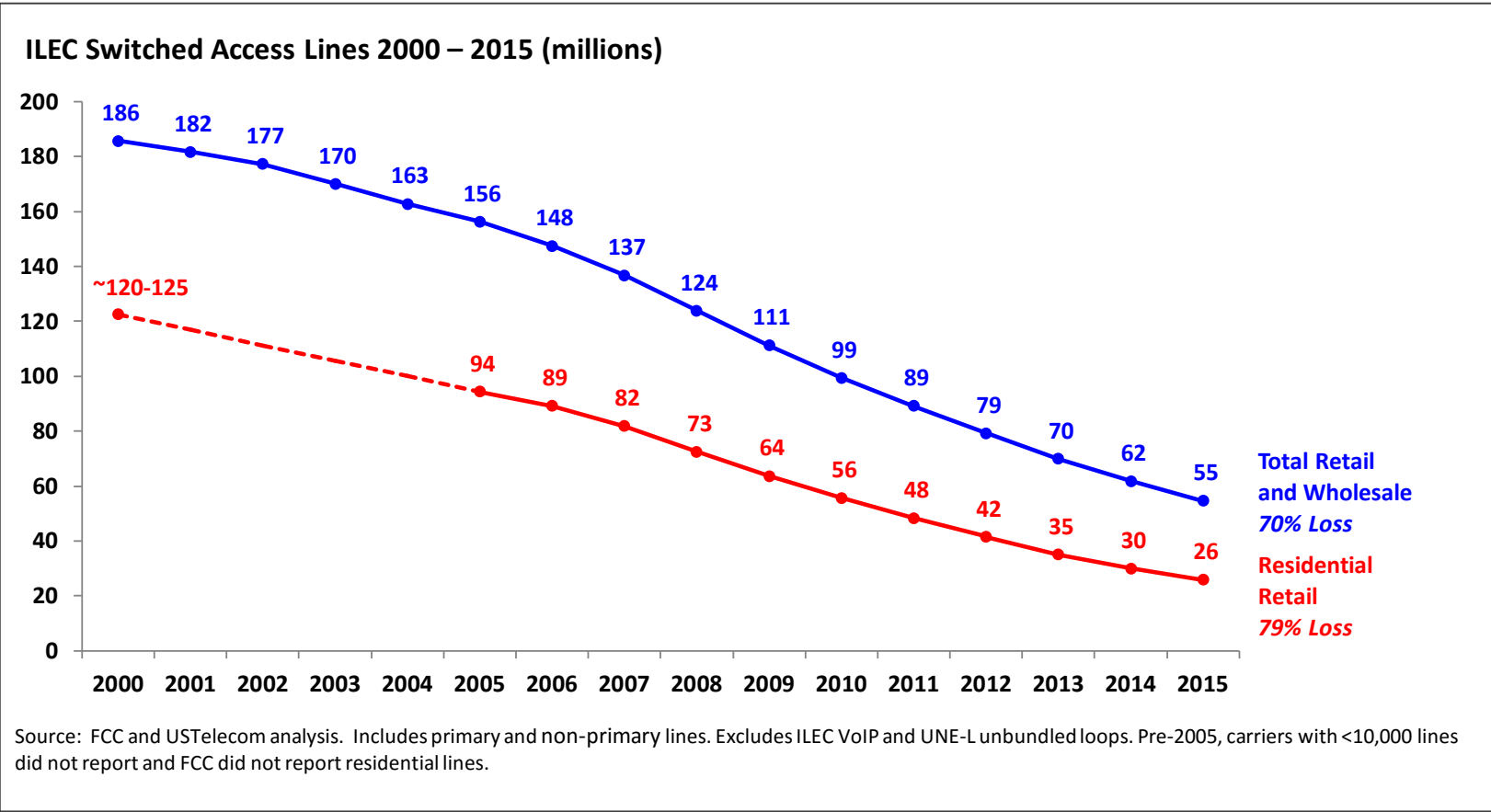
Incredible annual investment in broadband

