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TFI Technology Forecast Overview

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**TFI Technology
Conference 2026**

January 22-23, 2026
Austin, Texas
and Online

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Technology Forecasting

- Performance Improvement
- Cost Improvement
- Adoption of New Technology
- Replacement of Old Technology
- Impacts of these changes

**Perfect for estimating lives & values
of large capital investments**

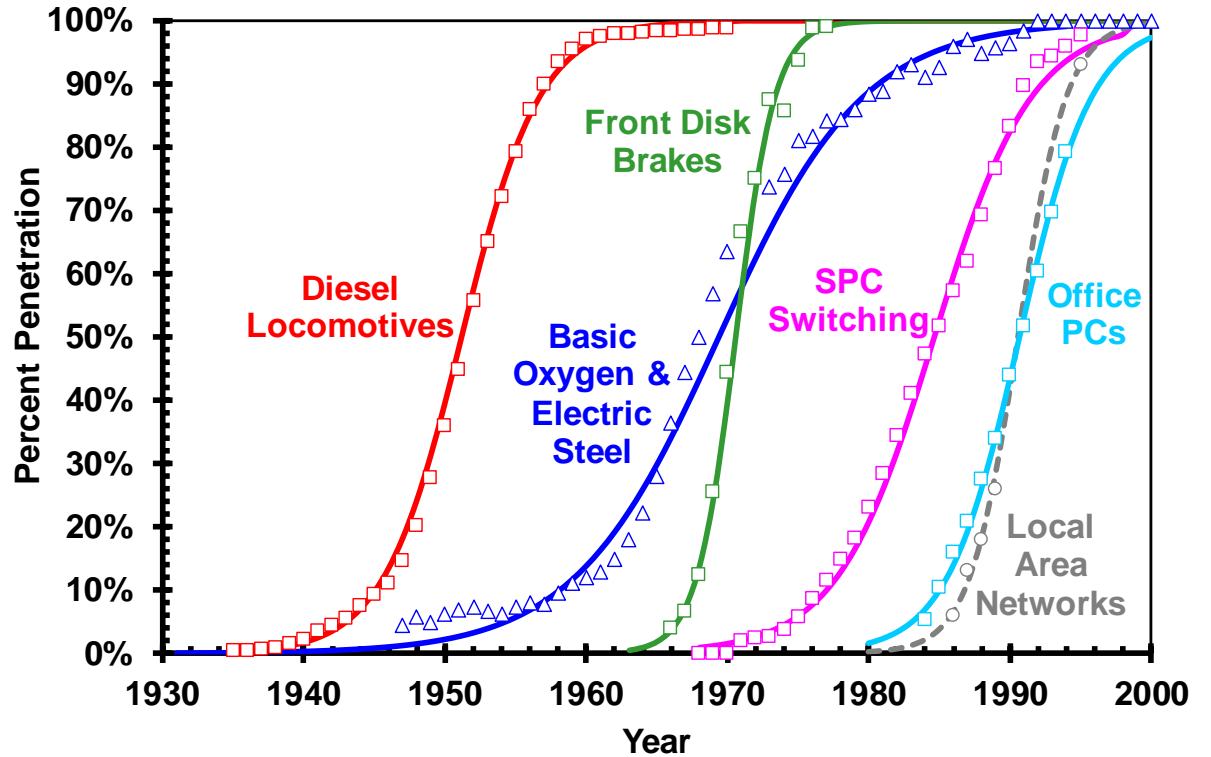
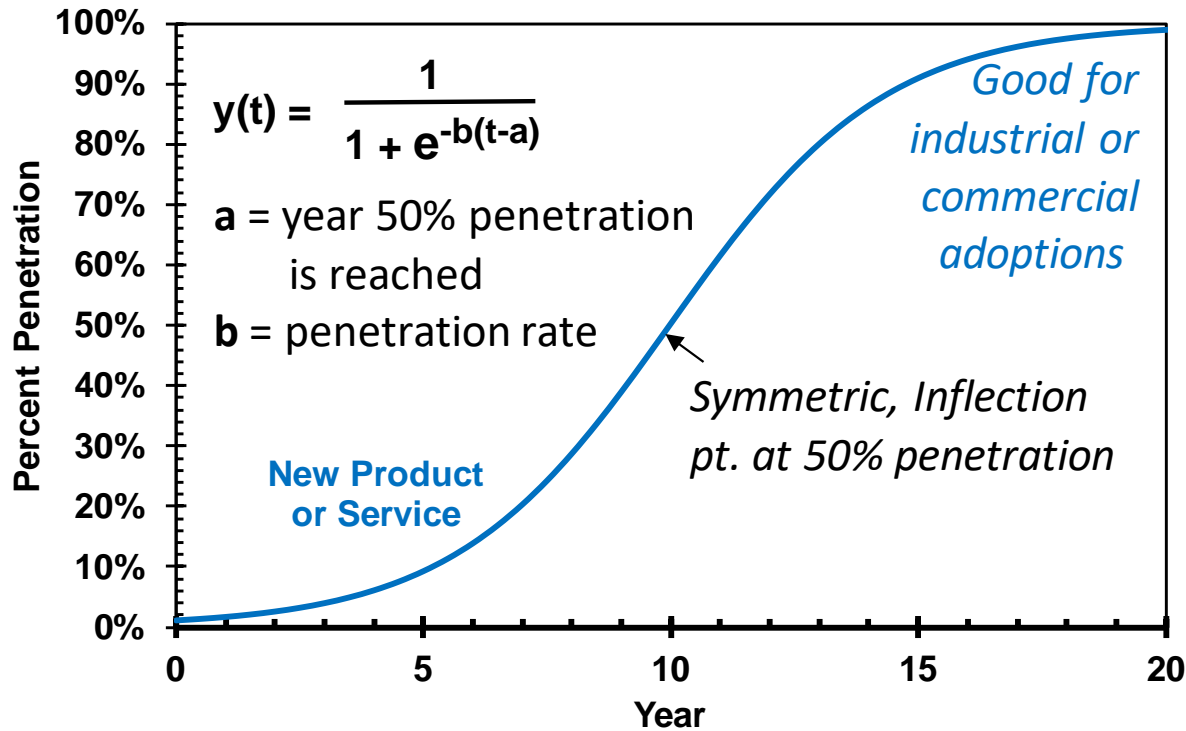
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Technology Forecasting Methods

- Fundamental Models of Technology Change
 - Technology Adoption and Substitution Curves
 - Performance Improvement Curves
- Analogies
- Drivers and Constraints
- Expert Opinion
- Many others!

Introduction to Technology Forecasting Models

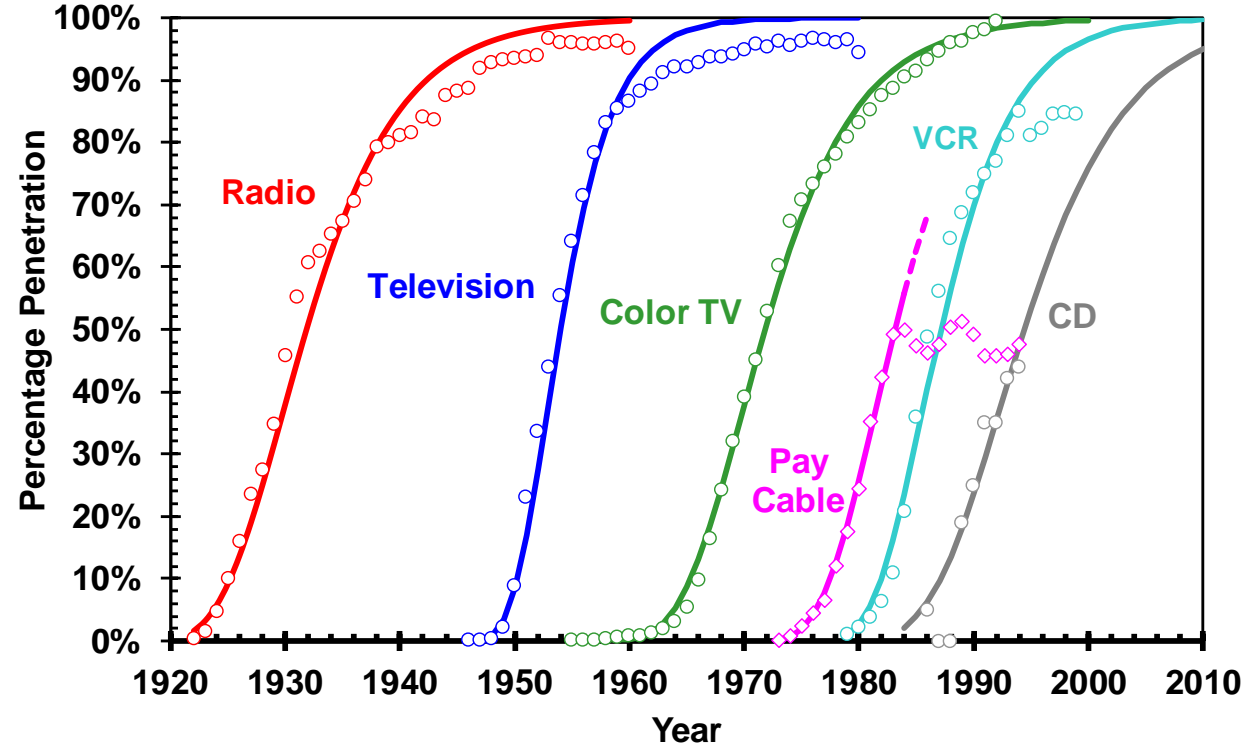
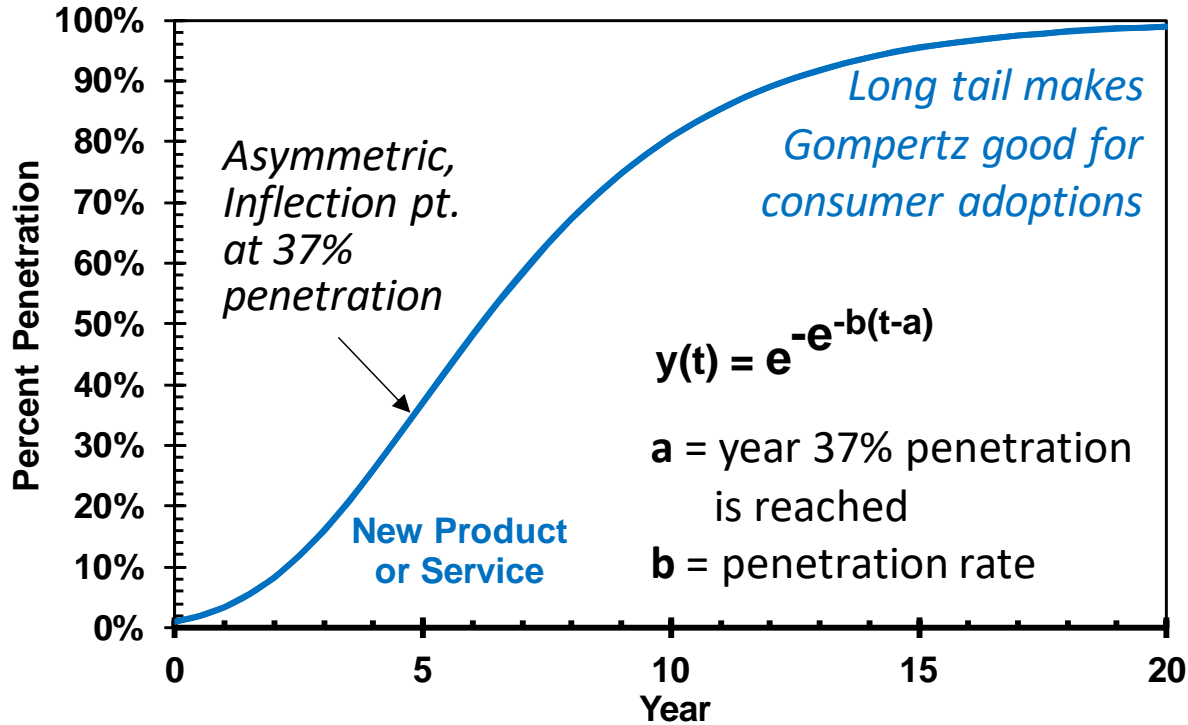
Fisher-Pry Substitution Model (aka Logistic Model)



Source: Technology Futures, Inc.

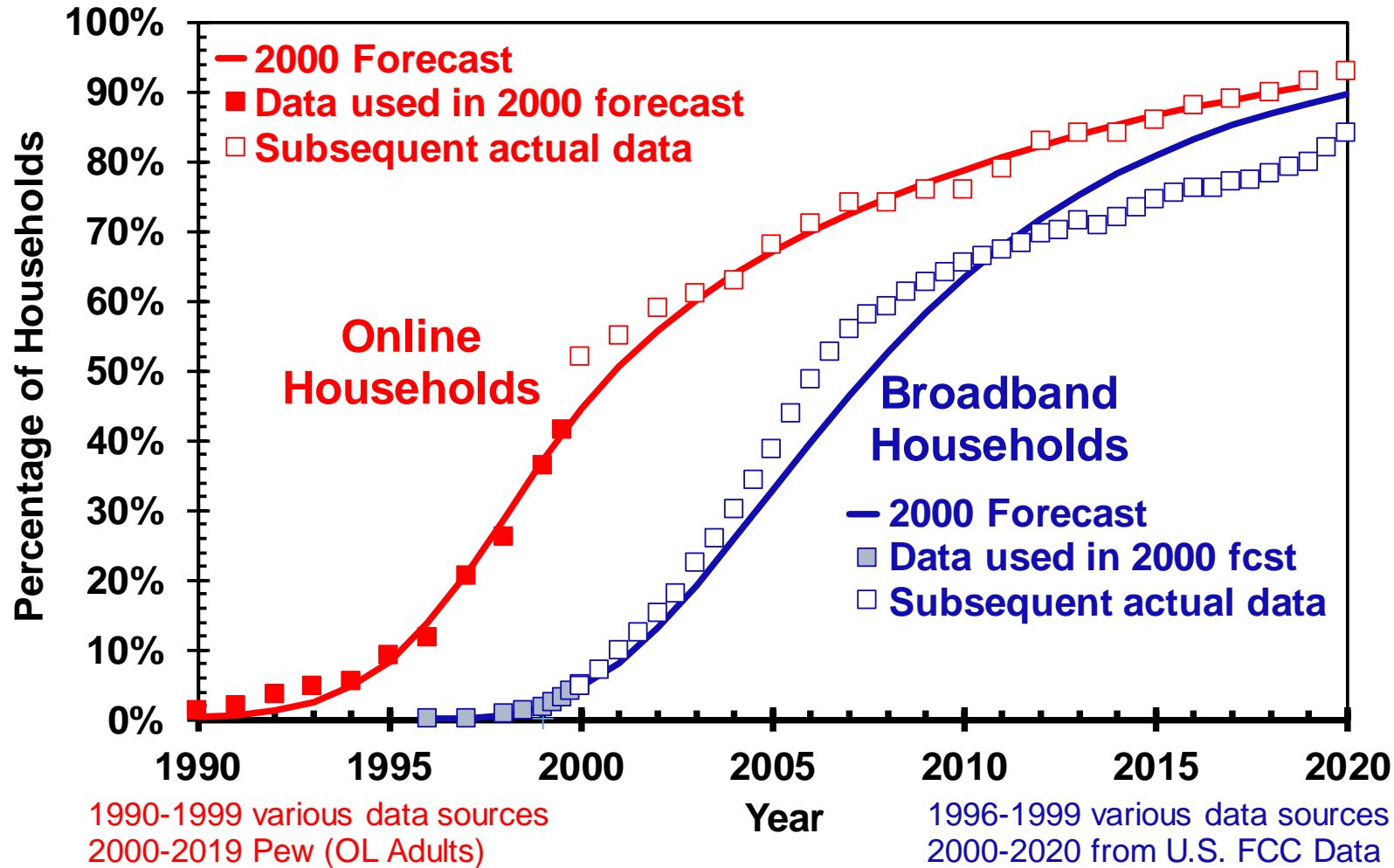
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The Gompertz Model



