



THE
GIGABIT ISLAND
PLAN

PUERTO RICO
BROADBAND STRATEGIC
ASSESSMENT
February 2015



The Gigabit Island Plan is a project of the Puerto Rico Broadband Taskforce, a public-private partnership of broadband stakeholders whose mission is to help define and implement policies to accelerate growth in broadband access and expand citizen adoption and use of online resources to improve the lives and economic opportunities of all Puerto Ricans.

Key partners of the Puerto Rico Broadband Taskforce in this project include:



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Oficina del Principal Ejecutivo
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Office of the Chief Information Officer of
Puerto Rico/Oficina del Principal Ejecutivo de Informática



Puerto Rico Telecommunications
Regulatory Board/Junta Reglamentadora de
Telecomunicaciones



Puerto Rico Internet Society



Other collaborators include:

Senator Ramón Luis Nieves
Senator José Nadal Powers

Puerto Rico Department of Education/
Departamento de Educación
Puerto Rico Institute of Statistics/Instituto de
Estadísticas

Puerto Rico Planning Board/Junta de Planificación
Puerto Rico Sewer and Aqueducts Authority/
Autoridad de Acueductos y Alcantarillado

Puerto Rico broadband providers include:

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AT&T Mobility, LLC
Ayustar Corporation
CoquiTel, LLC
Critical Hub Networks
Data @cess Communications
Hughes Network Systems, LLC
INTECO
IP Solutions
Liberty Cablevision of Puerto Rico, LLC
Neptuno Media, Inc.

PR Wi-Fi
PR Wireless, Inc.
PREPA Networks, LLC
Puerto Rico Cable Acquisition Company, Inc.
Puerto Rico Telephone Company Inc., Claro
Skycasters
Spacenet, Inc.
Sprint Nextel Corporation
T-Mobile USA, Inc.
Worldnet Telecommunications Inc.
XAirNet Corp.

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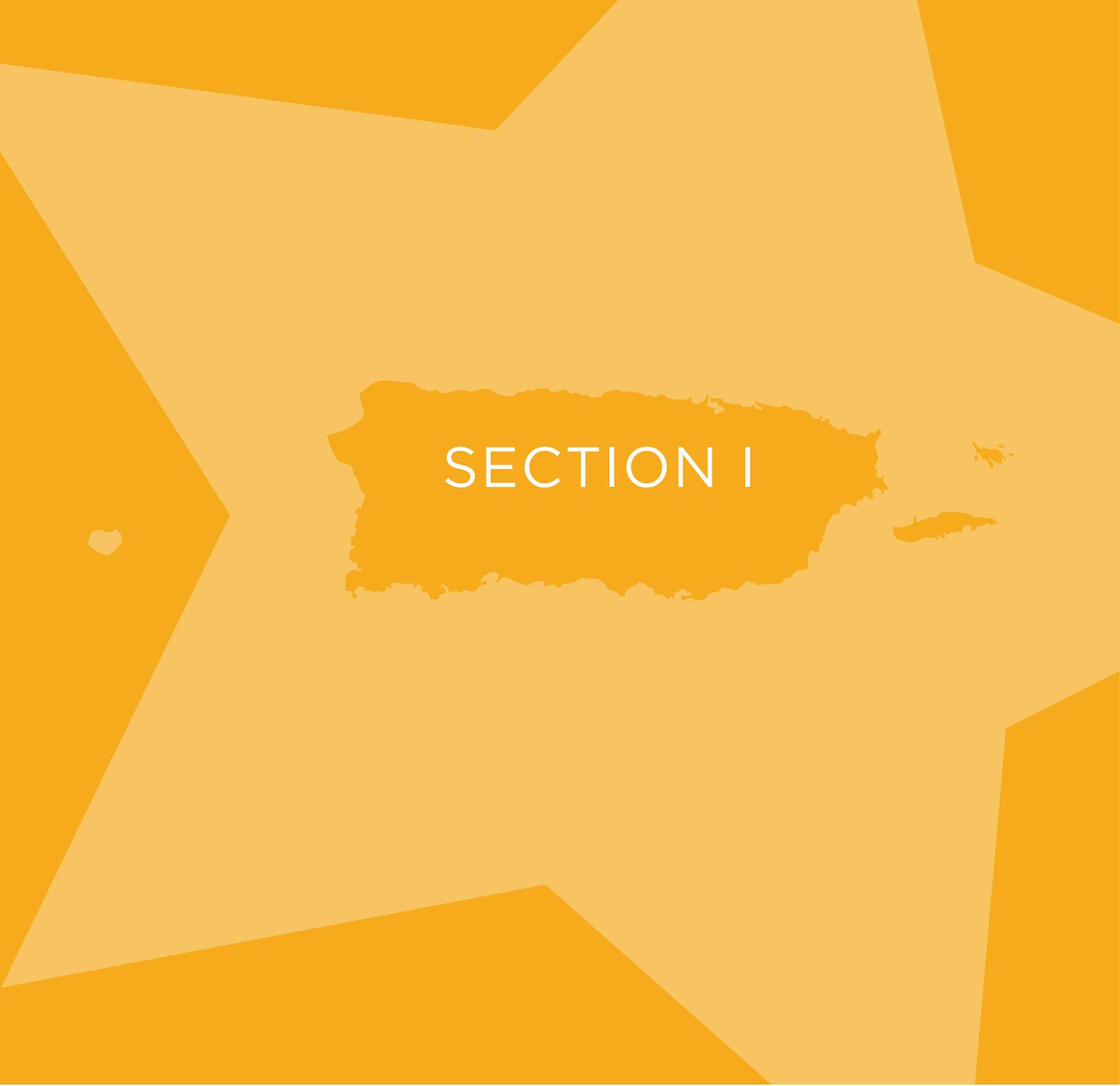
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SECTION I