BILLIONS SPENT ANNUALLY

75
60
45
30
15
0

$213B spent over 40 years
$5.3 billion
Construction of Interstate Highway System

$62B spent over 10 years
$6.2 billion
Reconstruction of Afghanistan

$164B spent over 10 years
$16.4 billion
Apollo Moon Landing

$1.385T spent over 50 years
$27.7 billion
Joint Strike Fighter Procurement/ Sustainment

$1.1T spent over 15 years
$73 billion
Private sector Broadband Investment

* From Wall Street Journal
● = Total $ Investment

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Voice Customers Have Overwhelmingly Chosen New Technologies

ILEC Switched vs. Wireless-Only and Interconnected VoIP Households

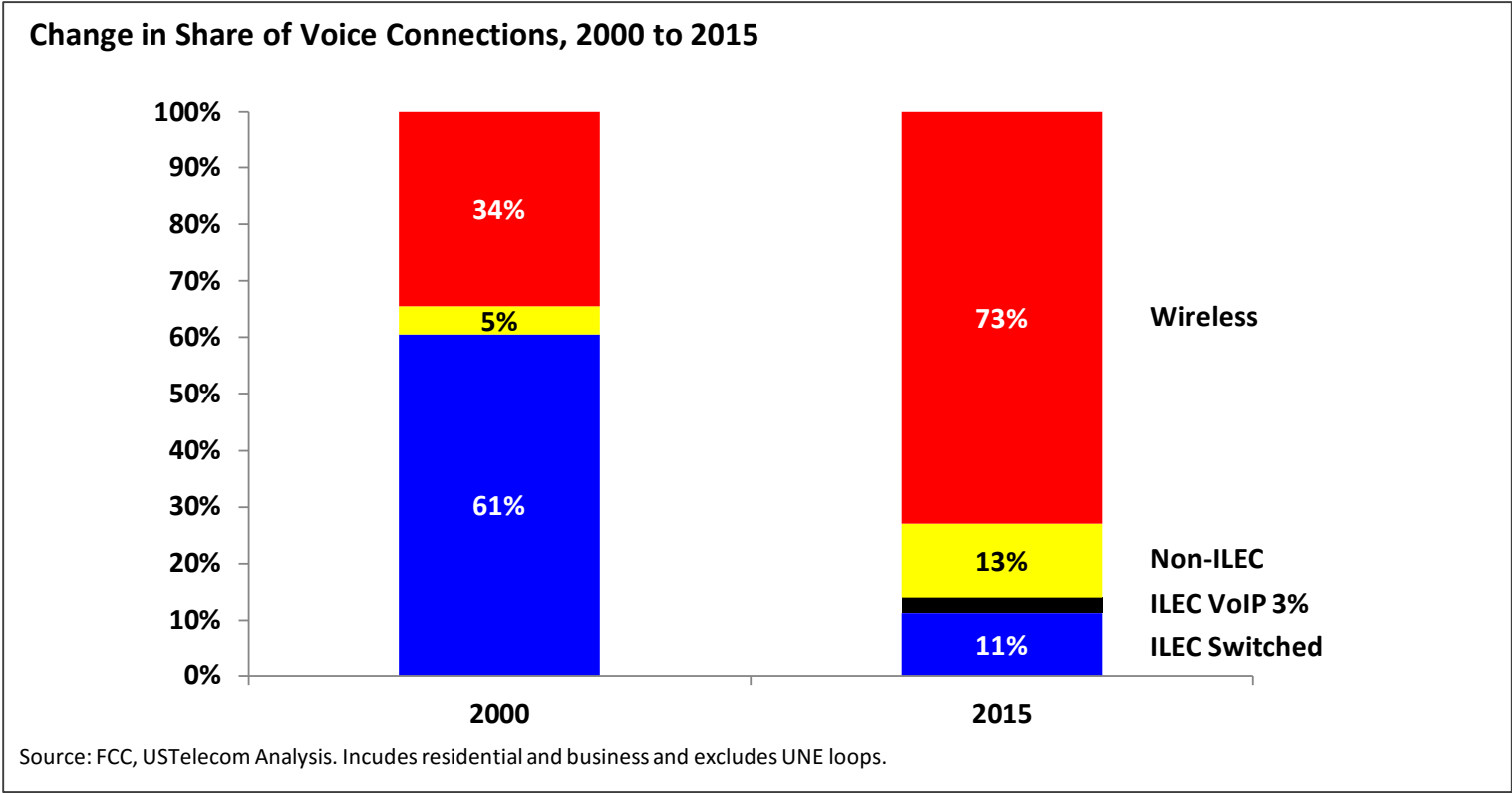**U.S. Household Voice Service Penetration and Projections**
(Percent of Telephone Households)