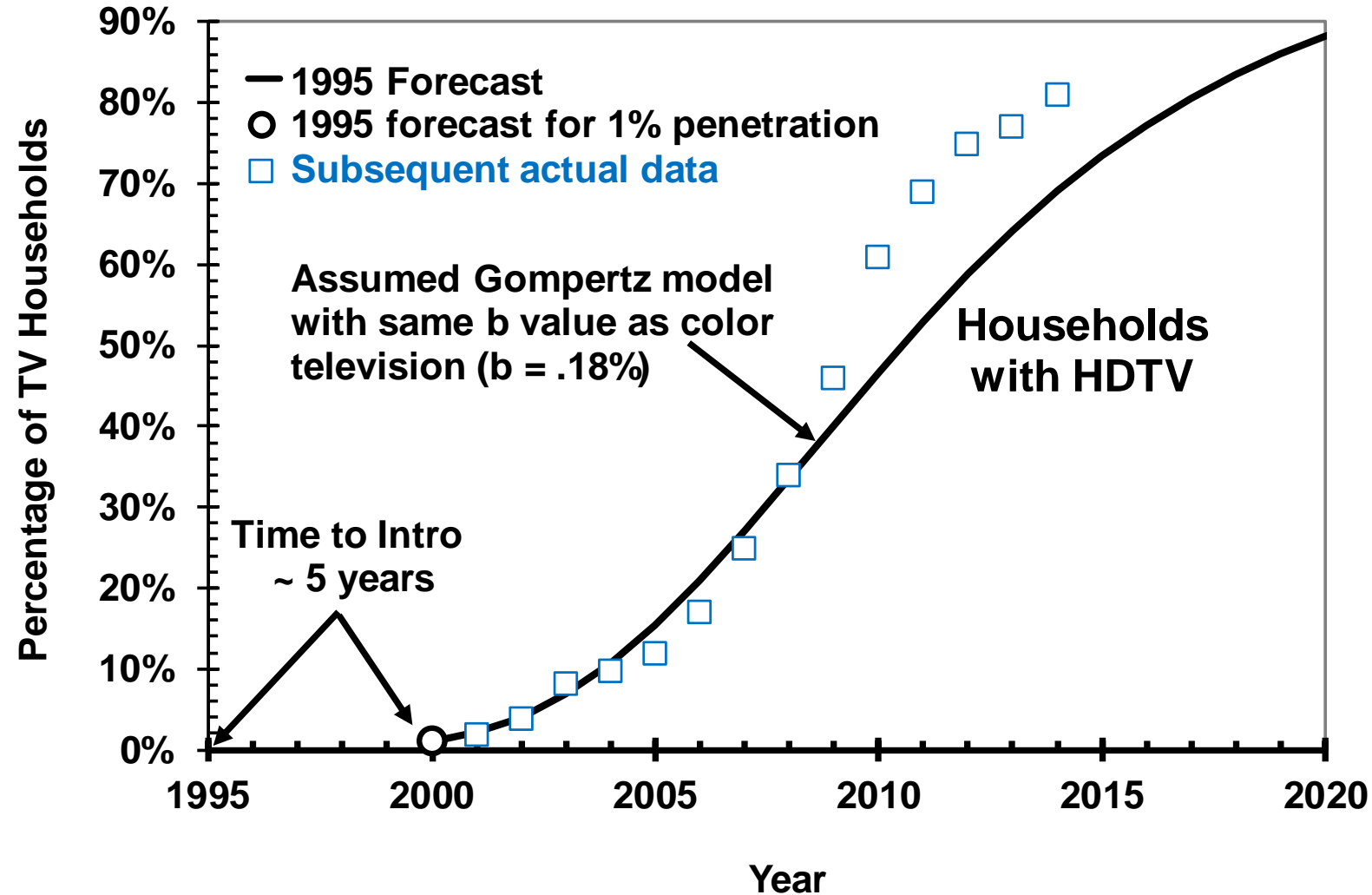
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Early TFI Broadband Forecast (2000)



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Early TFI HDTV Forecast (1995)



Special Feature:

Pitfalls in Forecast Evaluation

Preview of Q4 Special Feature: The Current State and Future Direction of Forecasting Software



2023:Q3

Issue 70

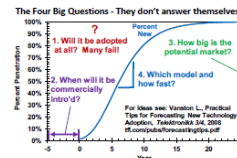
Minitutorial

Forecasting New Product Adoption Using S-Curves

LAWRENCE VANSTON

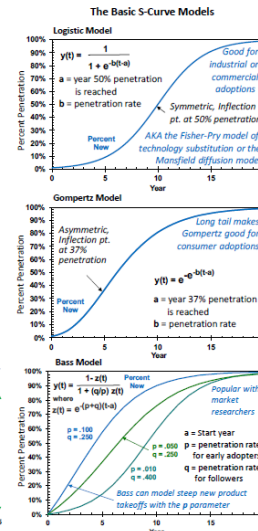
- S-Curves reflect the fundamental nature of adoption and technology change, proven over decades of use.
- They apply to new products, services, and technologies that use a fundamentally new approach, usually substituting for an old one.
- With enough historic data, we can use linear or nonlinear regression to estimate the 2-3 curve parameters.
- Without it (the usual case), we must rely on analogies, judgment, and analysis of underlying factors to estimate them.
- We usually forecast market penetration by all firms from which sales and share can be derived.

The S-shape's slow start reflects the fact that this type of new product must overcome constraints such as needed improvements, uncertainty, unfamiliarity, and high prices (due to low economies of scale, R&D costs, or lack of competition) often against entrenched existing products. Usually, a niche market or a community of innovators gives the new product its start. Once improvements are made, the new product's advantages becomes clear and the curve steepens dramatically. It flattens out as niches favorable to the old products are reached, including late adopters in the case of consumer products.



SELECTED CLASSIC REFERENCES

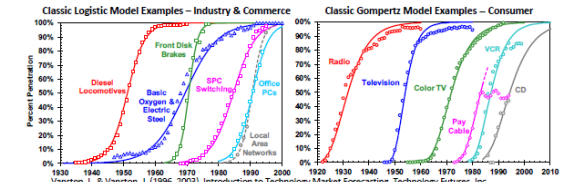
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- Fisher, J. & Pry, R. (1971). A Simple Substitution Model of Technological Change, *Techn. Forecast. & Soc. Change*, 3, 75-88.
- Mansfield, E. (1961). Technical Change and the Rate of Imitation, *Econometrica*, 29 (Oct), 741-766.
- Martino, J. (1983). *Technological Forecasting for Decision Making*, 2nd Ed., North-Holland Publishing.



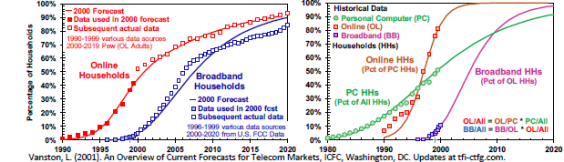
REFERENCES ON USING ANALOGIES

- Green, K. & Armstrong, J. (2007). Structured Analogies for Forecasting, *International Journal of Forecasting*, 23, 365-376.
- Goodwin, R., Dymussekera, K. & Meeran, S. (2013). The Use of Analogy in Forecasting the Annual Sales of New Electronics Products, *IMA J. Management Mathematics*, 24, 407-422.
- Wright, M. & Stern, P. (2015). Forecasting New Product Trial with Analogous Series, *Journal of Business Research*, 68, 1732-1738.

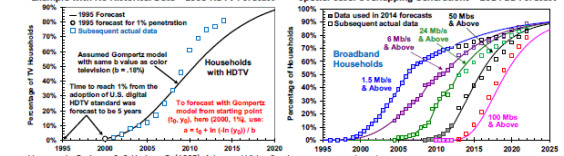
66 FORESIGHT 2023: Q3



Forecasting Example - We made this early broadband forecast (left) in 2000, combining three related forecasts (right). We worried that slow home PC adoption might cause a pure Gompertz model to over-forecast. Such judgment calls are usual.



Vanston, L. (2001). An Overview of Current Forecasts for Telecom Markets, IFC, Washington, DC. Updates at tfi-ctfg.com.



Vanston, L. (1995). Advanced Video Services. Vanston, L. (2014). Gigabit Broadband Access, International Symposium on Forecasting, Rotterdam. Updates at tfi-ctfg.com.

Other Special Cases: Market segmentation (e.g., consumer-service), geographic segmentation, multiple technologies, capital and other constraints, regulation and government action, etc. All require variations of the basic models.

REFERENCES ON EXTENSIONS AND OTHER MODELS

- Mahajan, V., Muller, E. & Bass, E. (1990). New Product Diffusion Models in Marketing: A Review & Directions for Research, *Journal of Marketing*, 54 (1), 1-26.
- Meade, N. & Islam, T. (2006). Modelling and Forecasting the Diffusion of Innovation - A 25-year Review, *International Journal of Forecasting*, 22 (3), 519-545.
- Sharif, M. & Kabir, C. (1976). System Dynamics Modeling for Forecasting Multilevel Technological Substitution, *Technology Forecasting and Social Change*, 9:1-2, 89-112.



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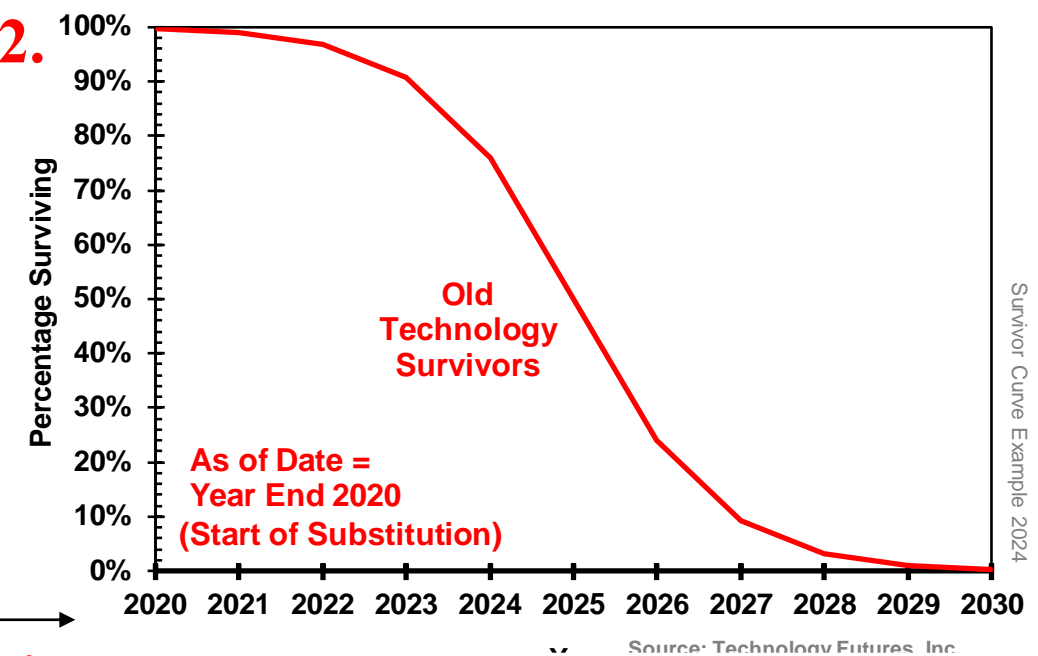
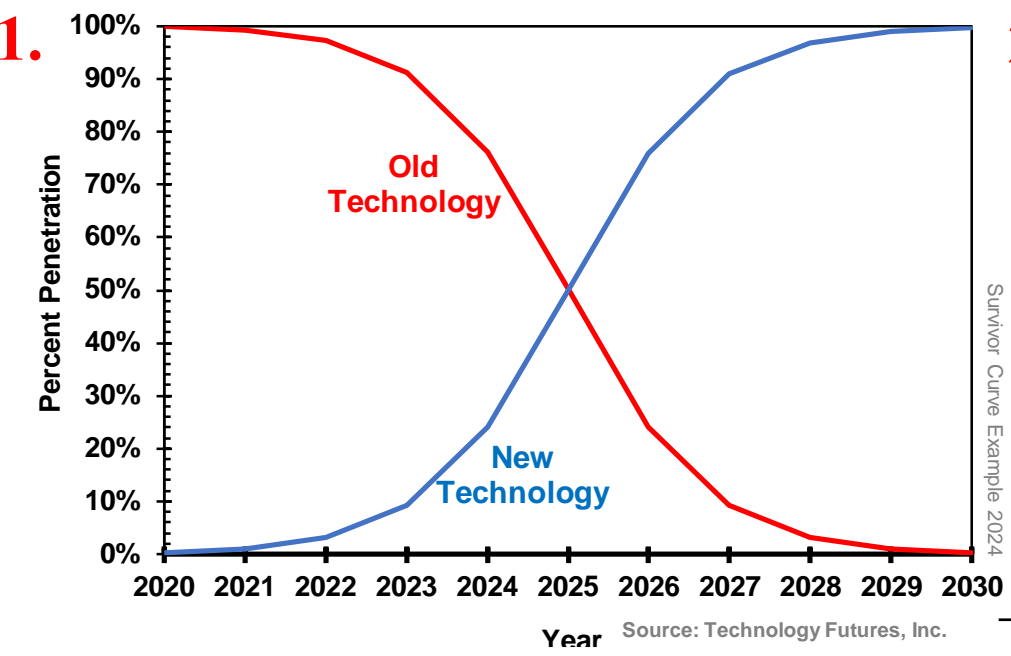
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<https://forecasters.org/foresight/> FORESIGHT 67

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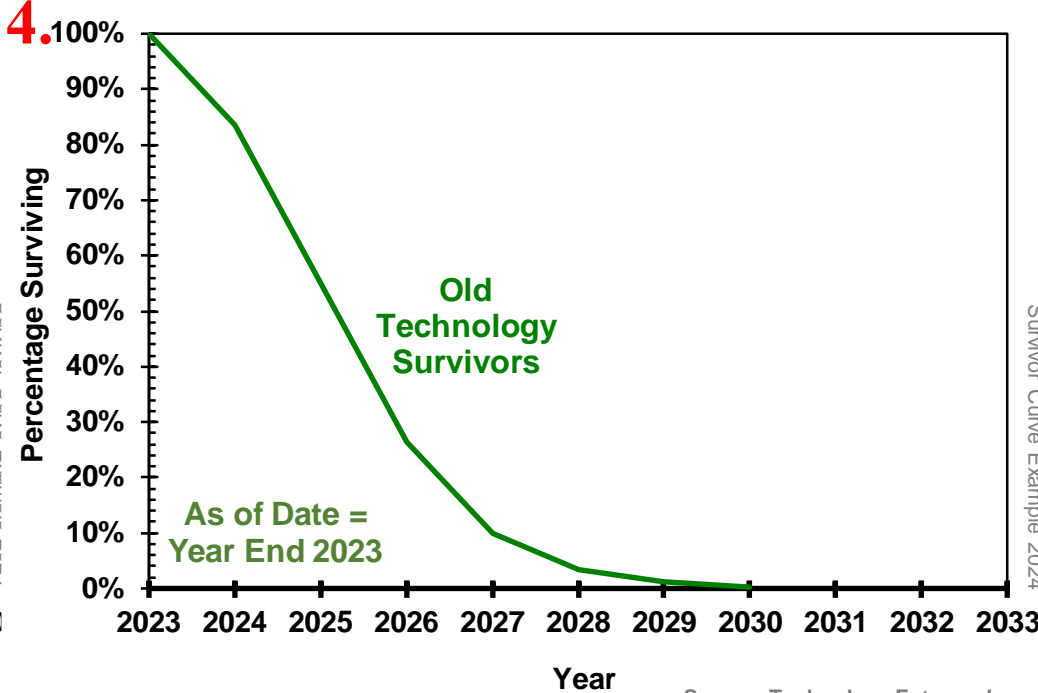
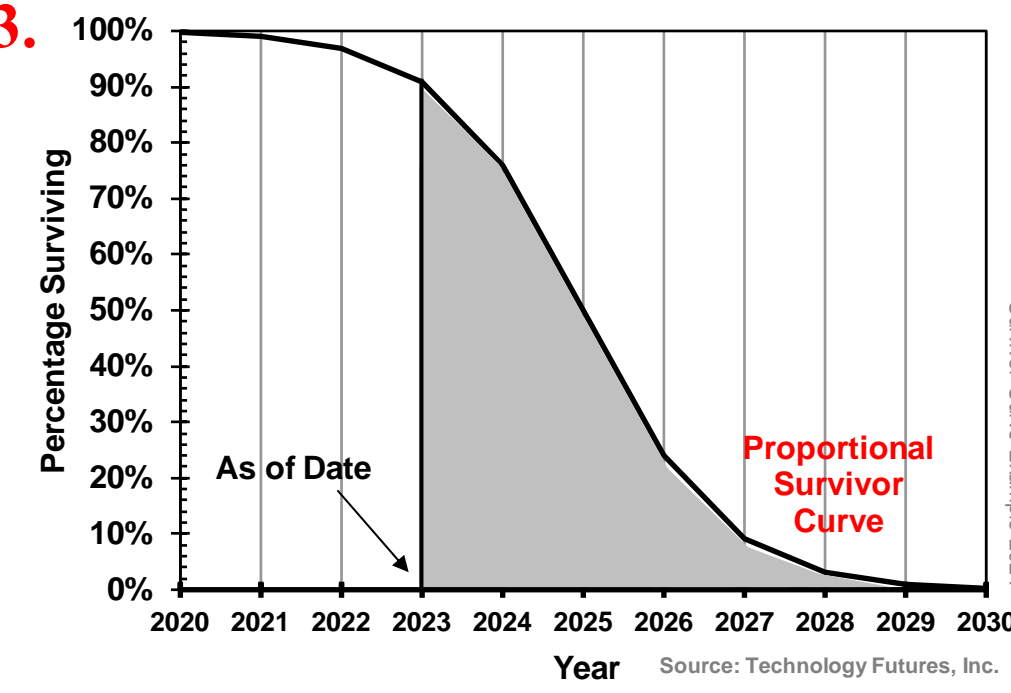
Application to Valuation

Simplified Example



5.

Year End	Survs
2023	100%
2024	84%
2025	55%
2026	26%
2027	10%
2028	3%
2029	1%
2030	0%
Sum =	2.8
1/2 yr	-0.5
RL =	2.3



6.