INTRODUCTION



In 2012, the Puerto Rico Broadband Taskforce, working with nonprofit organization Connect Puerto Rico, unveiled the first-ever Puerto Rico Broadband Strategic Plan.¹ This groundbreaking plan aimed to assess the digital divide in Puerto Rico and formulate a series of recommendations regarding twenty-first century technology infrastructure and broadband adoption opportunities to strengthen the economy, increase access to healthcare, and enhance education via technology in Puerto Rico.

To achieve this vision, the Plan set 25 strategic goals for access, adoption, and use of broadband in Puerto Rico, and recommended 40 specific policy strategies aimed at achieving those goals on the Island.

Public and private stakeholders throughout Puerto Rico took note. Since the release of the 2012 Plan, investment in broadband capacity expansion has steadily increased. As of June 2014, 78% of Puerto Rico households had broadband service available at download speeds of 10 Mbps or higher, a sizeable increase from less than 25% of households in 2011. Additionally, 53% of households in Puerto Rico have broadband available at download speeds of 100 Mbps - a percentage that was zero just 4 years earlier. This significant infrastructure build-out demonstrates the evolving demand for broadband market growth.²

According to the Puerto Rico Planning Board (Junta de Planificación) Strategic Plan for the Information sector in Puerto Rico, the Information sector has experienced an annual growth rate of 3.8% in Puerto Rico and accounted for \$2.6 billion (2.5%) of Puerto Rico's Gross Domestic Product in 2013, surpassing other major industries such as construction, which accounted for \$1.381 billion of the Island's 2013 GDP.³

Yet, the 2012 Broadband Strategic Plan was only a step toward expanding broadband access, adoption, and use on the Island. As the Plan explained, "this process will not happen overnight and will require waves of reform, coordination, and adjustment across multiple agencies and functions of government, and the private sector. As such, this Broadband Strategic Plan - the first one of its kind for Puerto Rico - should be understood as the beginning of a dialogue and action plan, not the end."⁴

Learning from this recent expansion, the present analysis aims to continue moving the broadband capacity goals for Puerto Rico forward and sets new goals that provide Puerto Rico residents, businesses, and public institutions with access to broadband speeds of 1 gigabit per second - **THE GIGABIT ISLAND.**



WHY SHOULD PUERTO RICO BECOME A GIGABIT ISLAND?

The National Broadband Plan unveiled by the Federal Communications Commission (FCC) in March 2010, provided a detailed strategy for maximizing the use of broadband to advance national purposes ranging from consumer welfare, civic participation, economic development, private sector investment, and others.⁵ The National Broadband Plan's fourth long-term goal provided that "every American community should have affordable access to at least 1 gigabit per second broadband service to anchor institutions such as schools, hospitals, and government buildings."⁶ In early 2013, the FCC expanded this call to action by challenging broadband providers as well as state and municipal community leaders to work together to meet a "Gigabit City Challenge" of at least one gigabit community in all 50 states by 2015.⁷

"... [S]uper-fast, high-capacity, ubiquitous broadband networks delivering speeds measured in gigabits, not megabits, isn't just a matter of consumer convenience, as important as that is. It's essential to economic growth, job creation and ... competitiveness."

- Forbes

Gigabit communities are defined as "the roll out of [fiber-to-the-home] infrastructure that can provide broadband subscribers with access to gigabit speeds."⁸ Gigabit-per-second connectivity is approximately 100 times faster than the average fixed high-speed Internet connection.⁹ At stake, however, is not just the ability to obtain and share information seamlessly and instantly, but the ventures and possibilities that this connectivity will unleash.



Despite the nascent nature of gigabit communities and the technology clusters that emanate from this hyper-capacity, available research suggests that the economic impact of gigabit connectivity is substantial and widespread:

- U.S. cities with gigabit fiber connections report 1.1% higher per-capita GDP than cities that lack such Internet speeds; in monetary terms, this suggests that communities with gigabit fiber networks experience approximately \$1.4 billion in additional GDP.¹⁰
- Homes with fiber access increase in value about five times the cost of connecting the home to the fiber network.¹¹
- Survey data indicates that buyers are willing to pay a two percent premium when purchasing a home or condominium if it is connected to fiber; renters are willing to pay up to a fifteen percent premium.¹²

In today's digital economy in which talent and capital can be recruited from and delivered to any location, the "[a]vailability of next generation broadband has risen dramatically in eyes of economic development professionals for what is required to

attract new business."¹³ Widespread gigabit connectivity can help solidify Puerto Rico's citizens' and organizations' ongoing participation in the worldwide knowledge economy in which value is generated through innovation in information and services,¹⁴ and competition on a global scale.