Preliminary Results for 2014-2017P

ILEC Switched Landline: 93%, 89%, 84%, 76%, 68%, 60%, 54%, 46%, 39%, 33%, 27%, 23%, 19%, 17%, 14%

Wireless-Only: 5%, 7%, 10%, 13%, 17%, 22%, 26%, 31%, 36%, 40%, 44%, 48%, 50%, 52%, 54%

Landline Other Than ILEC Switched: 3%, 4%, 6%, 10%, 15%, 18%, 20%, 23%, 26%, 28%, 29%, 29%, 30%, 31%, 32%

Years: 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016P, 2017P

Sources: FCC, CDC, Census, USTelecom Analysis (2008-17); and FCC, CDC, NCTA, Financial Reports, USTelecom Analysis (2003-7)

Voice Customers Have Overwhelmingly Chosen New Technologies

Declining Utilization of ILEC Switched Telephone Network

ILEC Switched Access Lines 2000 – 2015 (millions)

Total Retail and Wholesale (blue line): 186, 182, 177, 170, 163, 156, 148, 137, 124, 111, 99, 89, 79, 70, 62, 55 — **70% Loss**

Residential Retail (red line): ~120-125, 94, 89, 82, 73, 64, 56, 48, 42, 35, 30, 26 — **79% Loss**

Years: 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015

Source: FCC and USTelecom analysis. Includes primary and non-primary lines. Excludes ILEC VoIP and UNE-L unbundled loops. Pre-2005, carriers with <10,000 lines did not report and FCC did not report residential lines.

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Voice Customers Have Overwhelmingly Chosen New Technologies

ILEC Switched Lines Are an Increasingly Small Portion of Voice Connections

Change in Share of Voice Connections, 2000 to 2015

- 2000: 34% (Wireless), 5%, 61%
- 2015: 73% (Wireless), 13% (Non-ILEC), ILEC VoIP 3%, 11% (ILEC Switched)

Source: FCC, USTelecom Analysis. Incudes residential and business and excludes UNE loops.

The FCC Rejected an Equivalent Voice Service Standard

- FCC, *Tech Transitions, Non-Dominant Order* (FCC 16-90):

  o Automatic grant of discontinuance of legacy TDM-based voice service if adequate replacement test met
  o Replacement service must offer:
    o <u>Substantially similar</u> network infrastructure and service quality
    o Compliance with existing standards for critical applications such as 911 and network security
    o Interoperability and compatibility with an <u>enumerated list of applications and functionalities</u>
  o If not seeking automatic grant, existing five-factor test applies

- Why?
  o Technology transitions demand regulatory transitions
  o Maximize opportunities for creative disruption

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Petitions for Reconsideration or Clarification

- ## NTIA Petition

  - Modifications could make it more complicated, timely, and costly for providers seeking to discontinue
  - Proposals not necessary to safeguard federal government agencies; any supposed benefits do not outweigh burdens of delaying transitions

- ## NASUCA Petition

  - We agree that the technical guidance in Appendix B is problematic
  - However, we view the relief sought as outside the scope of the order

What's In It For You?

- Over $ 70 billion in new investment per year

- All providers strive to provide quality service
  - Managed IP-based voice services are high quality; OTT, apps are good and getting better
  - Consumers have spoken, loud and clear, that they prefer the advantages of non-traditional voice service offerings

- Technology transitions bring:
  - Better quality services
  - More reliable services
  - Better and more capabilities
  - More competitive choices
  - More eco-friendly services
  - Lower prices

What Is It?

When Did It Start?

When Will It Be Completed?

What Are The Gating Factors?

What's In It For You?

The IP Transition is the transition of the PSTN from circuit-switched, time-division multiplexing technology (TDM) to packet-switched, session multiplexing technology.

What does that mean???