Pct Good = $RL / (Age + RL)$

Year	Age	Pct Good
2023	0.5	82%
2022	1.5	61%
2021	2.5	48%
2020	3.5	40%
2019	4.5	34%
2018	5.5	29%
2017	6.5	26%
2016	7.5	23%

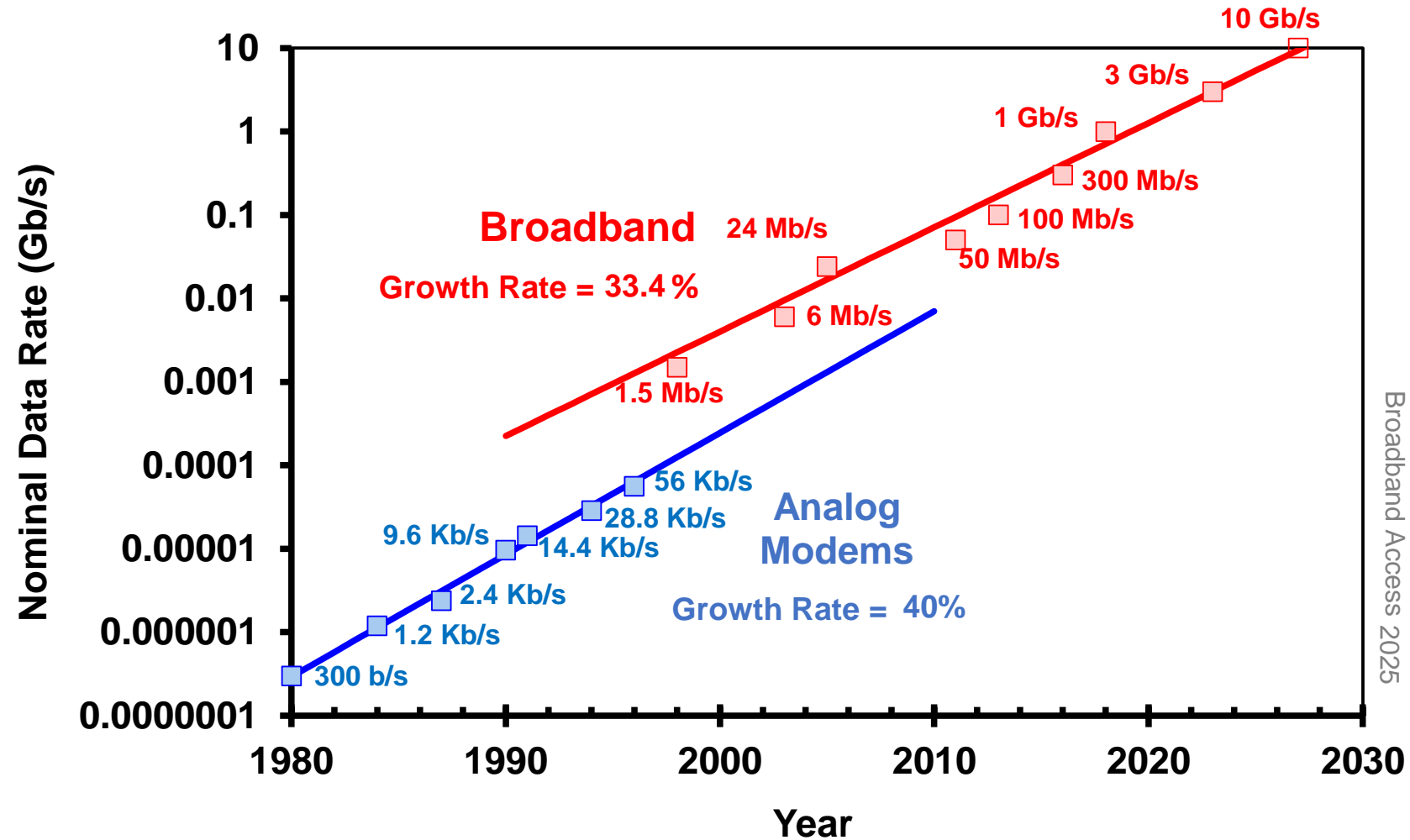
Technology Forecasting Lessons

- Nothing happens overnight – at least so far
- Fundamental technology trends are relentless
- Betting against fundamental technology trends is futile
- Fundamental technology trends destroy value in old technology

TFI Forecasts 2026

Broadband

Broadband Performance Milestones



Source: Technology Futures, Inc.

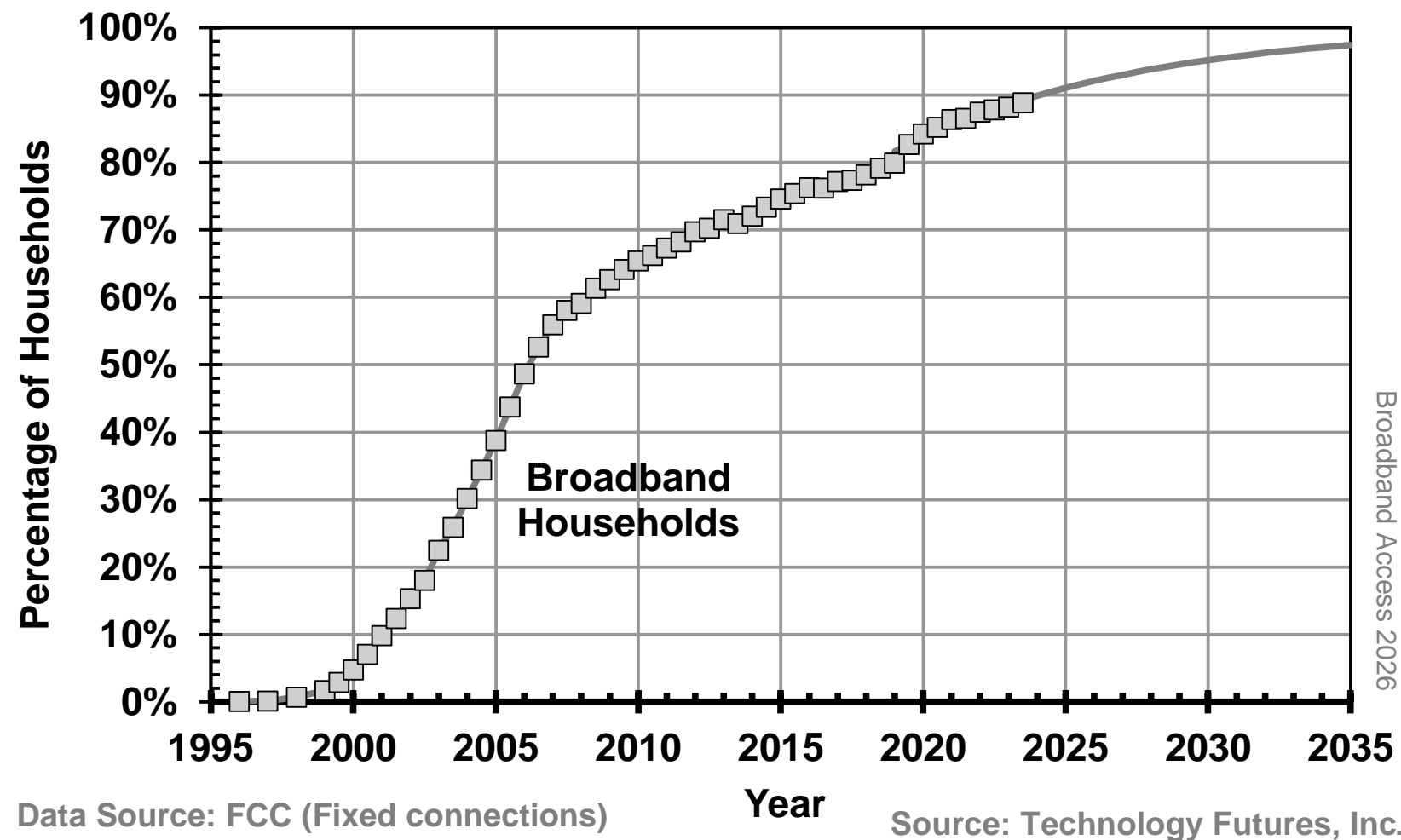
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How Long Will Broadband Speeds Increase?

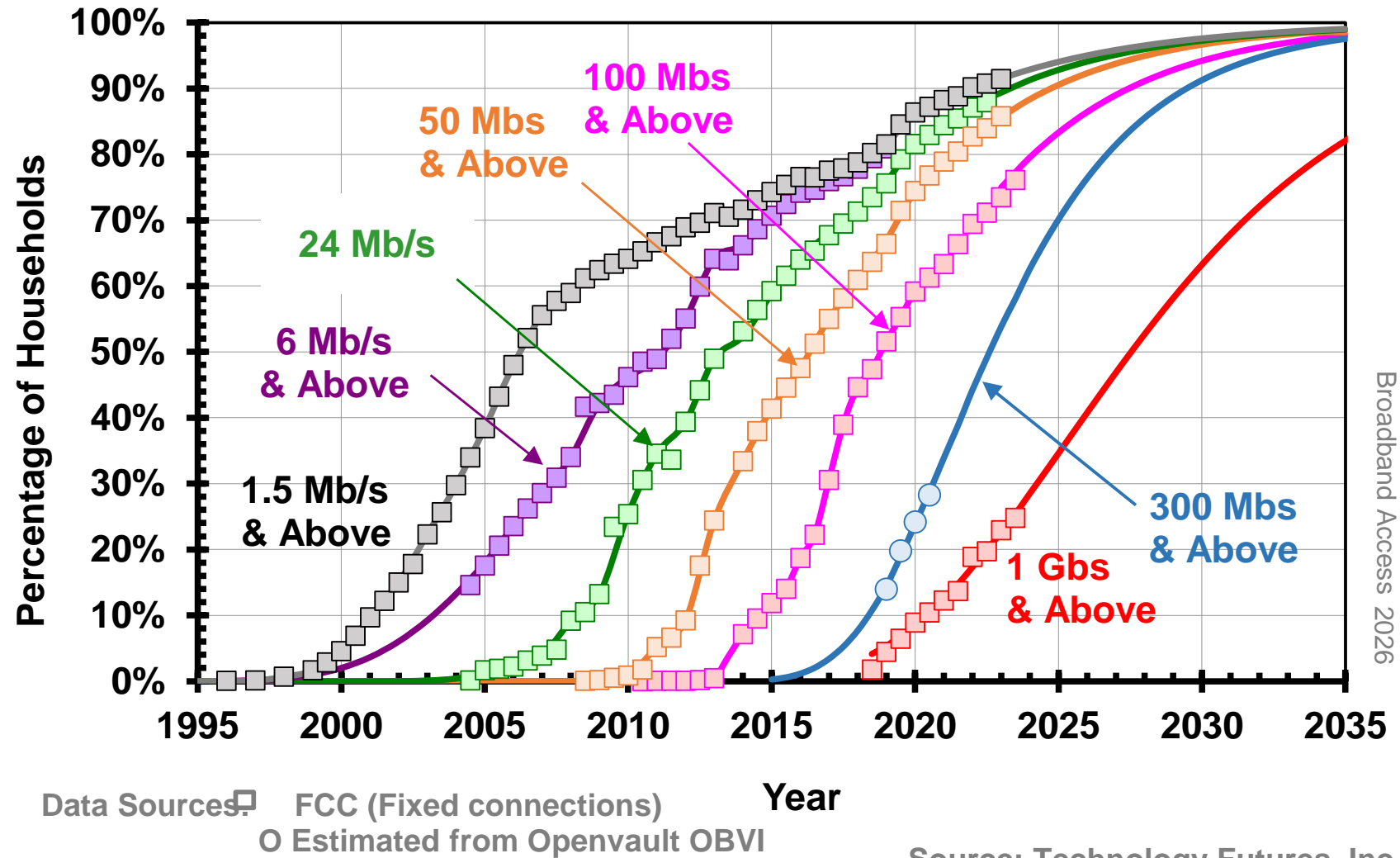
Key Technology Forecasting Principle:

- Performance improvement will continue as long as it's:
 - Technically feasible AND
 - Useful
- The rate may change if the technology approach changes.
- Rate often slow down as limits are reached (Pearl or logistic curve)

U.S. Broadband Households – 2026 TFI Forecast



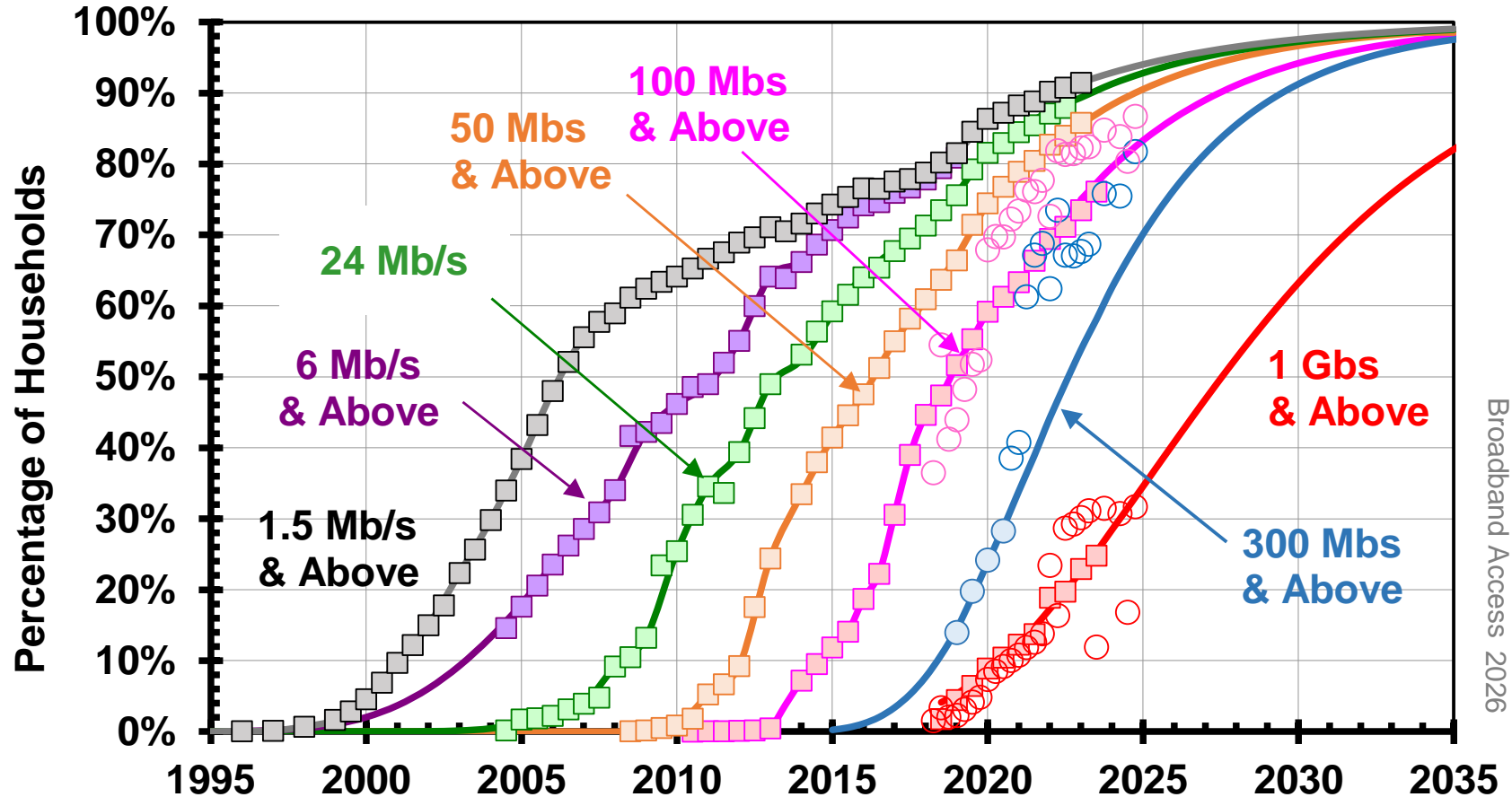
U.S. Broadband Households – 2026 TFI Forecast



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U.S. Broadband Households – 2026 TFI Forecast

Showing Openvault OBVI data (as pct of all households)



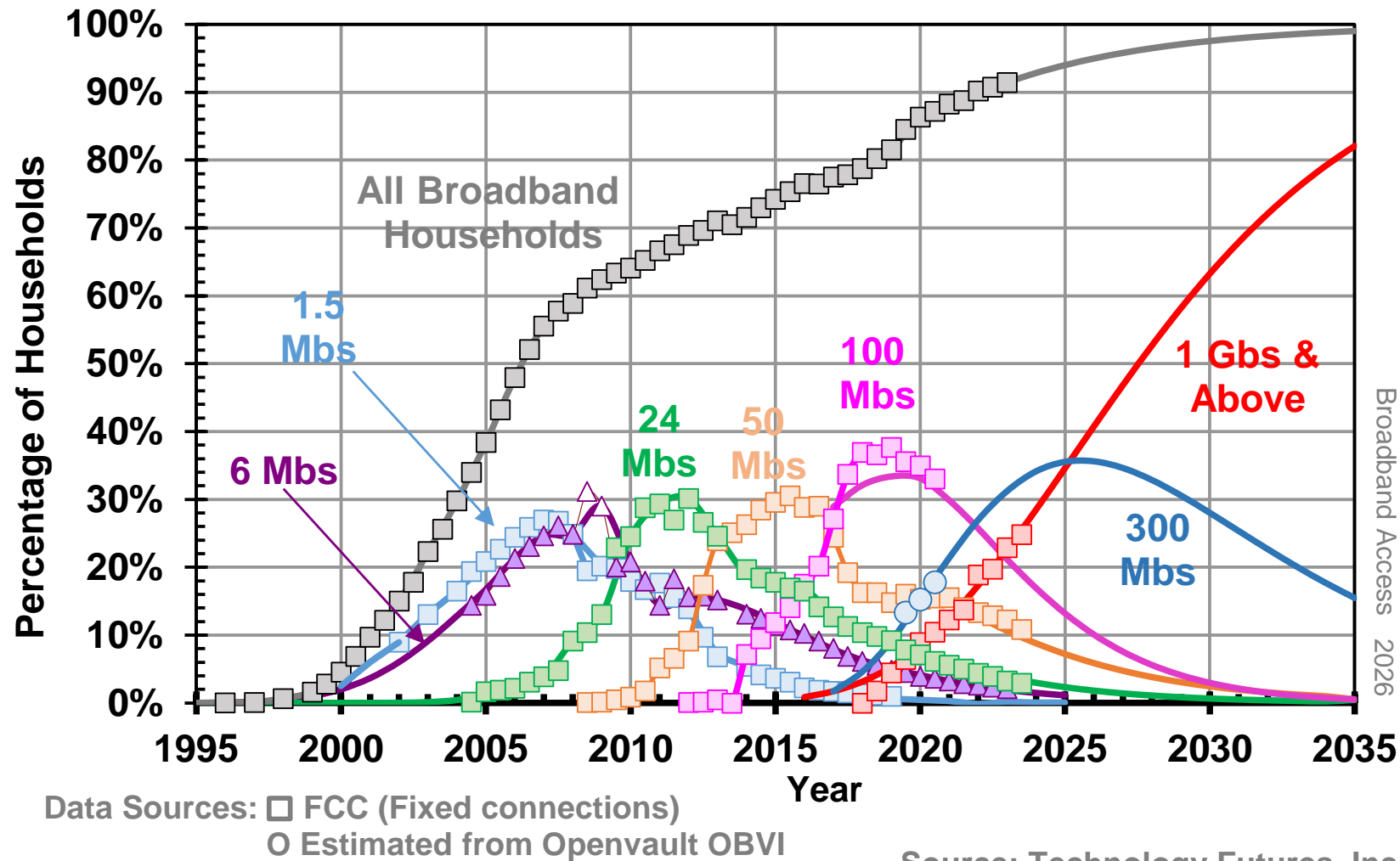
Broadband Access 2026

Data Sources: □ FCC (Fixed connections)
○ Estimated from Openvault OBVI

Source: Technology Futures, Inc.