"Providers and governments around the world all agree that unlocking the potential of broadband requires taking optical fiber all the way to subscribers' doors. Everyone also agrees that fiber will meet the world's needs for the foreseeable future. The only debates involve the speed of the transition."

-Broadband Communities



The 2012 Puerto Rico Broadband Strategic Plan established this vision.

Puerto Rico needs broadband access that is fast, robust, redundant, and ubiquitous to meet the economic challenges of the twenty-first century, ensure continued competitiveness of our business community, help contain the cost of government and social services, and ensure that all Puerto Ricans continue to partake in the social discourse that is increasingly taking place online.

A robust twenty-first century Island-wide broadband infrastructure is essential, in both urban and rural areas and across higher and lower income communities . . . The networks that support broadband service and connectivity across the Island will stand as a barrier to twenty-first century growth and competitiveness if they are inadequate to meet the capacity demanded by Puerto Rico's consumers and businesses. On the other hand, with a robust broadband infrastructure, there is nothing that prevents the establishment of Puerto Rico as a key target of direct foreign investment and as the central point of broadband and information economy commerce for the Caribbean and the Southern Hemisphere.¹⁵

The same holds true two years later; however, the connectivity speeds to achieve these goals have increased significantly.

A Gigabit Community Cedar Falls, Iowa

Cedar Falls was one of the first communities in the U.S. to have ubiquitous fiber gigabit connectivity, as well as one of the first communities in the nation to become a certified Connected community as part of Connected Nation's Connected Community Engagement program. Cedar Falls' municipal utility, Cedar Falls Utility (CFU), was also among the nation's first providers to offer high-speed Internet service in 1996. In May 2013, CFU began offering gigabit service to every Cedar Falls home and business through a new citywide fiber optic network. This network upgrade required three years, during which time CFU invested not only in the framework for high-speed connectivity, but also in three separate pipelines to ensure consistent, reliable service.⁷⁹ Citing the need for economic growth and competition, in January 2015 President Barack Obama launched a national community broadband initiative during a speech in Cedar Falls. The initiative will focus various federal agencies and programs on the need to continually expand access to fast, high-quality broadband networks.⁸⁰



THE GIGABIT ISLAND GOALS

“Gigabit Island” status requires a policy framework that will encourage public and private investment in broadband capacity build-out and growth. To do so, the Gigabit Island Plan proposes the following goals:

- By 2018, 90% of Puerto Rico households will have broadband available at download speeds of 10 Mbps.
- By 2018, 50% of Puerto Rico households will have broadband available at download speeds of 1 Gbps.
- By 2020, 99% of Puerto Rico households will have broadband available at download speeds of 10 Mbps.
- By 2020, 70% of Puerto Rico households will have broadband available at download speeds of 1 Gbps.

These goals are in line with Puerto Rico economic development plans detailed by Governor Alejandro Garcia Padilla in his Agenda for Economic Revitalization, 2014-2018,¹⁶ and consistent with U.S. definitions and expectations for broadband growth. In December 2014, the FCC adopted new capacity standards for broadband networks that are built with support from the FCC’s Universal Service Fund (USF). Under the new rules, broadband networks benefiting from these subsidies must meet speeds of at least 10 Mbps download and 1 Mbps upload, significantly upgrading the previous standard of 4 Mbps down/1 Mbps up. After consideration of current consumer broadband usage patterns and the proliferation of Internet users and connected devices, the FCC concluded that a connection of 10 Mbps download speeds is necessary to meet the demand of a three-user household with moderate broadband usage patterns.¹⁷

This Plan outlines a strategy for public and private stakeholders to work together to make this vision of a Gigabit Island possible. The Plan places particular focus on three key developments affecting growth in the Puerto Rico broadband market:

1. factors affecting investment in broadband build-out;
2. expansion of broadband adoption and evolution of use among Puerto Ricans; and
3. the role of high-speed broadband in the twenty-first century education sector.

A Gigabit Community Chattanooga, Tennessee

Chattanooga’s fiber-optic network was first developed in 1996 when the city’s Electric Power Board (EPB) authorized the first phase build-out of a communications network to connect electrical assets.⁸¹ Underutilized for its initial years, in 2007 the Board approved a plan to use the network for fiber-to-the-home services. The following year the city granted EPB a franchise to achieve this purpose, and in 2010, Chattanooga launched its gigabit broadband network.⁸² Rebranding itself “the gig city,”⁸³ gigabit service is now available to 170,000 educational facilities, residences, and businesses, equating to 600 square miles and several hundred thousand people.⁸⁴ Chattanooga credits its gigabit fiber network with helping attract corporations such as Amazon and Volkswagen to the area and creating more than 3,700 jobs.⁸⁵



Focusing on these areas, the Plan analyzes trends in the Puerto Rico broadband market over the last four years, evaluates the evolution of key policy strategies outlined in the 2012 Puerto Rico Broadband Strategic Plan, and establishes new broadband goals and strategic policies that will help achieve the Gigabit Island vision.

What Does Gigabit Connectivity Enable?