Packet-switching allows communications facilities and systems to be shared, and subsequently, they operate much more efficiently than their legacy counterparts. By transitioning to IP, the PSTN will increase its ability and capacity to support all forms of REAL-TIME communications.

Production use of Voice over Internet Protocol technology began more than 20 years ago.

Pace Long Distance Demonstrates VoIP calls at COMPTEL Legislative Retreat in Baltimore	**Remi Communications Provides Local Exchange Service Using VoIP Class 5 Platform**	**LNPA Migration From Neustar to iconective Complete (TOM Timeline)**
6/17/1995	2/24/2005	5/25/2018

1995 | 1995 | 1997 | 1999 | 2001 | 2003 | 2005 | 2007 | 2009 | 2011 | 2013 | 2015 | 2017 | **2018**
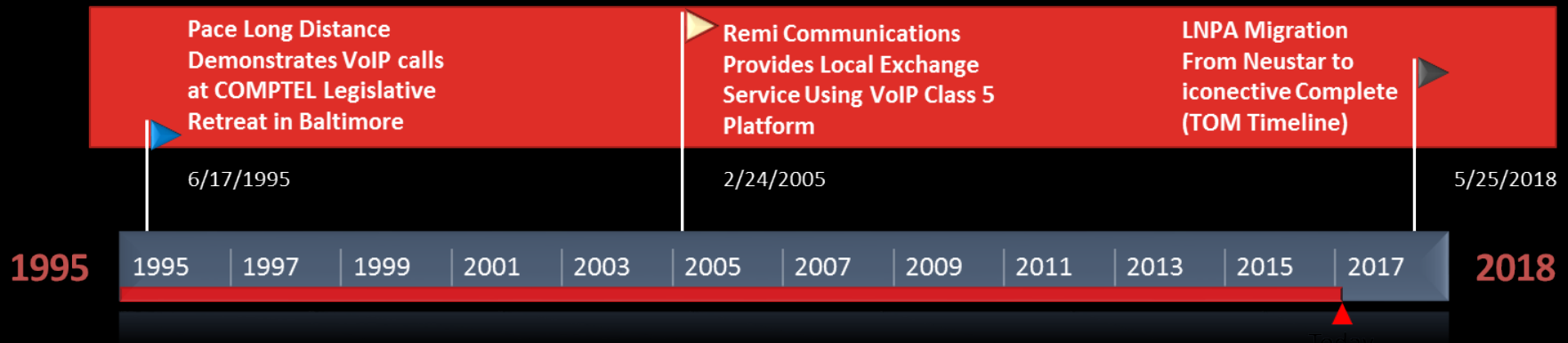
The LNPA Transition is not scheduled for completion until May of 2018. Since PSTN "systems" such as NENA's NG911 and other advanced services will require the LNPA to do some "heavy lifting" for advanced service support, the IP Transition will most likely continue deep into the 2020s.

In addition to the LNPA Transition, clear direction from regulators (i.e. the FCC) regarding the IP interconnection obligations of carriers is absent. This regulatory "black hole" has done more to stagnate the IP Transition than any other factor.

Absent defined IP interconnection obligations, advanced services between subscribers of different carriers cannot be supported. Even legacy equivalents such as the ubiquitous routing of telephone calls are impossible to conduct in an IP environment without defined IP interconnection obligations.

Technology is not the gating issue of the IP Transition; the lack of regulatory direction to the technology community is.

The Crux of the Matter:

"The bells & whistles may be good…
But how are
 Network Quality,
 Reliability,
 Resiliency, and
 Security
being addressed???"

- Cary Hinton

On the Internet…

They're Not!

(being addressed)

The Internet cannot provide assured…

Network Quality,

Reliability,

Resiliency, or

Security

Because the Internet is a "best effort" network of networks governed by:

No One

The Internet Engineering Task Force ("Standards Body")

"In many ways, the IETF runs on the beliefs of its members. One of the "founding beliefs" is embodied in an early quote about the IETF from David Clark: "We reject kings, presidents and voting. **We believe in rough consensus and running code.**"

"One more thing that is important for newcomers: the IETF in no way "runs the Internet", despite what some people mistakenly might say. **The IETF makes standards that are often adopted by Internet users,** *but it does not control, or even patrol, the Internet*. If your interest in the IETF is because you want to be part of the overseers, you may be badly disappointed by the IETF."