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U.S. Broadband Households – 2026 TFI Forecast

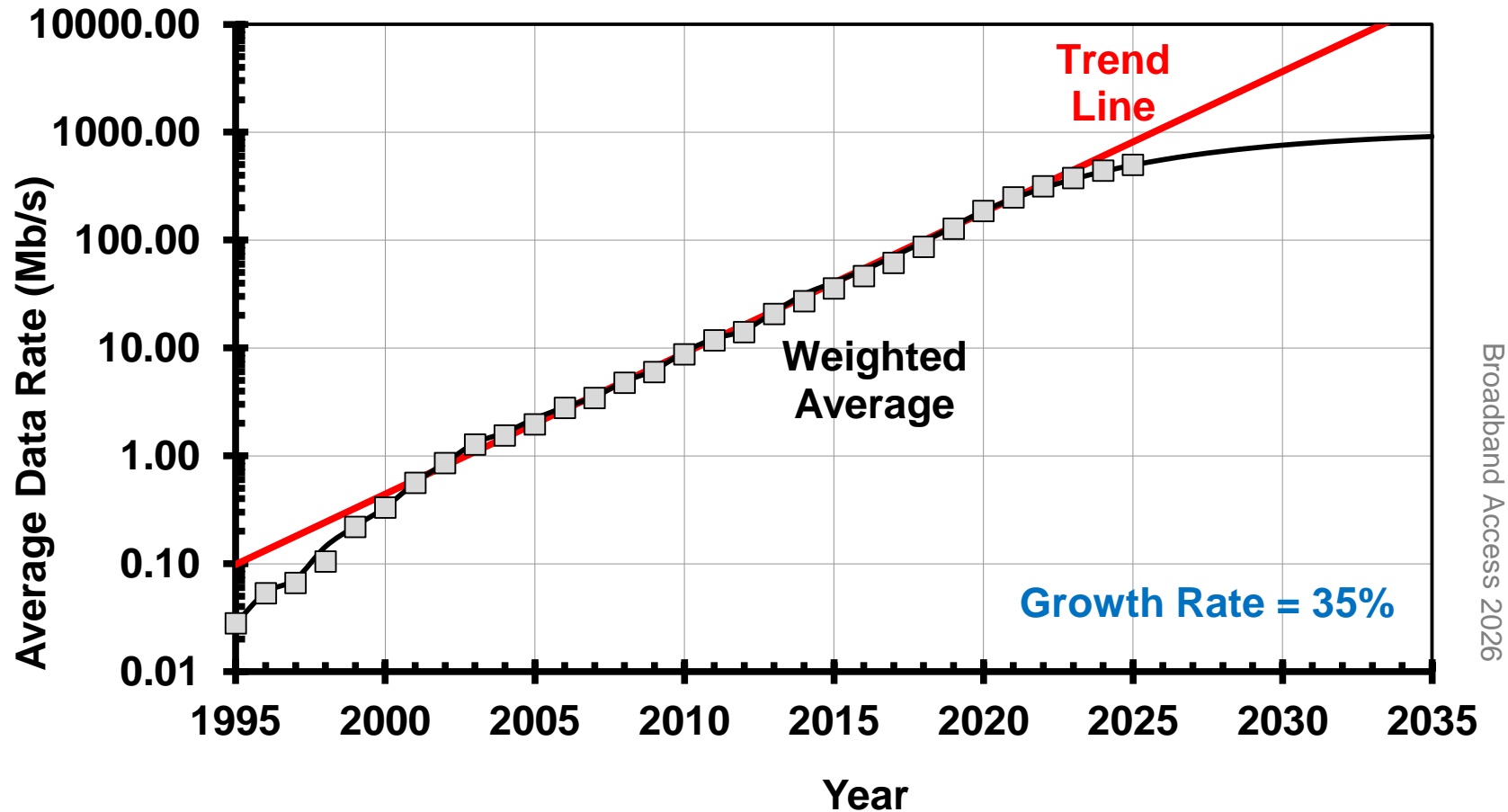


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Lifecycle (t) = Substitution (t) – Next Substitution (t)

Average Broadband Speed Trend

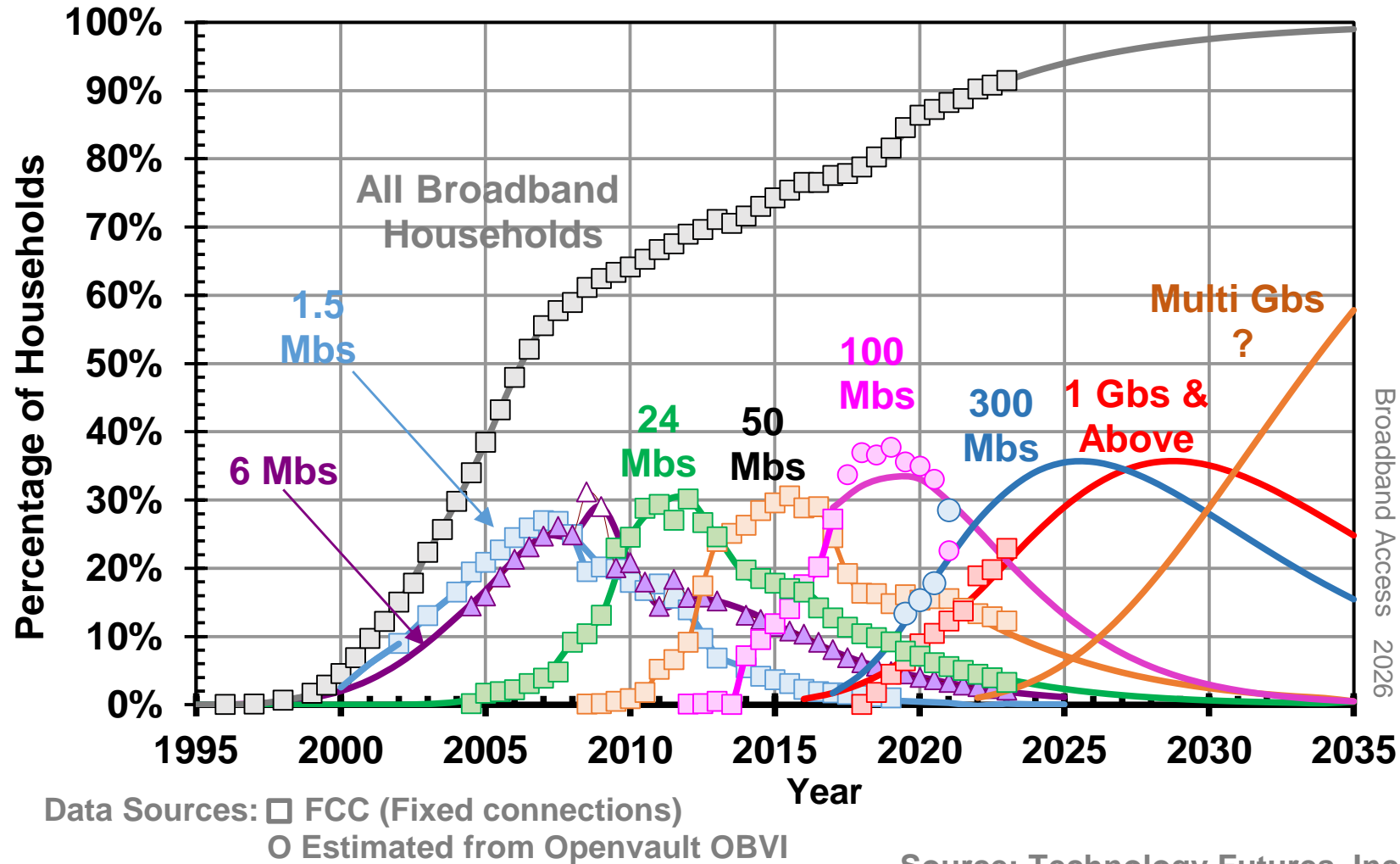
TFI Forecasts to 1 Gb/s



Source: Technology Futures, Inc.

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U.S. Broadband Households – 2026 TFI Forecast

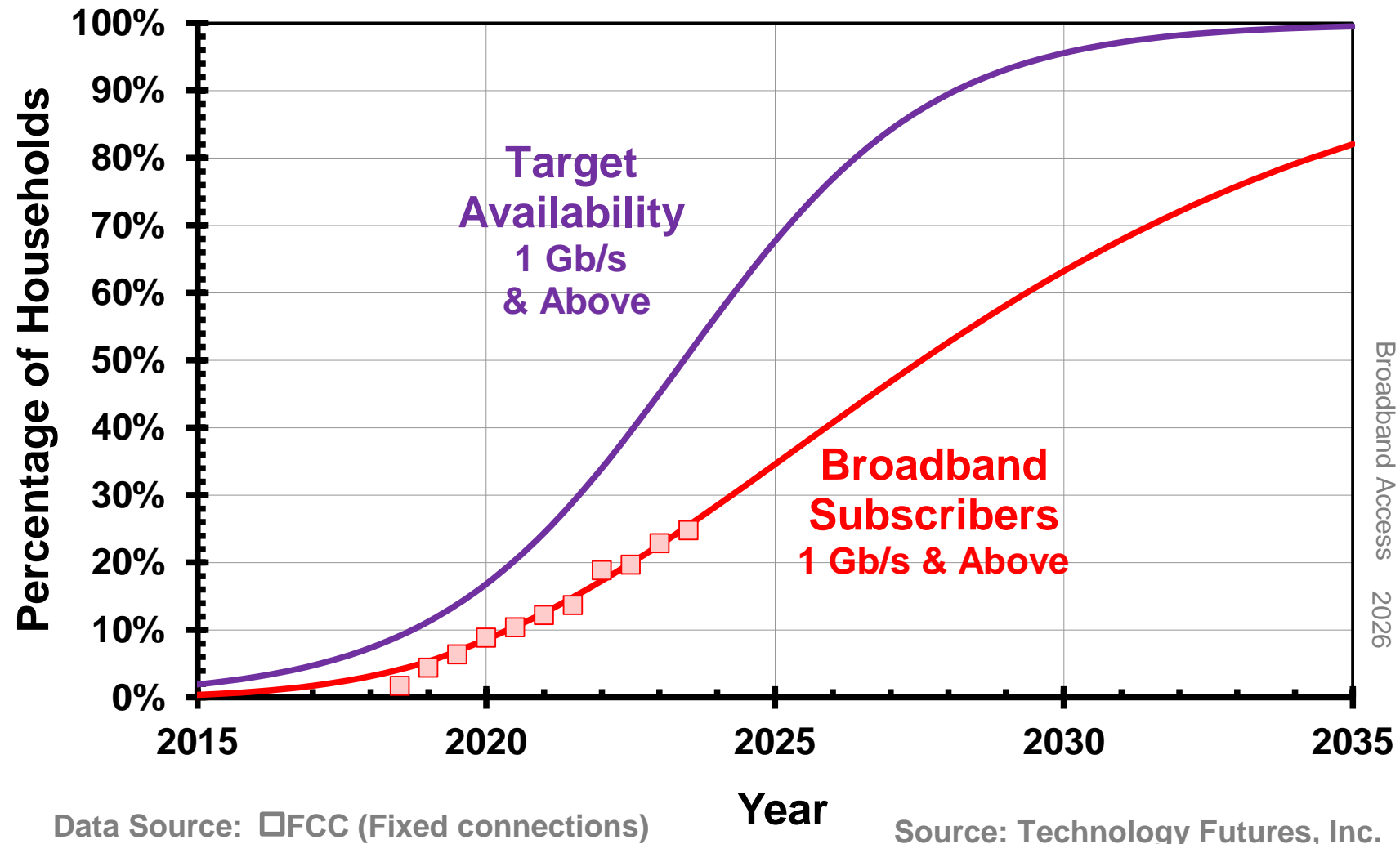


Source: Technology Futures, Inc.

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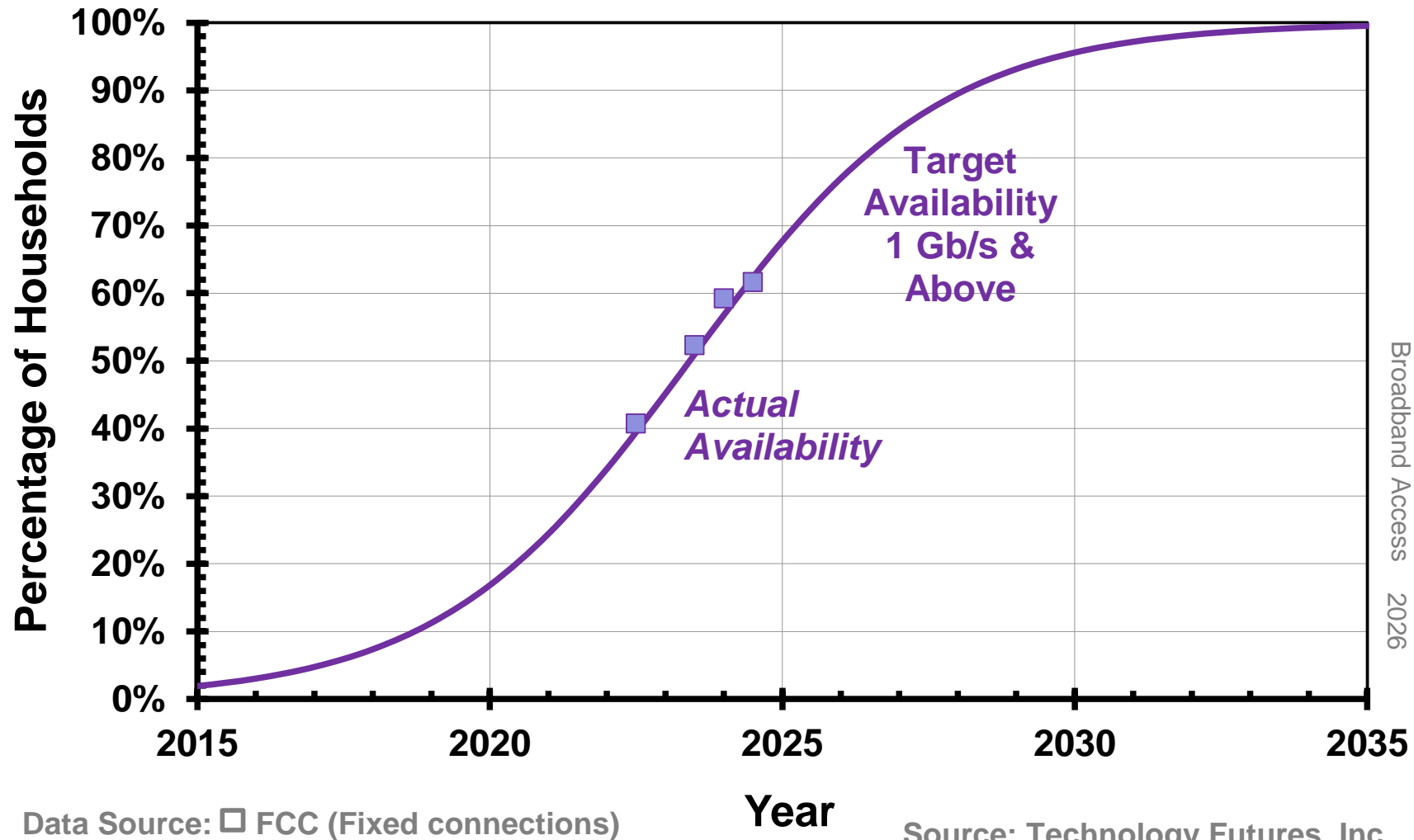
$\text{Lifecycle (t)} = \text{Substitution (t)} - \text{Next Substitution (t)}$