According to Google Fiber, gigabit capability enables consumers and businesses to stream high-definition videos, movies, and television shows with little to no delays or buffering; experience an improved online experience, even when multiple devices (e.g., smartphones, computers, gaming systems, televisions, and more) and users connect to the network simultaneously; videoconference through sites such as Skype and Google Hangouts; download files, images, and videos in only seconds; and more.⁸⁶ Specifically, users of a gigabit per second connection can:

- Stream—without buffering—at least 5 high-definition videos (1080p) at the same time and still have enough bandwidth to e-mail and surf the web.
- Transfer data over the Internet faster than writing data to a thumb drive.
- Download data as fast as many computers can save the data to a hard drive.
- Download an entire digital movie (14 GB) in a little less than 2 minutes.⁸⁷

However, the benefits of gigabit connectivity expand far beyond the individual user.

- U.S. cities with gigabit fiber connections report 1.1% higher per-capita GDP than cities that lack such Internet speeds; in monetary terms, this suggests that communities with gigabit fiber networks experience approximately \$1.4 billion in additional GDP.⁸⁸
- Responding to economic growth, research demonstrates that homes with fiber access increase in value about five times the cost of connecting the home to the fiber network.⁸⁹
- Similarly, survey data indicates that buyers are willing to pay a 2% premium when purchasing a home or condominium if it is connected to fiber; similarly, renters are willing to pay up to a 15% premium.⁹⁰



1. Puerto Rico Broadband Strategic Plan, May 2012 (“Strategic Plan” or “Broadband Strategic Plan”). http://www.connectednation.org/sites/default/files/bb_pp/pr_bb_plan_final.pdf.
2. See availability estimates in this report.
3. Puerto Rico Junta de Planificacion, Strategic Plan 2014. http://gis.jp.pr.gov/Externo_Econ/PDE2014/Chapter06%20Information%20Sector.pdf.
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7. FCC Chairman Genachowski Issues Gigabit City Challenge, January 2013, <http://www.fcc.gov/document/fcc-chairman-genachowski-issues-gigabit-city-challenge>.
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10. Brian Fung, Study: Cities with super fast Internet speeds are more productive, The Washington Post, September 2014, <http://www.washingtonpost.com/blogs/the-switch/wp/2014/09/18/study-cities-with-super-fast-internet-speeds-are-more-productive/>; see also Sean Buckley, 1 Gbps-enabled communities have higher GDP, says FTTH Council study, FierceTelecom, Sept. 18, 2014, http://www.fiercetelecom.com/story/1-gbps-enabled-communities-have-higher-gdp-says-ftth-council-study/2014-09-18?utm_medium=nl&utm_source=internal.
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13. Remarks of Blair Levin, Executive Director, Gig.U, Sept. 15, 2014, <http://www.gig-u.org/blog/blair-levins-remarks-on-the-announcement-of-connecticut-cities-rfq-seeking-gigabit-speeds>.
14. “The general idea of an ‘information economy’ includes both the notion of industries primarily producing, processing, and distributing information, as well as the idea that every industry is using available information and information technology to reorganize and make themselves more productive.” http://gis.jp.pr.gov/Externo_Econ/PDE2014/Chapter06%20Information%20Sector.pdf.
15. 2012 Puerto Rico Broadband Strategic Plan, p. 86.
16. Agenda para la Recuperación Económica, 2014-2018, Estado Libre Asociado de Puerto Rico, April 2014, <http://www.fortaleza.pr.gov/sites/default/files/files/Agenda%20para%20la%20Recuperaci%C3%B3n%20Econ%C3%B3mica%202014-2018.pdf>.
17. FCC Increases Rural Broadband Speeds Under Connect America Fund, Press Notice, Dec. 11, 2014, <http://www.fcc.gov/document/fcc-increases-rural-broadband-speeds-under-connect-america-fund>.

A stylized map of Puerto Rico is centered on the page. The map is rendered in a dark green color with a torn-paper edge effect. The text "SECTION II" is written in white, uppercase letters across the middle of the map. The background of the entire page is a light green color with several large, dark green geometric shapes (triangles and polygons) scattered across it.

SECTION II

PUERTO RICO
BROADBAND
INFRASTRUCTURE
2011-2014



This section analyzes the most current broadband inventory across Puerto Rico and identifies broadband infrastructure gaps at various connection speeds across the Island. The broadband inventory is based on data collected by Connect Puerto Rico, a nonprofit organization working on behalf of the Office of the Chief Information Officer of the Government of Puerto Rico (OCIO), as part of the State Broadband Initiative (SBI) federal grant program. Since 2010, this federal effort has been implemented in partnership with U.S. states and territories to collect and submit data to the Department of Commerce on a bi-annual basis for incorporation into the National Broadband Map. Funding for this program was made available through the American Recovery and Reinvestment Act. The interactive map and additional broadband data can be found at www.connectpr.org.

Based on this data, this section examines the growth of broadband capacity across the Island from 2011 to 2014, and benchmarks the current state of broadband against the Puerto Rico Broadband Taskforce capacity goals set for 2015. Further, the section examines broadband market trends, focusing in particular on investment and revenue streams within the sector and the remaining gap(s) that Puerto Rico must address in order to become the Gigabit Island.

ISLANDWIDE BROADBAND INFRASTRUCTURE

The National Broadband Plan released in 2010 recommended that all Americans have access to minimum broadband speeds of 4 Mbps download and 1 Mbps upload.¹⁸ The speed tier collected under the SBI initiative and NTIA guidelines nearest to that is 3 Mbps download and 768 Kbps upload.