RFC4677 – "The TAO of IETF"

"We believe in rough consensus and running code." RFC4677

In other words, Internet protocol standards (deployed on the Internet) are tested <u>until they work.</u>

Conversely, PSTN protocols, systems and network interconnections are tested <u>until they do not fail.</u>

The PSTN is a <u>deterministic</u> ecosystem that can be engineered to assure acceptable Network Quality, Reliability, Resiliency and Security. The Internet is not.

Cisco Visual Networking Index (VNI)

Frequency of **DDoS attacks** has increased over **2.5 times** over the last three years — *Arbor Networks*

458% increase in the number of times hackers searched *IoT* connections for vulnerabilities — *AT&T*

Spear-phishing campaigns targeting employees *increased* **55%** last year — *Symantec*

Malware attacks nearly doubled to **8.19 billion**, with Android ecosystem being the prime target — *Dell*

There's a **221% increase** in compromised *WordPress* sites — *Cisco*

89% of all cyber attacks involve financial or espionage motivations — *Verizon*

The Zettabyte Era — Trends and Analysis – Cisco, June 2016

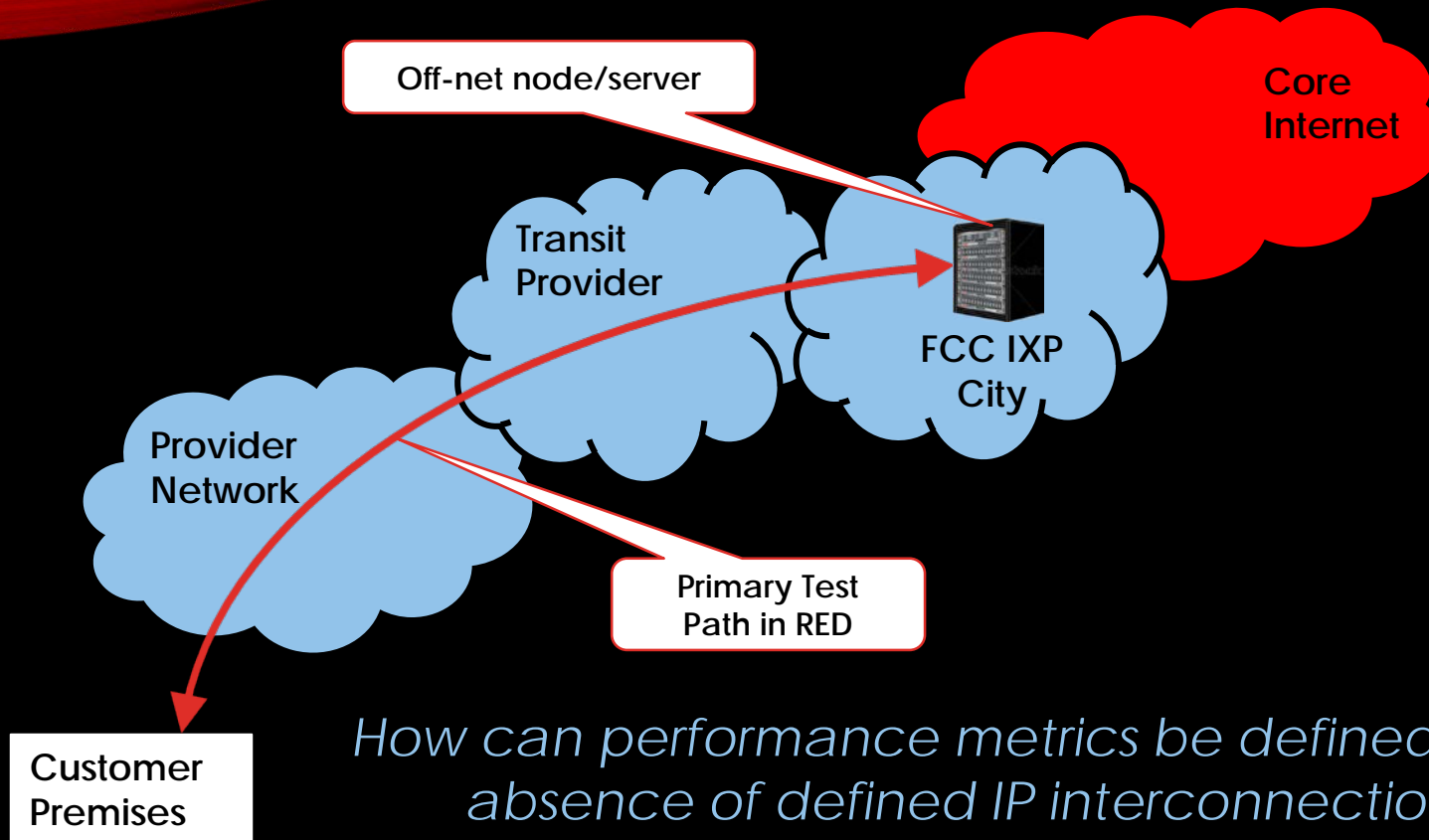## What Frankenstein Can Teach Engineers

IEEE SPECTRUM – February 2017 Issue

Referencing the MIT Press 2017 edition of "FRANKENSTEIN" to be released on the 200th anniversary of the original novel by Mary W. Shelley (May, 1817)

*"Designing technology with the best intentions can still lead to disaster"*

Off-net node/server

Core Internet

Transit Provider

FCC IXP City

Provider Network

Primary Test Path in RED

Customer Premises

How can performance metrics be defined when, in the absence of defined IP interconnection obligations, network behavior cannot be predicted?

HINT: Eliminating interconnection from the analysis does not solve the problem.