Availability vs Subscribers, 1 Gb/s & Above



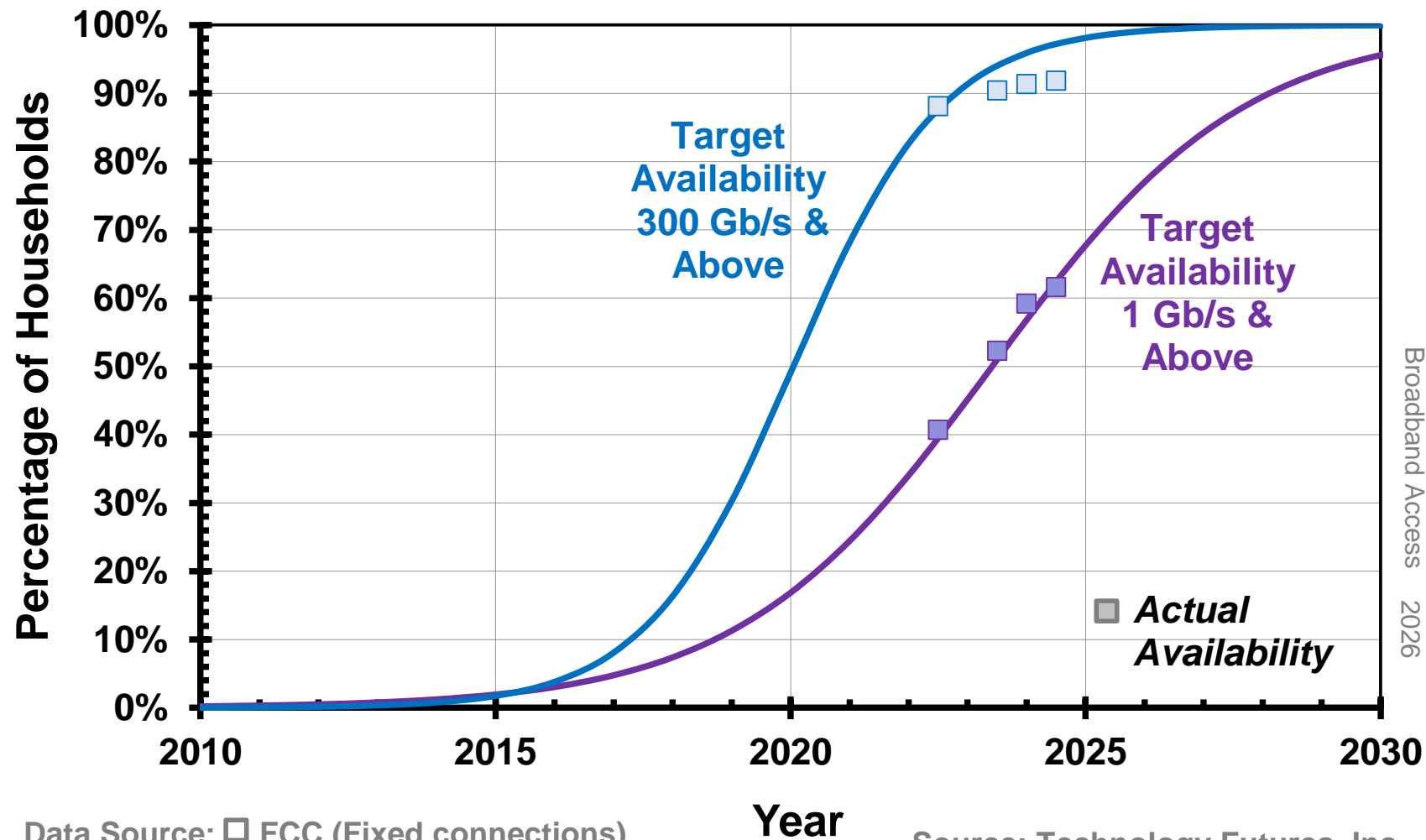
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Availability vs Subscribers, 1 Gb/s & Above



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Availability vs Subscribers, 300 Mb/s & Above



Data Source: □ FCC (Fixed connections)

Source: Technology Futures, Inc.

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Actual Availability

June 2025

Speed (Down/Up)	Fiber	Cable	Cable /Fiber	Fixed Wireless	Copper	All Terrastral
25M / 3M	52%	82%	91%	74%	20%	97%
100 / 20M	52%	82%	91%	54%	4%	95%
250M / 20M	52%	81%	90%	14%	0%	92%
1G /100M	46%	27%	61%	2%	0%	62%

FCC National Broadband Map

[https://broadbandmap.fcc.gov/
area-summary/fixed](https://broadbandmap.fcc.gov/area-summary/fixed)

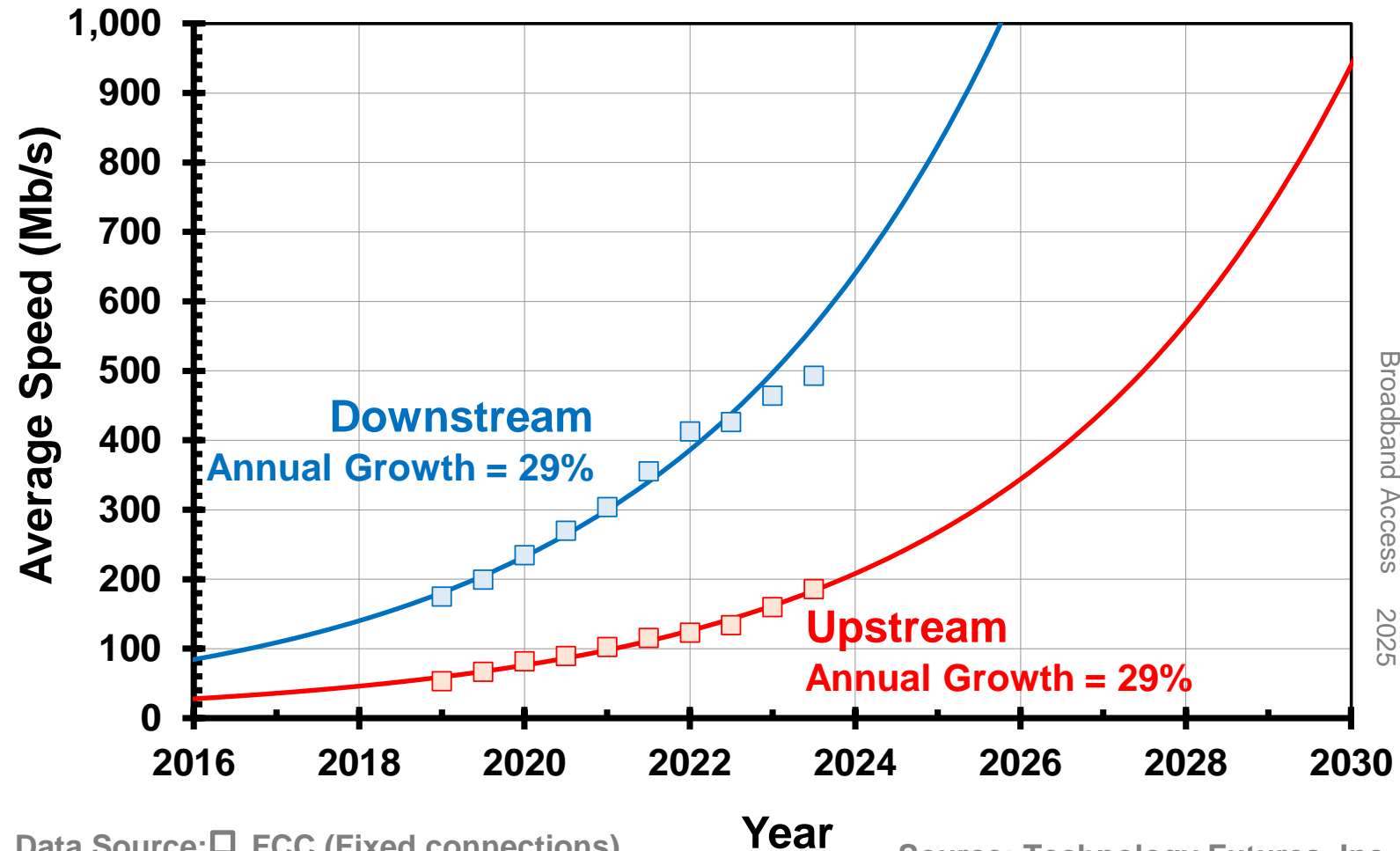
Accessed 1/18/2026

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Average Broadband Speed Trend

FCC Data (2026)



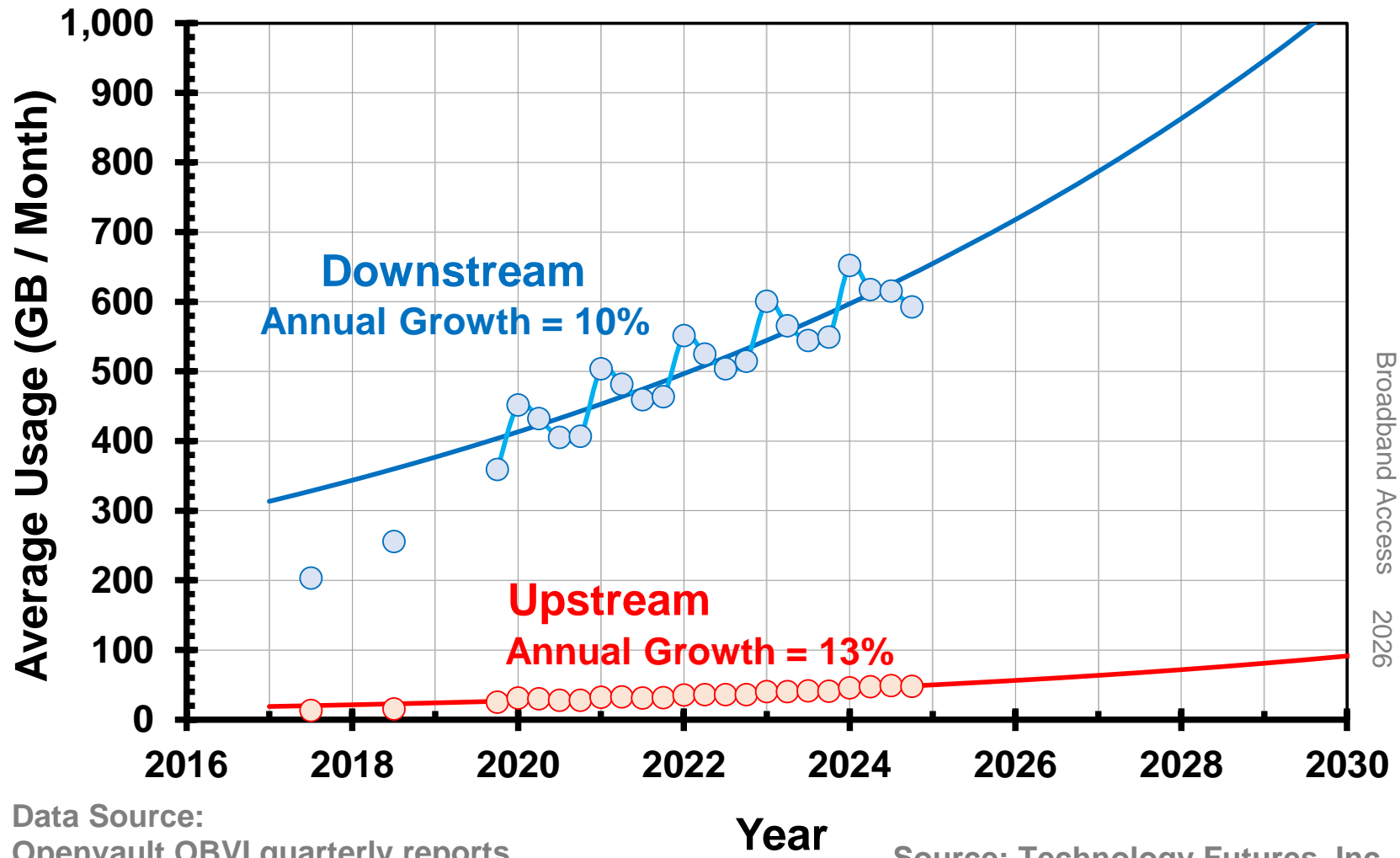
Data Source: ☐ FCC (Fixed connections)

Year

Source: Technology Futures, Inc.

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Broadband Usage



Data Source:
Openvault OBVI quarterly reports

Source: Technology Futures, Inc.

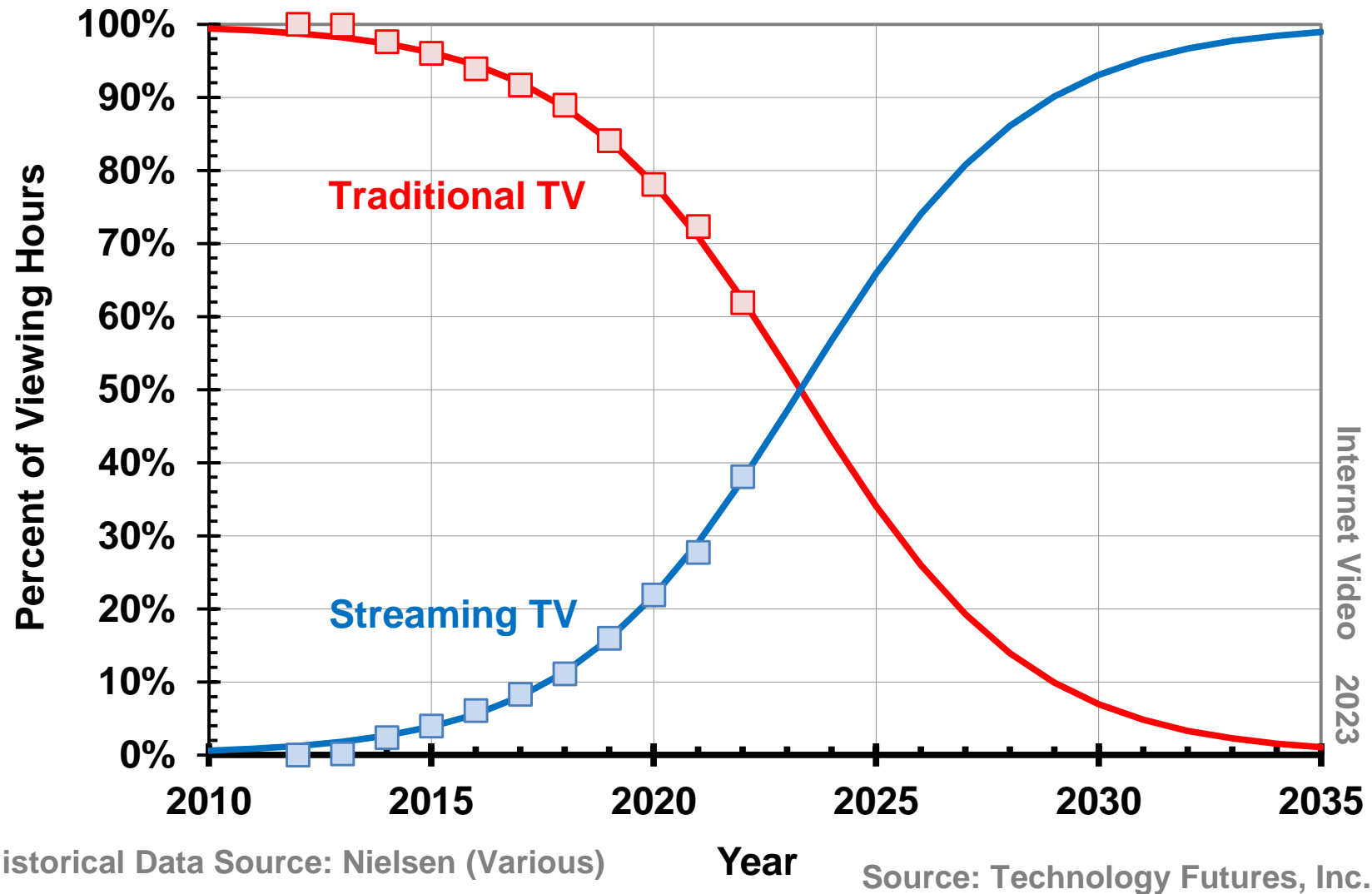
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Broadband Summary

- Broadband speeds continue to increase, 300 Mb/s standard. 1 Gb/s gold standard. Multi Gb/s available. 10G coming.
- Relentless bandwidth demand, quality improvement, and upstream means deploying fiber and upgrading / replacing equipment at least through current cycle.
- Competition from wireless, especially 5G
- Telco copper is doomed. Has been for years.