As seen in the following table, 90.8% of households across the Island have access to 3 Mbps download and 768 Kbps upload as of June 2014. However, that leaves approximately 125,000 households in Puerto Rico without access to the 3 Mbps download/768 Kbps upload speed tier.



Broadband Availability by Speed Tier Among Fixed Platforms*

Minimum Down / Up Speed	% Households Served**			
	2011	2012	2013	2014
At Least 768 Kbps/200 Kbps	85.2	85.8	89.4	90.9
At Least 1.5 Mbps/200 Kbps	84.4	85.0	89.1	90.8
At Least 3 Mbps/768 Kbps	77.8	85.0	89.1	90.8
At Least 6 Mbps/1.5 Mbps	33.1	56.4	77.3	79.7
At Least 10 Mbps/1.5 Mbps	24.5	49.0	77.1	77.9
At Least 25 Mbps/1.5 Mbps	0	49.0	77.1	77.9
At Least 50 Mbps/1.5 Mbps	0	24.3	24.3	76.9
At Least 100 Mbps/1.5 Mbps	0	0.3	0.3	52.9
At Least 1 Gbps/1.5 Mbps	0	0.0	0.0	0.0

Source: Connect Puerto Rico.

*Inventory estimate as of June 30 each year. Broadband platforms include cable, DSL, fixed wireless, and fiber. Mobile broadband platform is excluded.

** Total households based on 2010 Census data of 1,373,000.

The following table displays estimates regarding the percentage of households across Puerto Rico having broadband available at the 3 Mbps download and 768 Kbps upload speed tier or greater by broadband platform type, followed by a broadband inventory map of advertised speeds of at least 3 Mbps download and 768 Kbps upload.

Broadband Availability by Broadband Platform*

Platform	% of Households Served at \geq 3 Mbps Down / 768 Kbps Up			
	2011	2012	2013	2014
Cable	61.3	77.9	76.9	77.0
DSL	N/A	62.6	65.0	67.1
Fiber**	0.0	0.3	0.3	0.1
Fixed Wireless	25.2	31.7	49.9	58.0
All Platforms Except Mobile	56.9	85.0	89.1	90.9
Mobile Wireless	98.9	99.7	99.8	99.9
All Platforms	99.0	99.8	99.8	99.9

Source: Connect Puerto Rico.

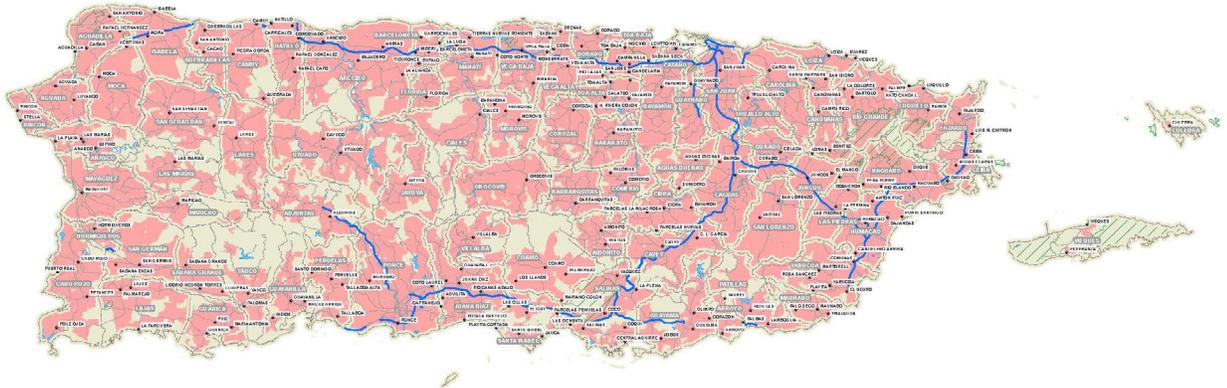
* Inventory estimate as of June 30 each year.

** The reported reduction in Fiber to the Home (FTTH) estimate does not reflect a decrease in fiber infrastructure but rather a nuanced interpretation of broadband availability estimates based on federal guidelines set by the U.S. Department of Commerce. According to these rules, broadband service is deemed "available" if service can be activated within 7 to 10 business days following a customer request without an extraordinary commitment of resources. Due to business models chosen by some providers laying FTTH in Puerto Rico, plans for build-out included in earlier versions of the Puerto Rico broadband inventory have been removed until such networks are actually constructed.