THE FOUR LAYERS OF PSTN OPERATIONAL QUALITY

Managed Network
Operational Quality
End-to-End

Voice
Quality

Conversation
Quality

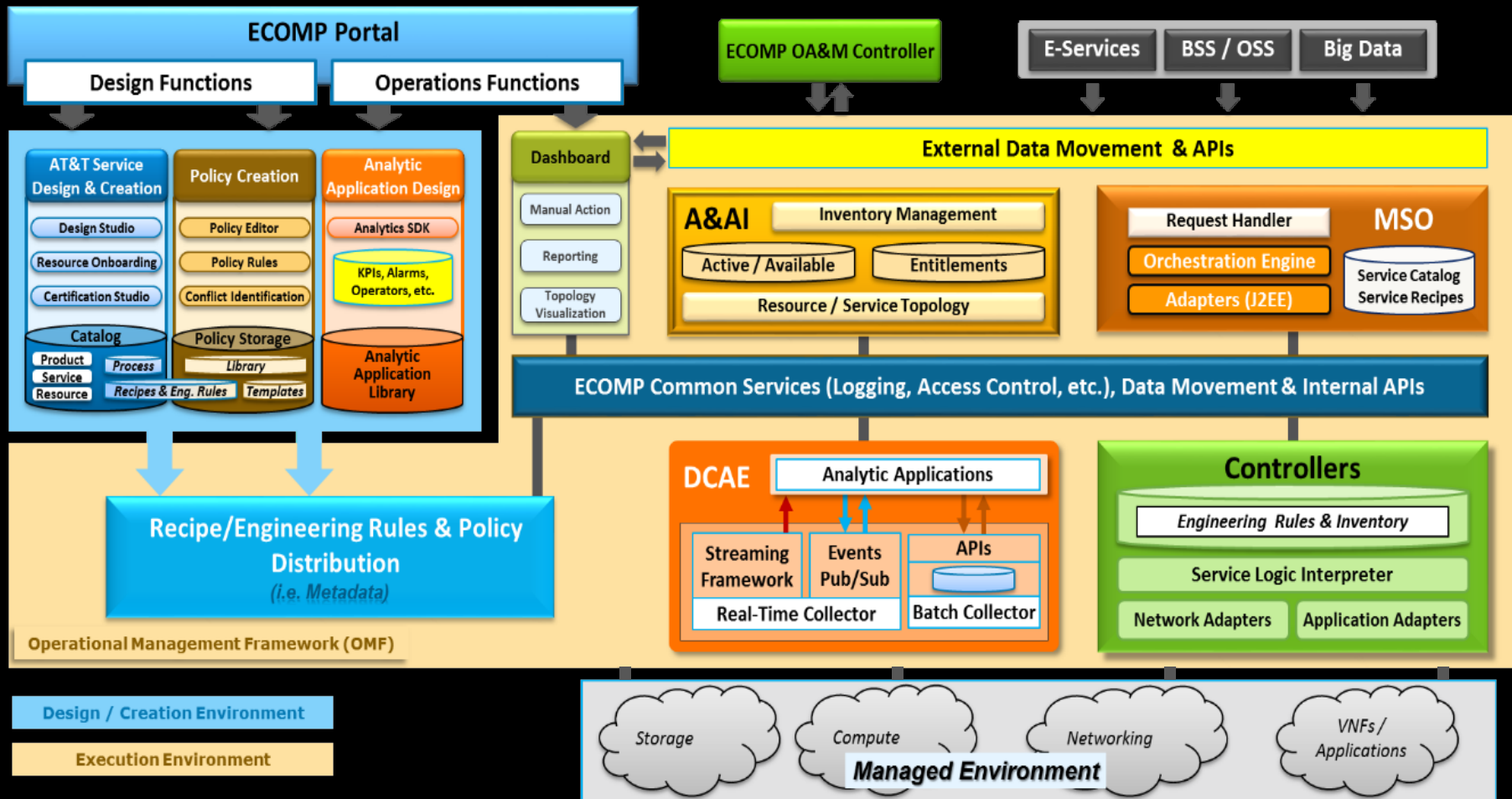Service Quality
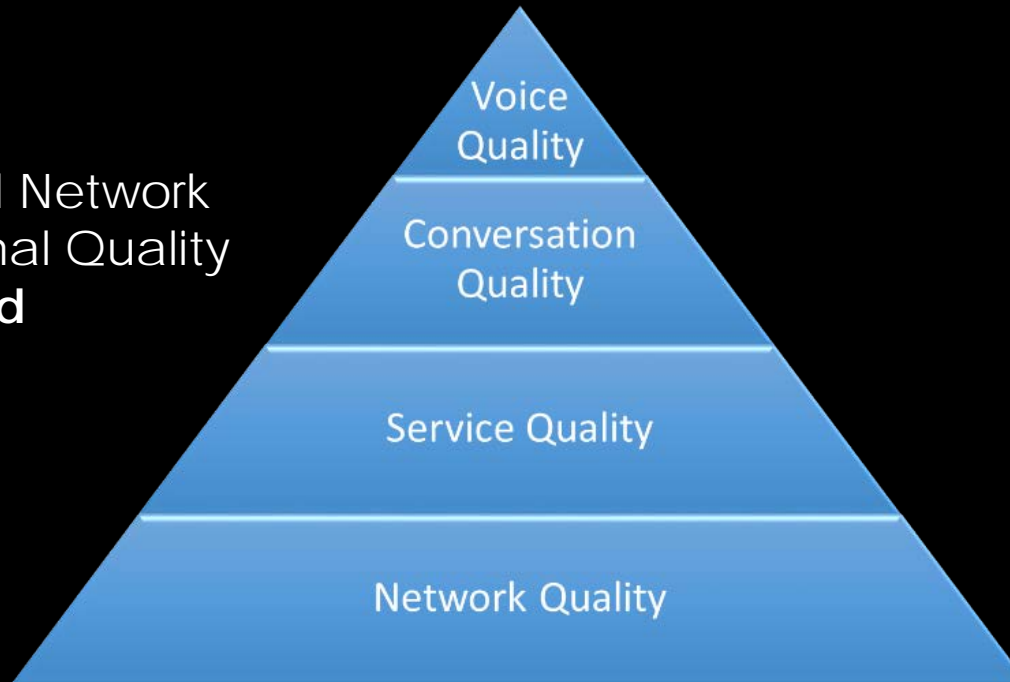
Network Quality

PSTN Operational Quality Reference Model

Quality standards must be maintained, end-to-end, as the PSTN transitions to a managed Public Real-Time Network (*i.e.* a PRTN) that supports the advanced services now made possible with IP technologies.

AT&T's Open Source Enhanced Control, Orchestration, Management and Policy (ECOMP) platform

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