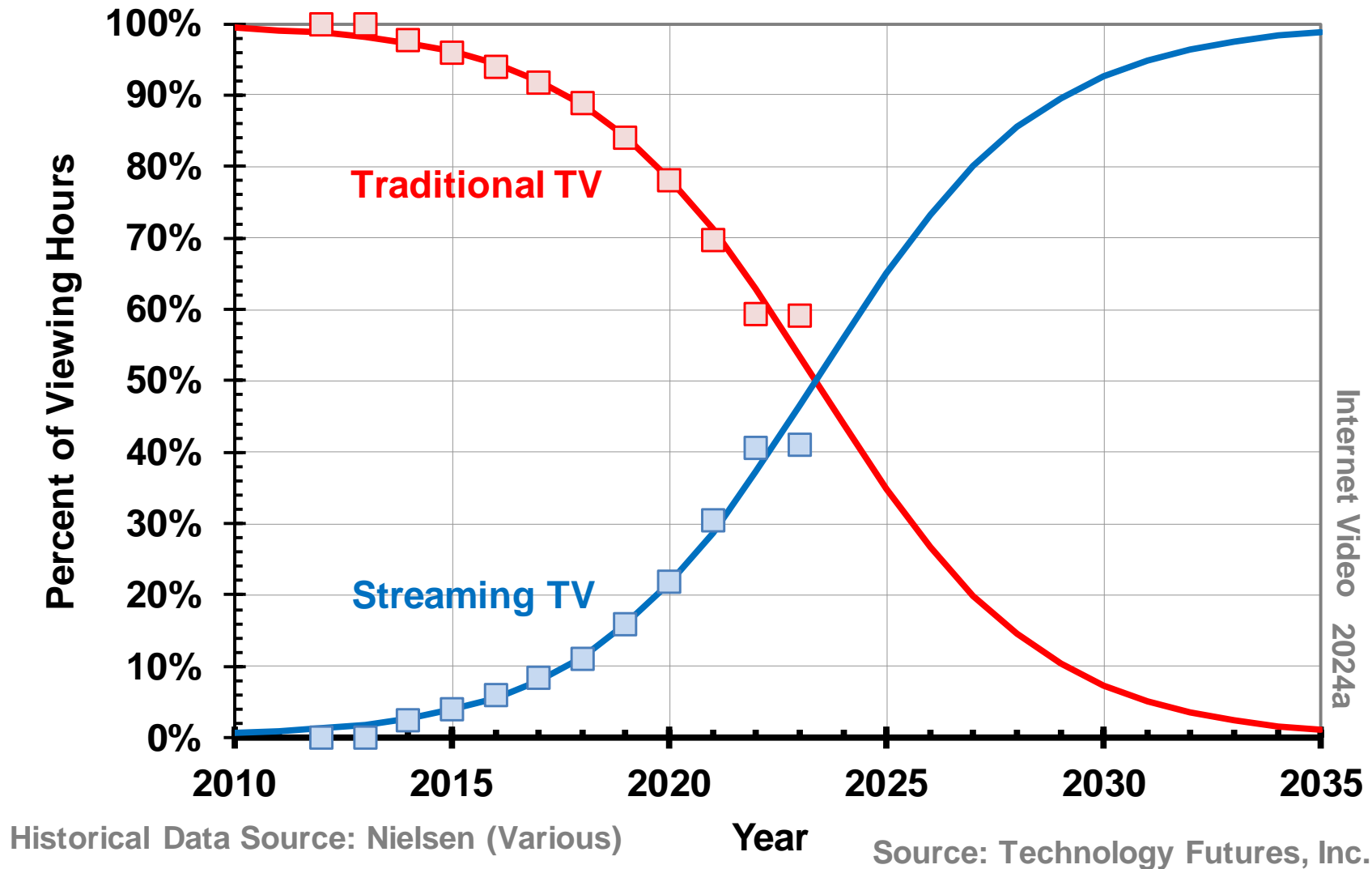
Online Video Forecasts

Traditional TV vs Streaming TV – 2023 TFI Forecast



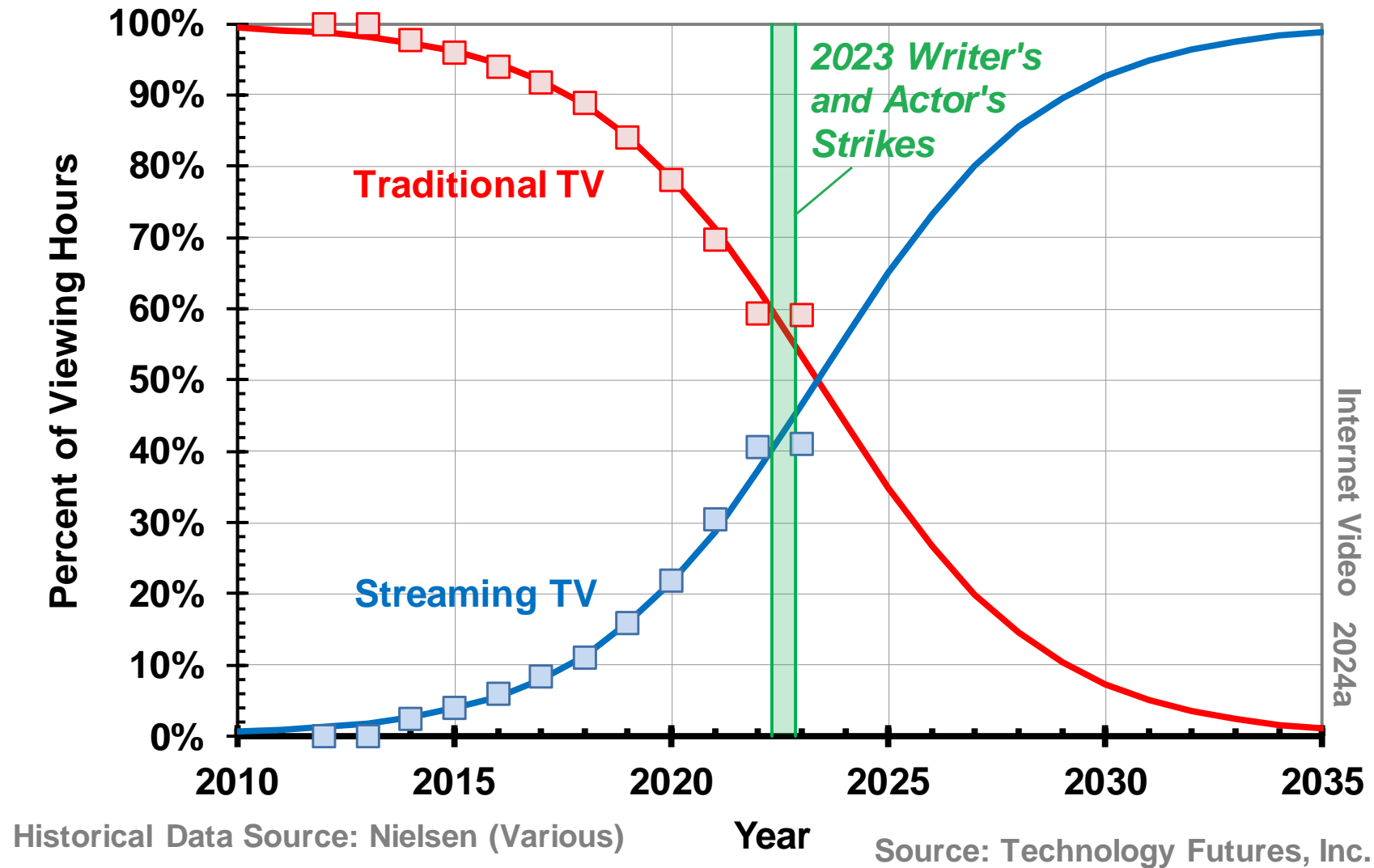
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Traditional TV vs Streaming TV – 2024 TFI Forecast



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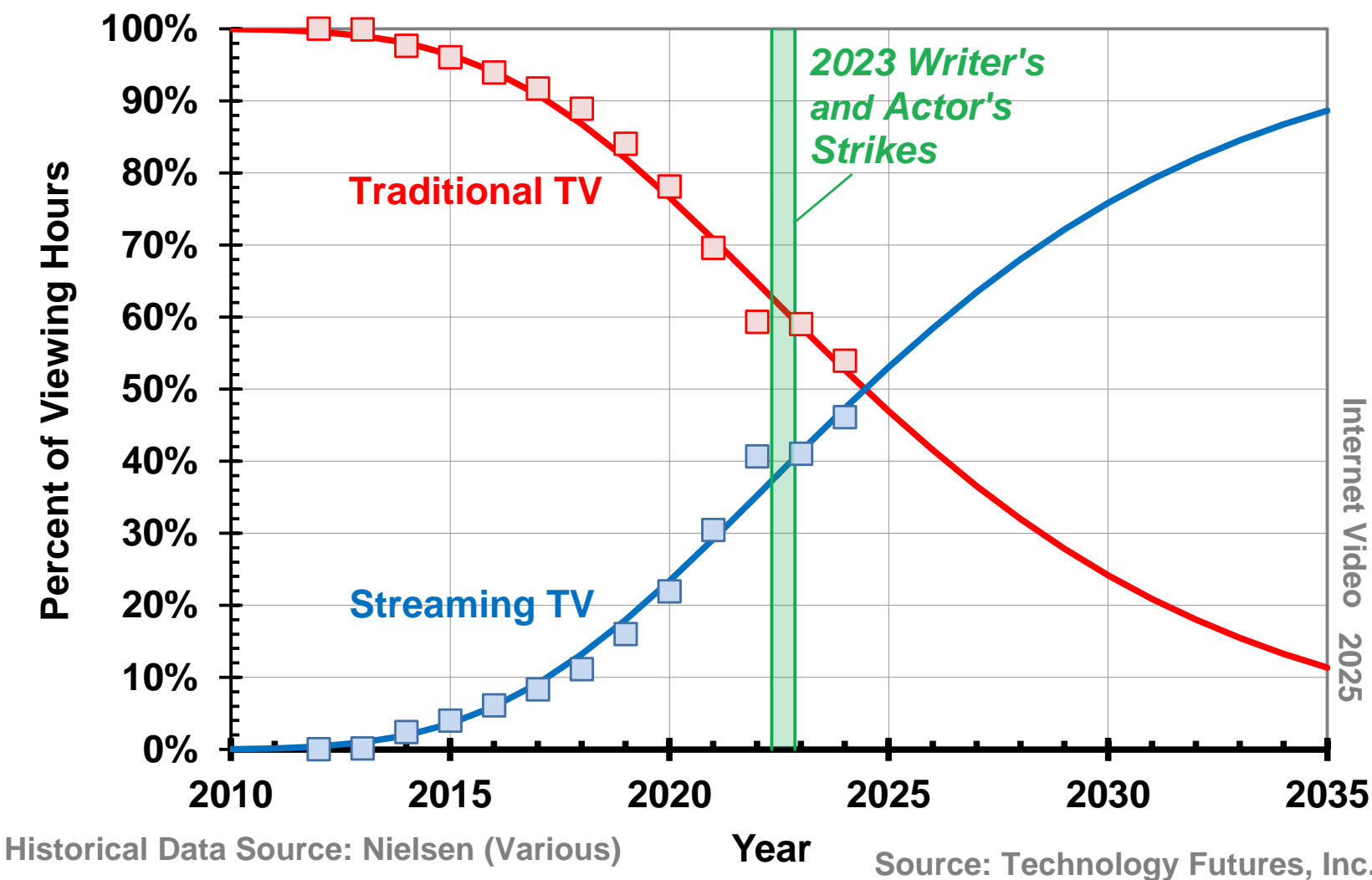
Traditional TV vs Streaming TV – 2024 TFI Forecast



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Traditional TV vs Streaming TV – 2025 TFI Forecast

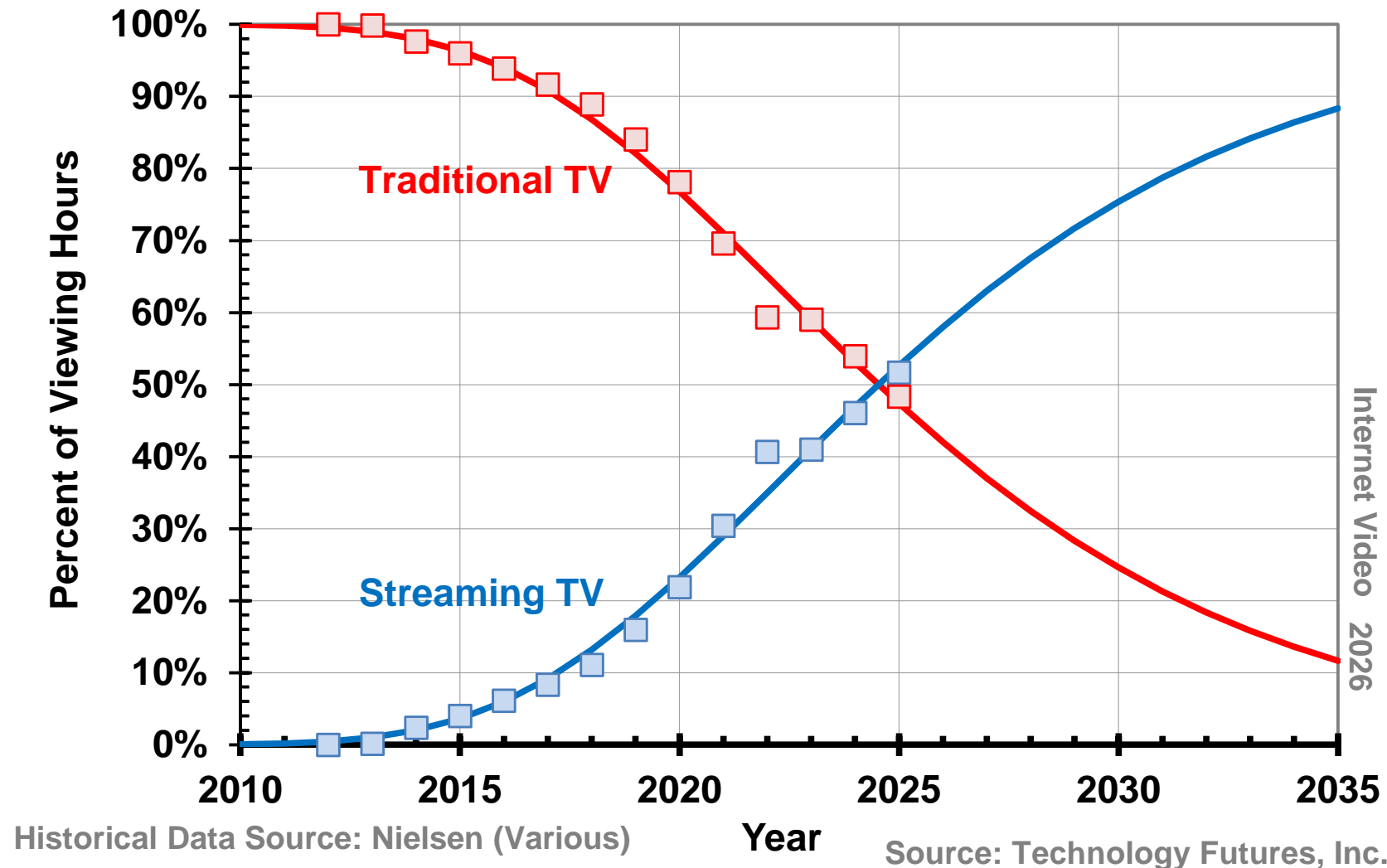
Consumer Trend



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Traditional TV vs Streaming TV – 2026 TFI Forecast