PUERTO RICO BROADBAND INFRASTRUCTURE 2011-2014

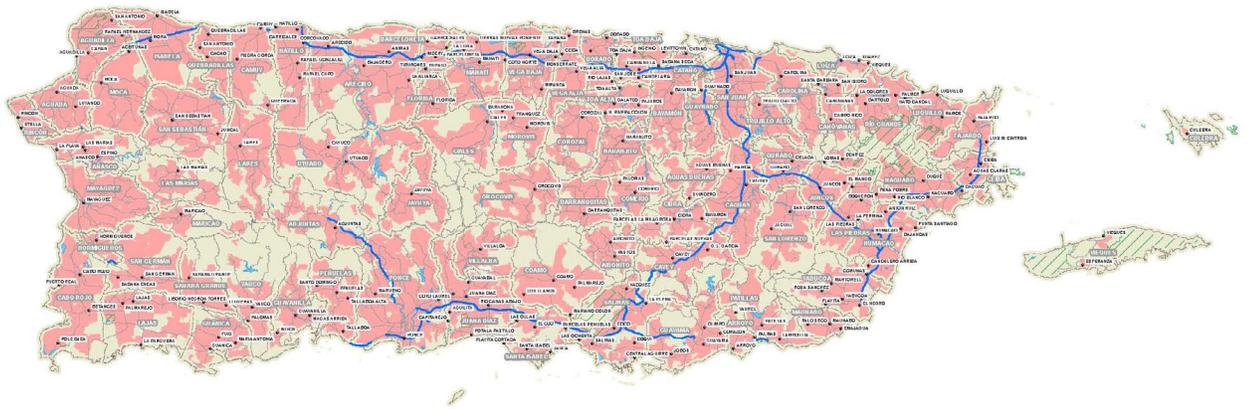


BROADBAND INVENTORY - ADVERTISED SPEED OF AT LEAST 3 MBPS DOWN / 768 KBPS UP - JUNE 2014



The following map displays the broadband inventory of advertised speeds of at least 10 Mbps download and 1.5 Mbps upload. The served areas in pink cover 78% of all households in Puerto Rico.

BROADBAND INVENTORY - ADVERTISED SPEED OF AT LEAST 10 MBPS DOWN / 1.5 MBPS UP - JUNE 2014



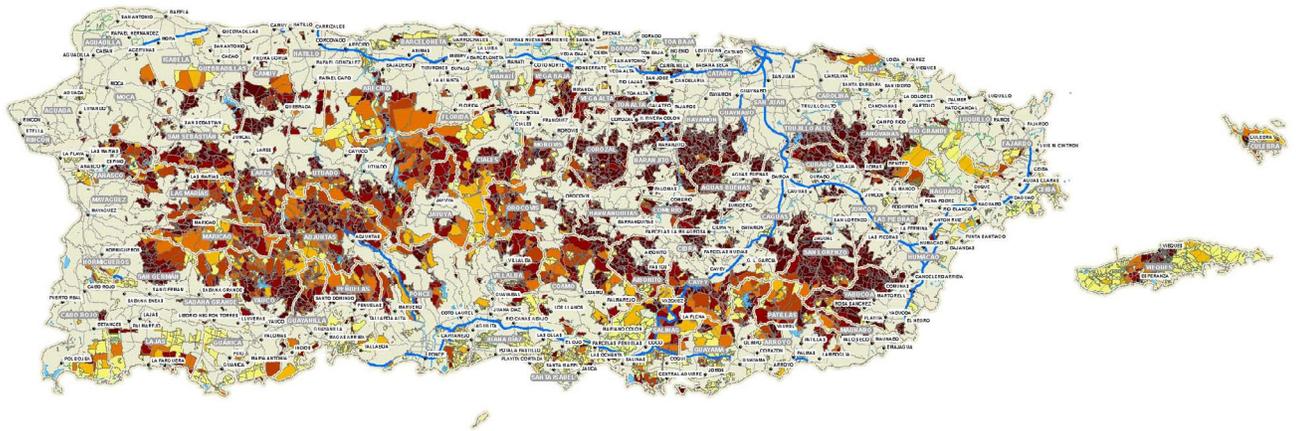
Symbology

- City
- Primary Road
- Municipality Boundary
- Water
- National Lands
- Terrestrial, Non-Mobile Broadband Service
- Unserved Areas



To further demonstrate the impact of broadband inventory of at least 10 Mbps Down/ 1 Mbps Up, the following map shows the areas unserved at these levels. The shaded areas represent unserved census blocks with the deeper colors indicating more densely populated areas as clarified in the legend.

UNSERVED AREAS - AREAS WITHOUT BROADBAND OF AT LEAST 10 MBPS DOWN / 1.5 MBPS UP



Symbology

- City
 - Primary Road
 - Secondary Road
 - Municipality Boundary
 - Water
 - National Lands
- | | |
|---|---------------------|
| Number of Unserved Households per Square Mile, per Census Block | 0.06 - 8.49 |
| 85.5+ | 0 - 0.05 |
| 40.50 - 85.49 | Broadband Available |
| 20.50 - 40.49 | |
| 8.50 - 20.49 | |

Currently, 77.9% of households across Puerto Rico have access to speeds of at least 10 Mbps download and 1.5 Mbps upload. Sixty-six percent of rural households on the Island have access to speeds of at least 10 Mbps download and 1.5 Mbps upload. Urban areas, however, have expectations for faster speed offerings than rural areas. Given those expectations, 98.9% of urban households have access to speeds of at least 25 Mbps download and 1.5 Mbps upload, and approximately 98.6% of urban households have access to speeds of at least 50 Mbps download and 1.5 Mbps upload.



Broadband Availability Across Rural and Urban Households**			
Down / Up Speed	% of Households Served*		
	Island-wide	Urban	Rural
At Least 3 Mbps/768 Kbps	90.77	99.99	85.20
At Least 6 Mbps/1.5 Mbps	79.73	99.65	68.13
At Least 10 Mbps/1.5 Mbps	77.87	98.87	65.96
At Least 25 Mbps/1.5 Mbps	77.87	98.87	65.95
At Least 50 Mbps/1.5 Mbps	76.90	98.60	64.84
At Least 100 Mbps/1.5 Mbps	52.90	81.18	36.29
At Least 1 Gbps/1.5 Mbps	0	0	0

Source: Connect Puerto Rico.