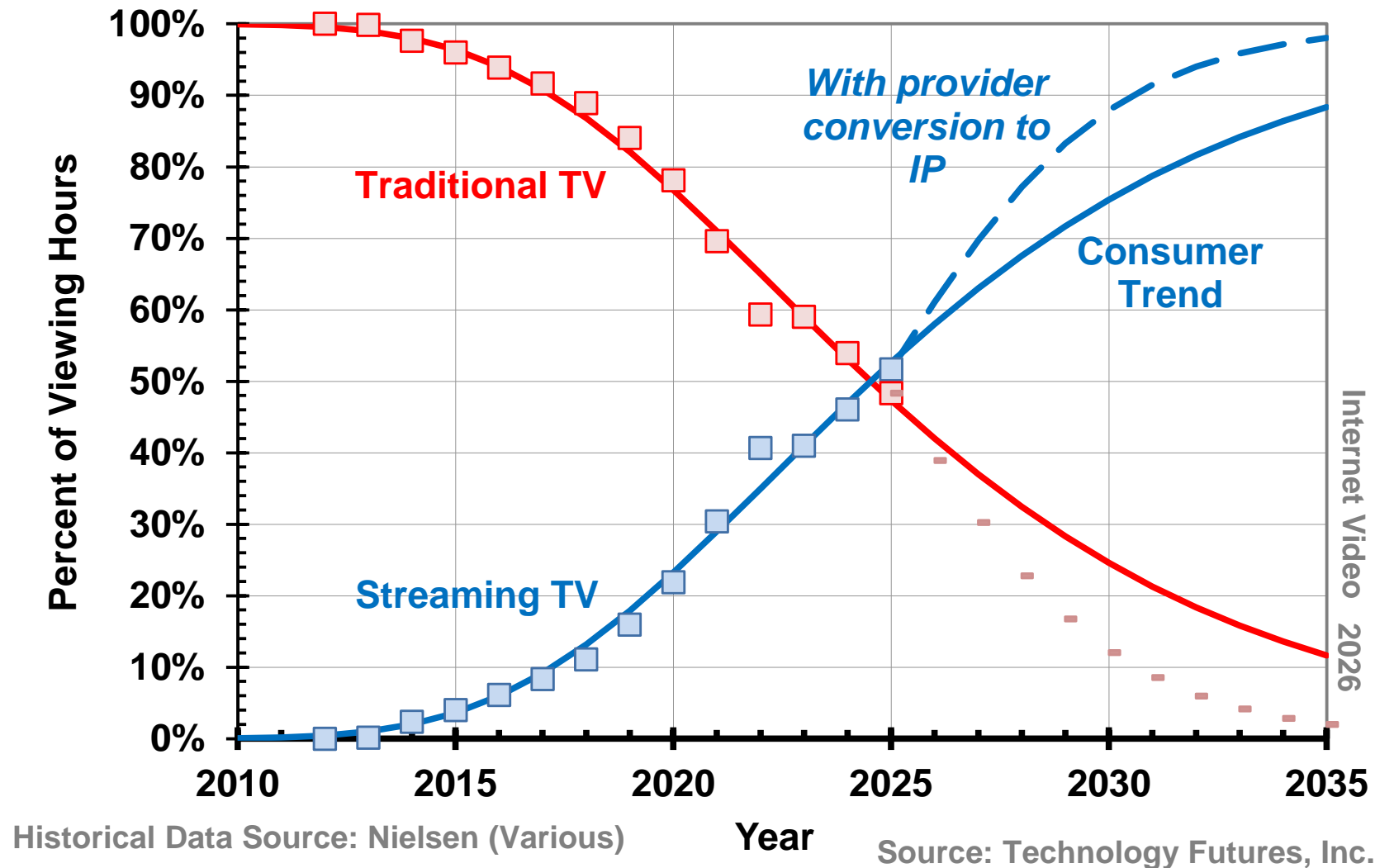
Consumer Trend



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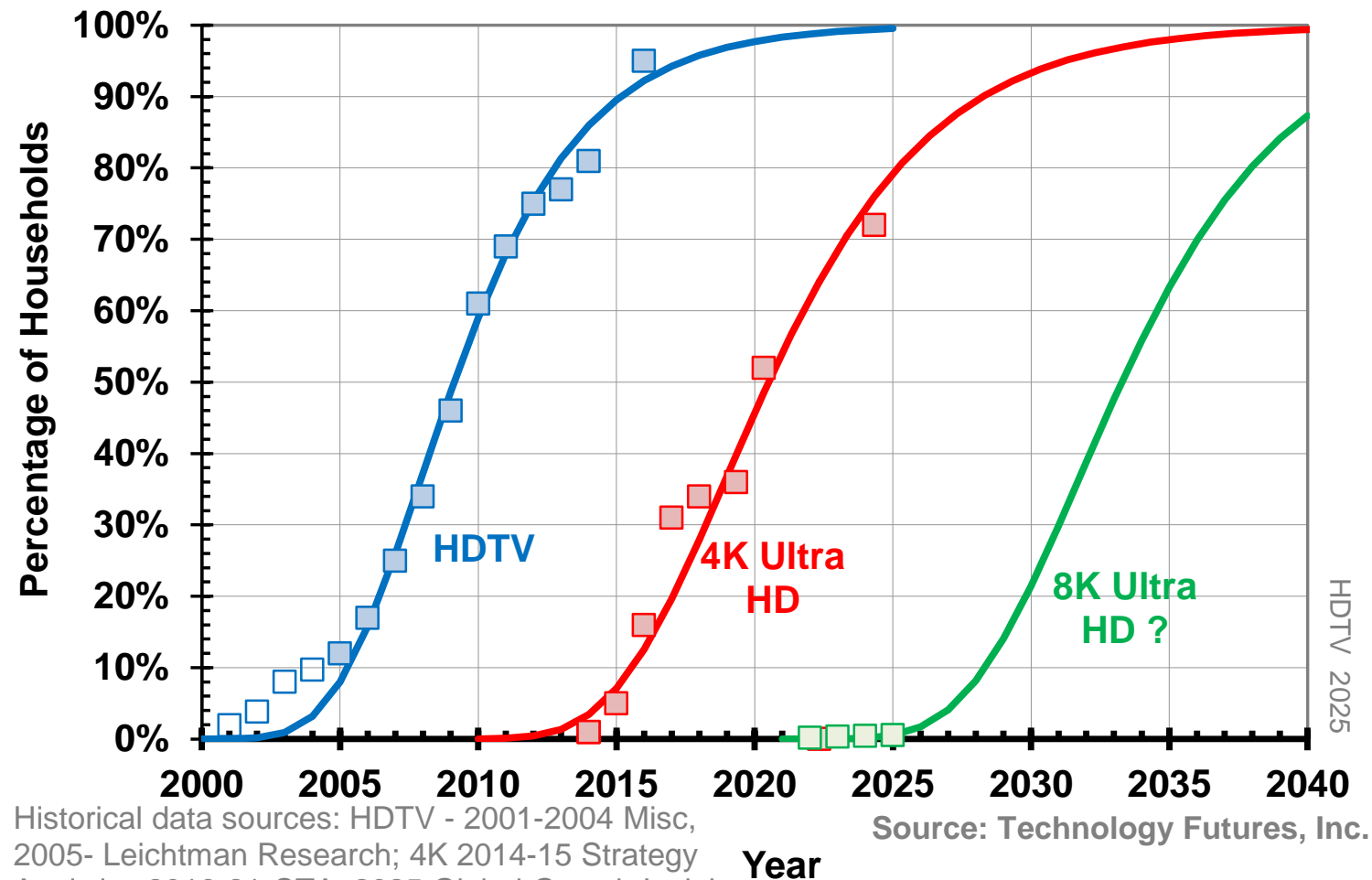
Traditional TV vs Streaming TV – 2026 TFI Forecast

With provider conversion to IP



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Ultra HD Households (4K and 8K) - 2026 TFI Forecast



Historical data sources: HDTV - 2001-2004 Misc,
2005- Leichtman Research; 4K 2014-15 Strategy
Analytics, 2016-21 CTA; 2025 Global Growth Insights
8K - 2019-20 Strategic Analytics, 2021-25 CTA

Typical Streaming Data Rates

Std TV = ~ 2 Mb/s

HDTV = ~ 4 Mb/s

4K UHD = ~ 18 Mb/s

8K UHD = ~ 60 Mb/s

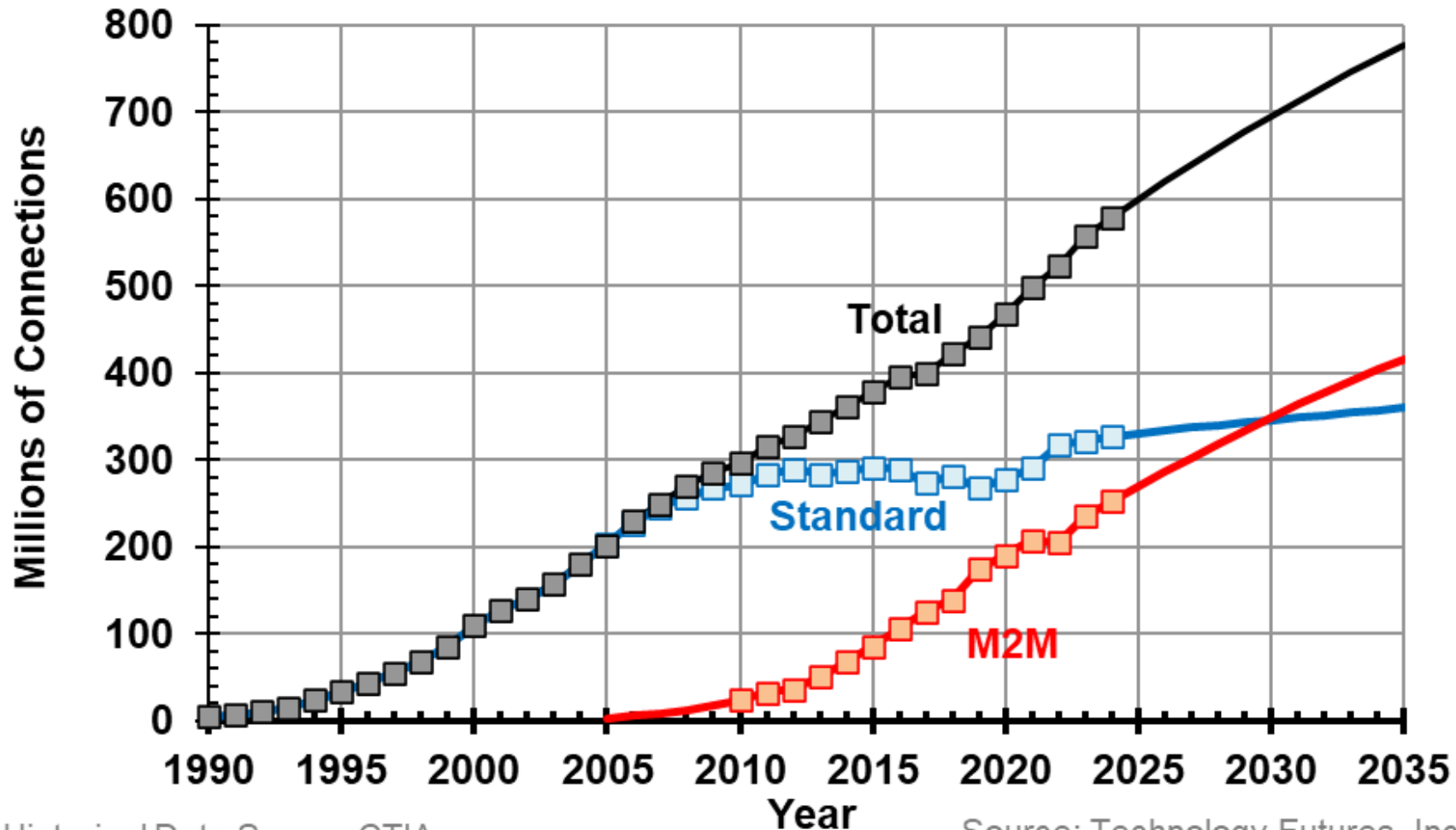
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Implications for Cable Companies

- Continued losses in multichannel TV subscriptions
- Continued need to provide multichannel and enhance broadband service simultaneously
- Competition from wireless, especially 5G
- Telcos have stepped up their game
- HFC networks are less energy efficient
- Increased investment without commensurate increase in revenue

Wireless Forecasts

Wireless Connections – 2026 TFI Forecast

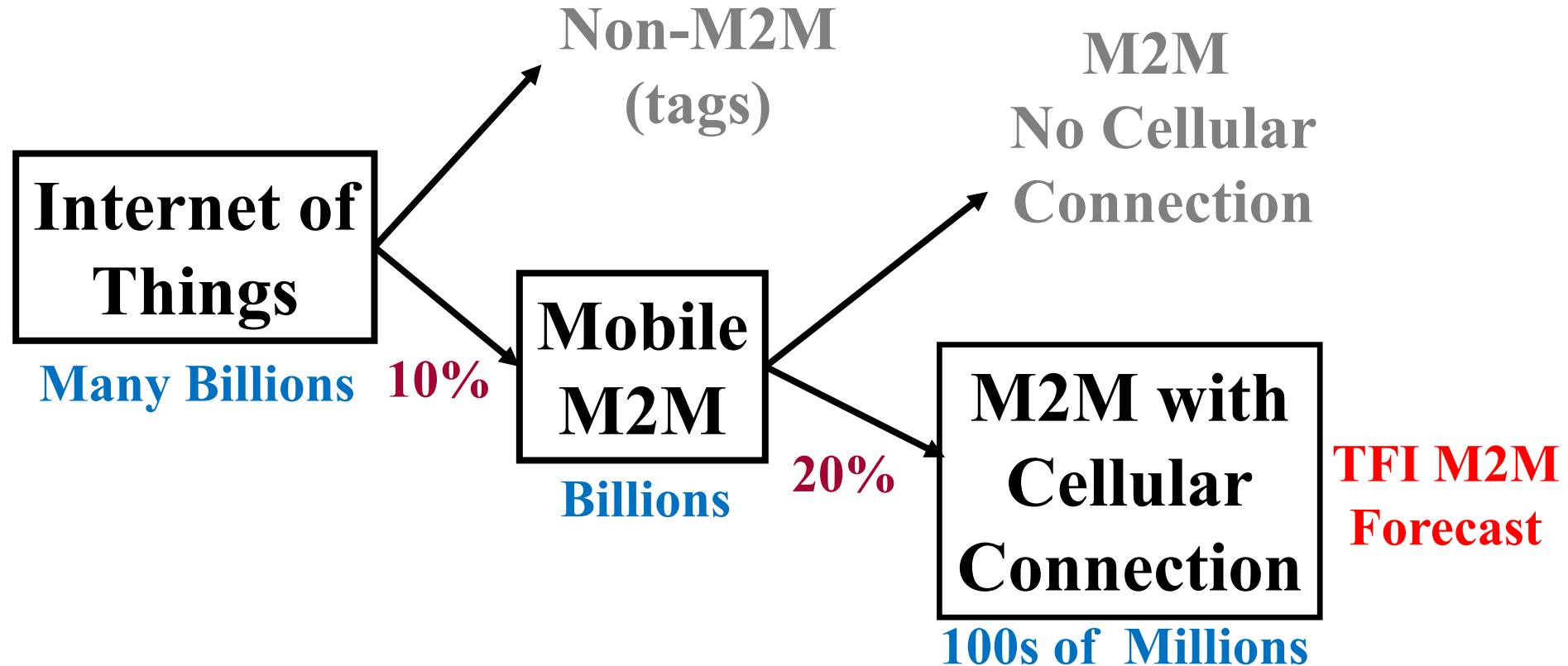


Historical Data Source:CTIA

Source: Technology Futures, Inc.

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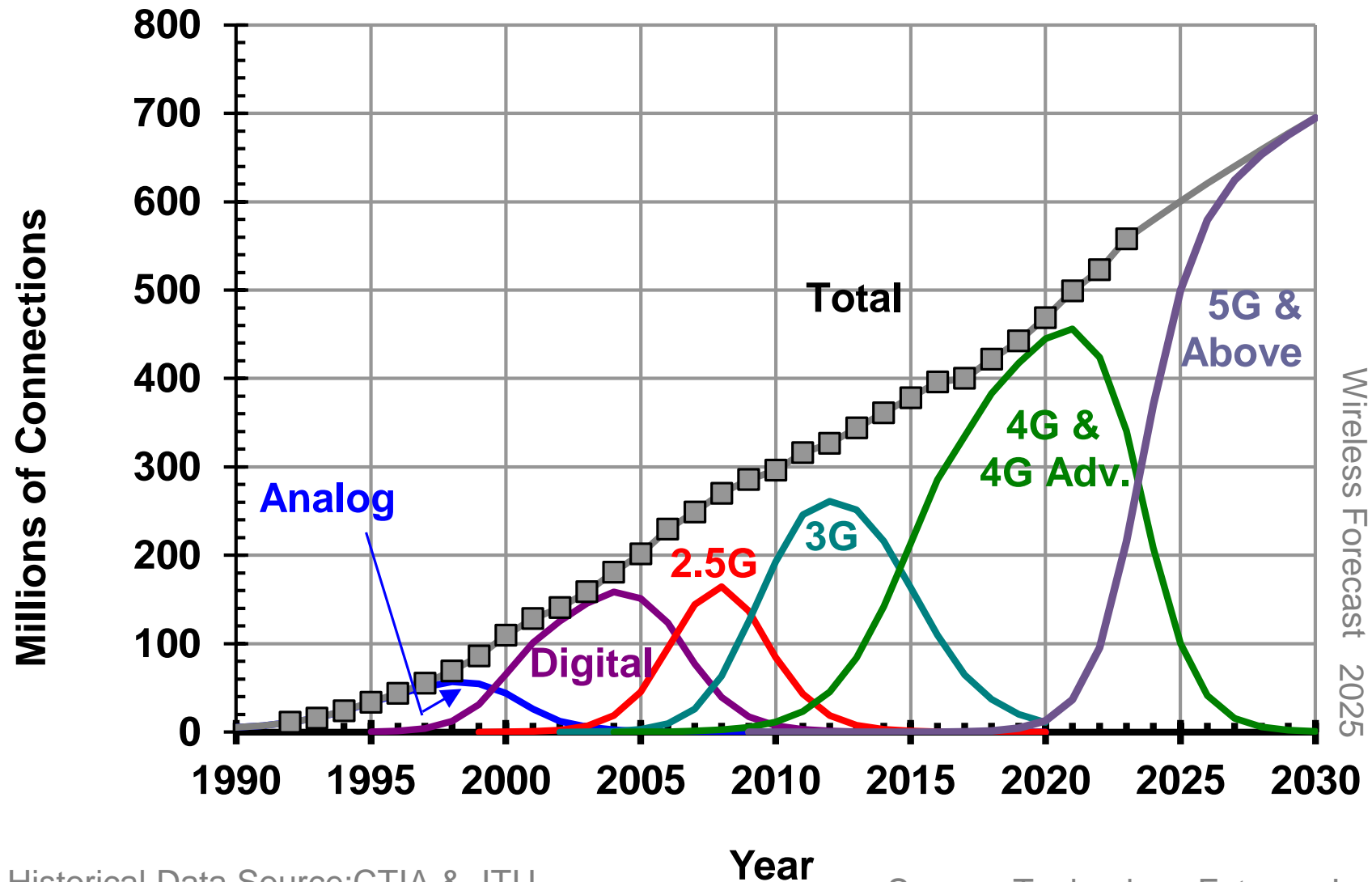
The IoT will include many items unconnected to the cellular network



Based on GSMA estimates

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Wireless Generations – 2025 TFI Forecast



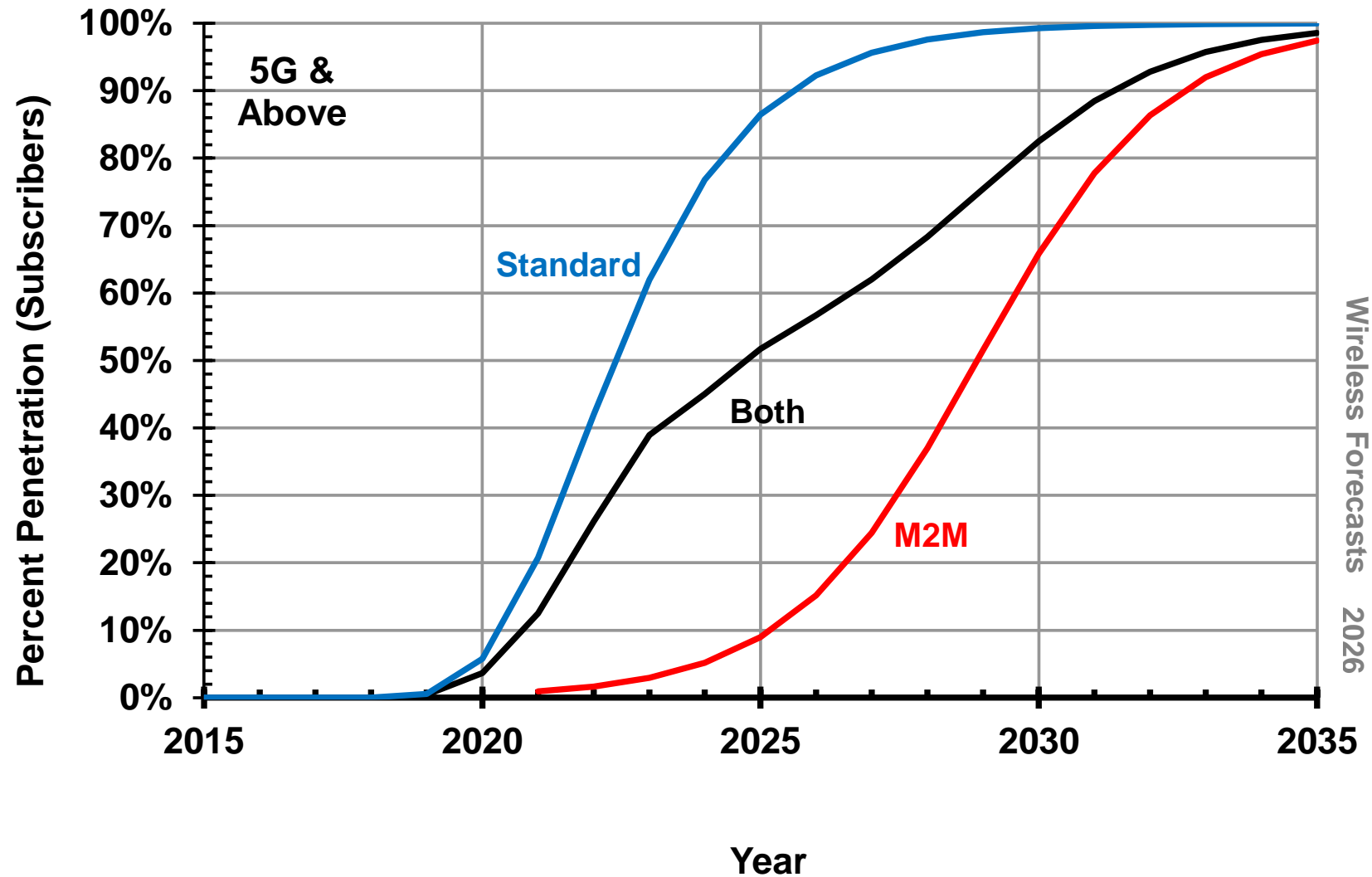
Historical Data Source: CTIA & ITU

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5G Adoption: Standard vs M2M