*Inventory estimate as of June 30 each year. Broadband platforms include cable, DSL, fixed wireless, and fiber. Mobile broadband platform is excluded.

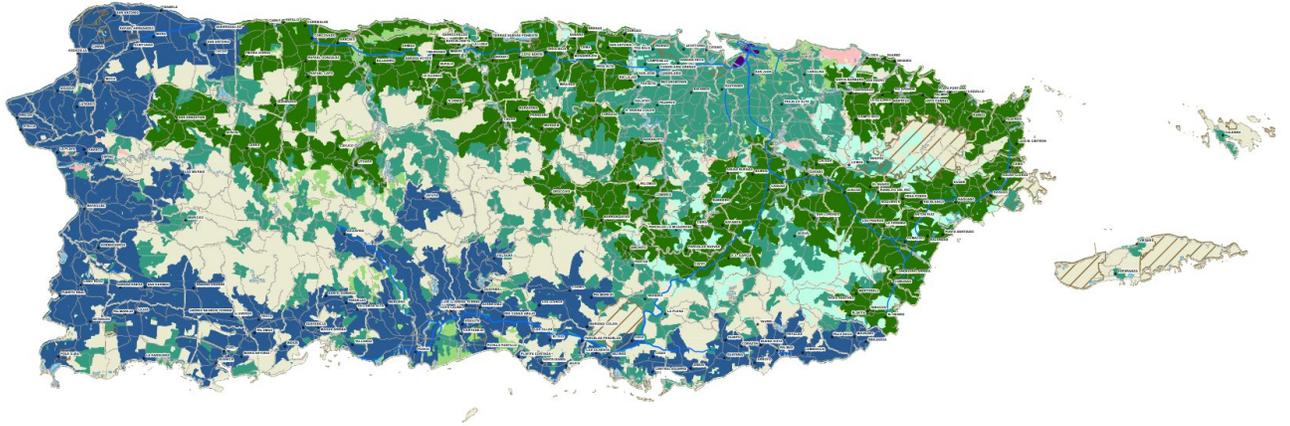
** Rural areas are defined as any area, as confirmed by the latest decennial census of the Bureau of the Census, which is not located within: (i) a city, town, or incorporated area that has a population of greater than 20,000 inhabitants; or (ii) an urbanized area contiguous and adjacent to a city or town that has a population of greater than 50,000 inhabitants. For purposes of the definition of rural area, an urbanized area means a densely populated territory as defined in the latest decennial census of the U.S. Census Bureau.

While important infrastructure gaps remain, particularly across rural areas of the Island, the 2014 broadband landscape demonstrates strong growth in broadband deployment across most urban and suburban areas over the last four years. The following maps demonstrate this investment from 2011-2014. The speed tiers represented in the mapping legend were established by the NTIA and reflect maximum advertised download speeds.