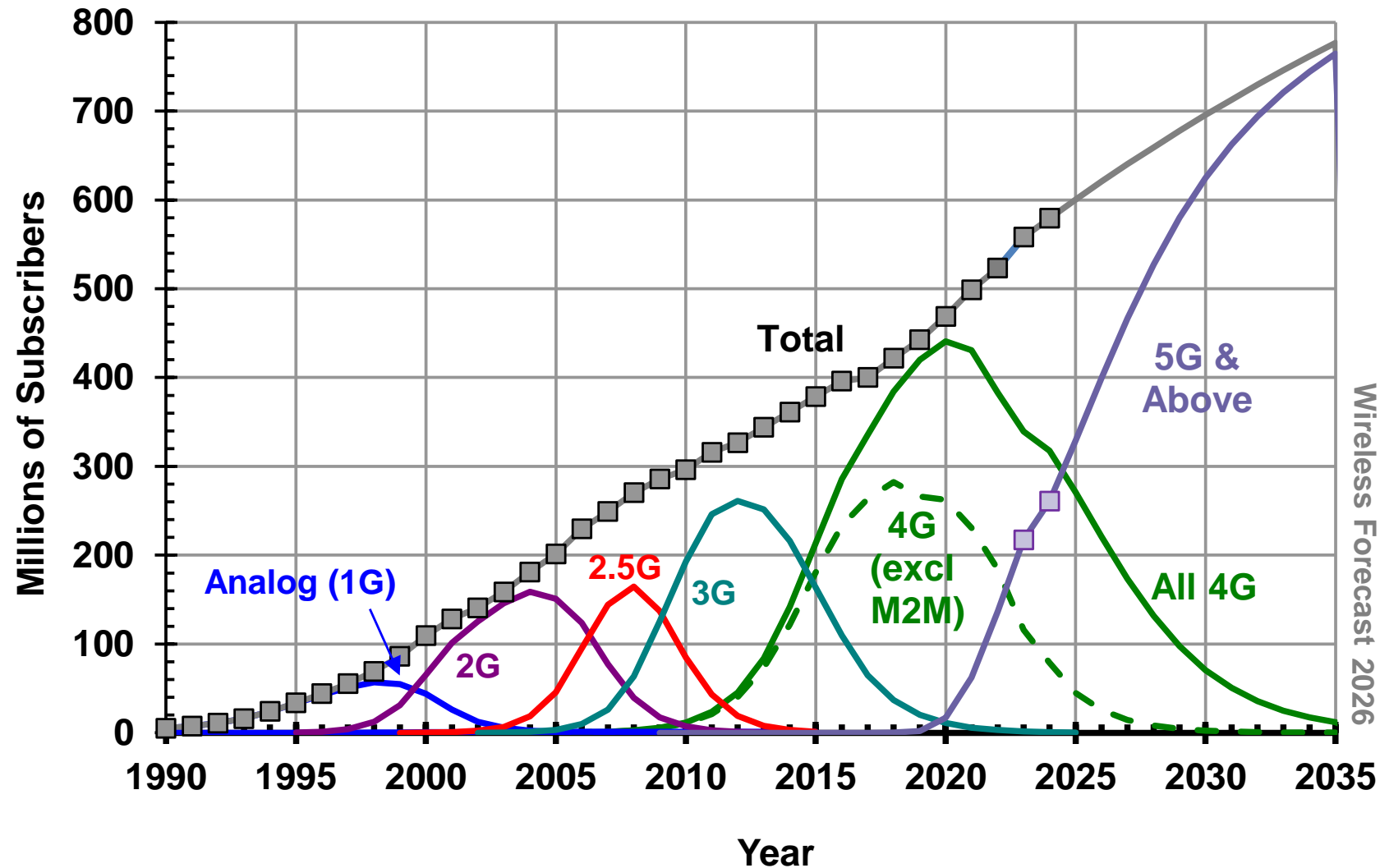
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Wireless Generations – 2026 TFI Forecast

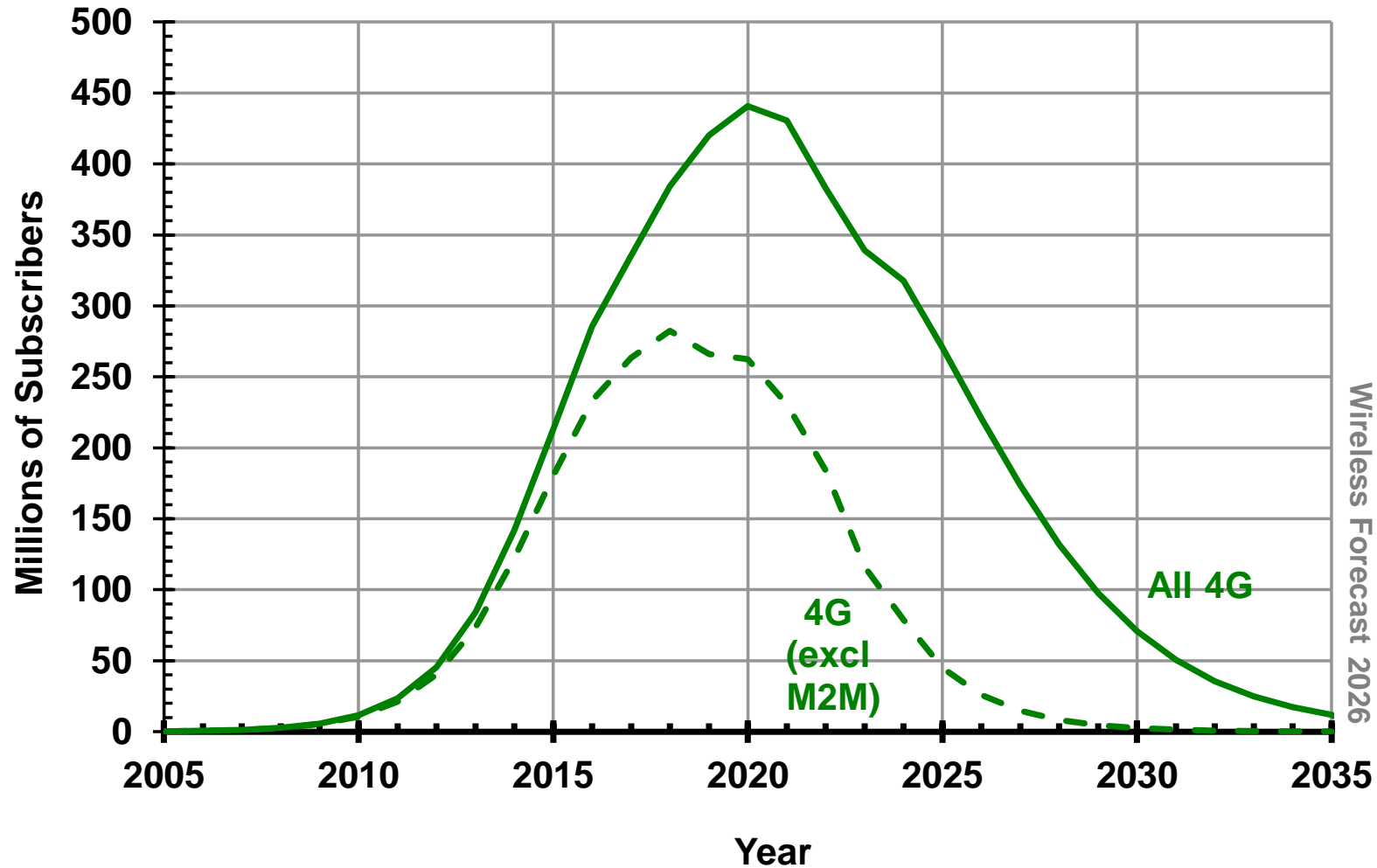


Historical Data Sources: CTIA, ITU

Source: Technology Futures, Inc.

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4G Generation Lifecycle Closeup

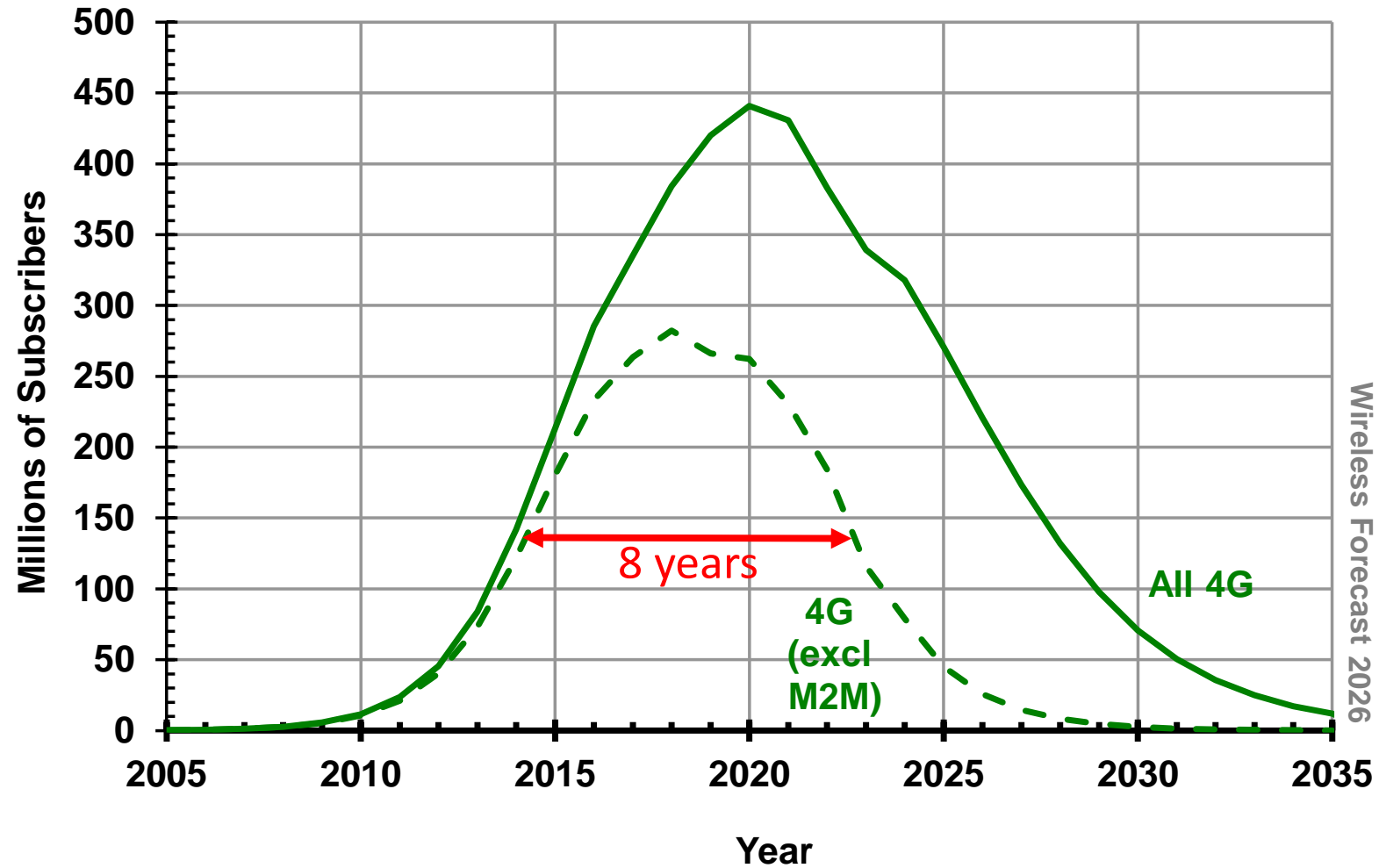


Historical Data Sources: CTIA, ITU

Source: Technology Futures, Inc.

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4G (Standard) Average Life



Wireless Forecast 2026

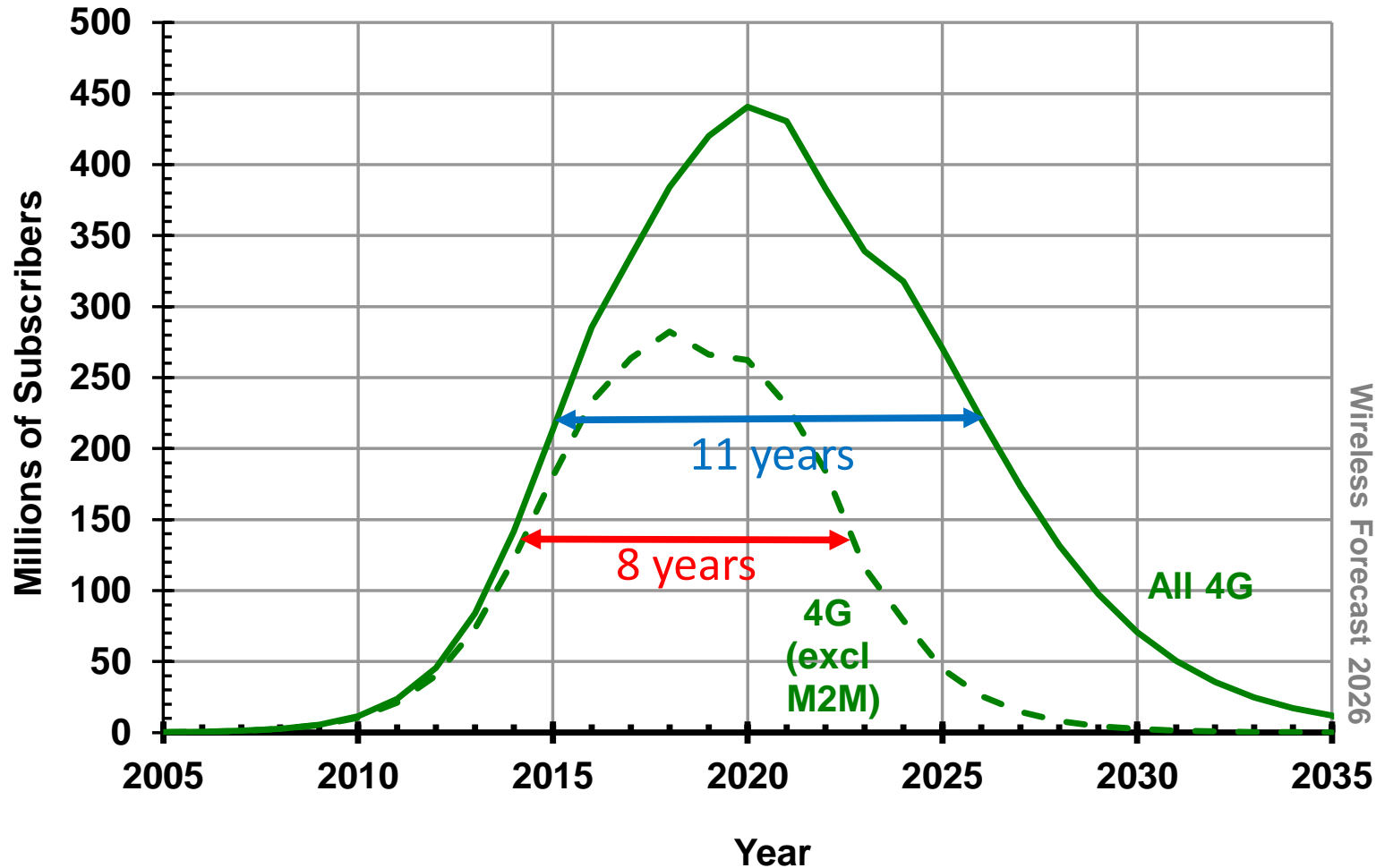
Historical Data Sources: CTIA, ITU

Source: Technology Futures, Inc.

8 years, or less
accounting for
Intra-Generational r
replacements

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All 4G (Standard & M2M) Average Life



11 years, or less
accounting for
Intra-Generational r
replacements

Historical Data Sources: CTIA, ITU

Source: Technology Futures, Inc.

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Implications for Wireless Providers

- Continued appetite for more bandwidth and performance
- Now seriously competing with wireline broadband in some cases
- More focus on M2M
- Continued investment in new technology

Overall Industry Assessment

- Continued increases in demand for bandwidth and higher performance with shift in emphasis on reliability, quality, and upstream
- Continued delivery of those increases at least through current cycle
- Continued investment in technology to make them happen
- All in a highly competitive environment
- And still central to our future!

A stylized graphic of a bridge with two arches, rendered in light blue and pink lines, serving as a background for the main text.

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