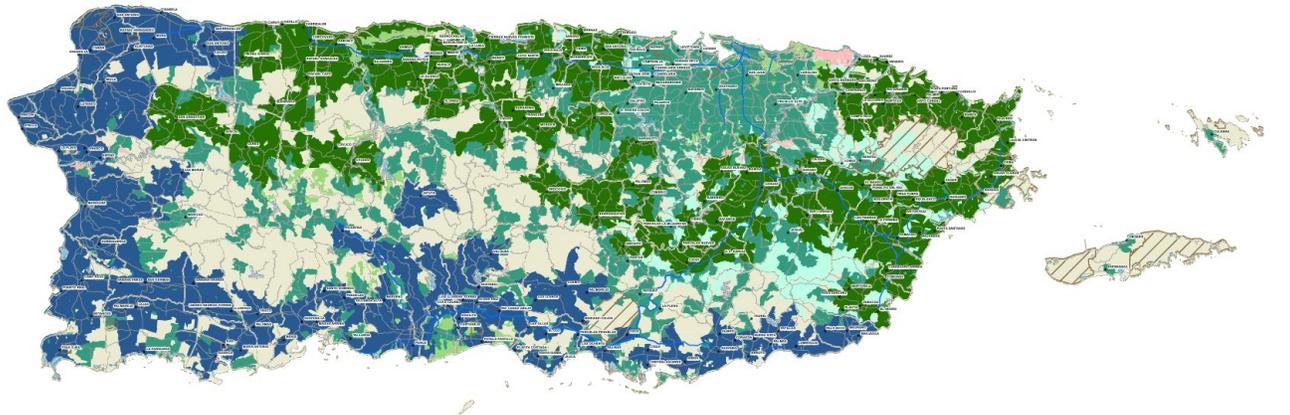


BROADBAND INVENTORY BY SPEED TIER 2011-2014

2011



2012

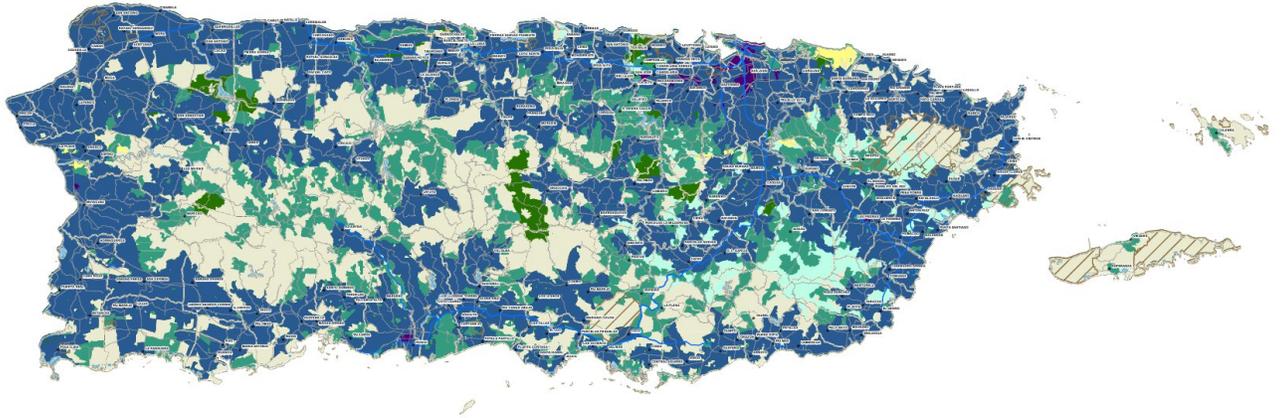


Symbology

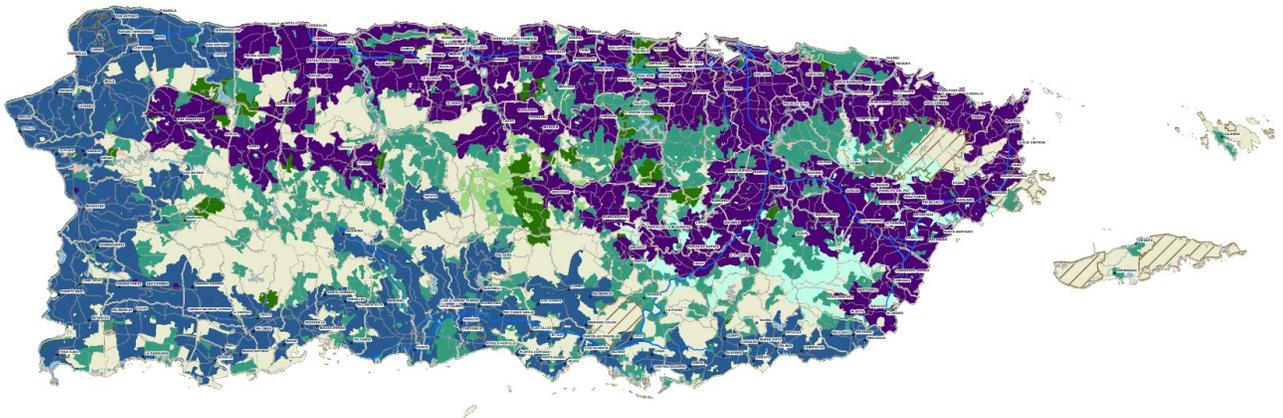
- City
- Primary Road
- Secondary Road
- Municipality Boundary
- Water
- National Lands
- Tier 10 (100 Mbps to < 1 Gbps)
- Tier 9 (50 Mbps to < 100 Mbps)
- Tier 8 (25 Mbps to < 50 Mbps)
- Tier 7 (10 Mbps to < 25 Mbps)
- Tier 6 (6 Mbps to < 10 Mbps)
- Tier 5 (3 Mbps to < 6 Mbps)
- Tier 4 (1.5 Mbps to < 3 Mbps)
- Tier 3 (768 Kbps to < 1.5 Mbps)
- Unserviced Areas



2013



2014



Symbology

- City
- Primary Road
- Secondary Road
- Municipality Boundary
- Water
- National Lands
- Tier 10 (100 Mbps to < 1 Gbps)
- Tier 9 (50 Mbps to < 100 Mbps)
- Tier 8 (25 Mbps to < 50 Mbps)
- Tier 7 (10 Mbps to < 25 Mbps)
- Tier 6 (6 Mbps to < 10 Mbps)
- Tier 5 (3 Mbps to < 6 Mbps)
- Tier 4 (1.5 Mbps to < 3 Mbps)
- Tier 3 (768 Kbps to < 1.5 Mbps)
- Unserved Areas



As reflected in the map of broadband availability at speeds of 50 Mbps download/ 1.5 Mbps upload, below, this growth is the result of an aggressive capacity upgrade of cable networks, as well as deployment of fiber by other broadband providers. Broadband capacity is expected to grow across Puerto Rico as commercial and public enterprises develop business models to deploy fiber-to-the-home (FTTH). Some of such projects are described in detail below.

BROADBAND INVENTORY BY PLATFORM - ADVERTISED SPEED OF AT LEAST 50 MBPS DOWN / 1.5 MBPS UP - JUNE 2014



Symbology

- City
- Primary Road
- Secondary Road
- Municipality Boundary
- Water
- National Lands
- Fiber Broadband Available
- Cable Broadband Available
- Unserved Areas



BROADBAND LANDSCAPE BY MUNICIPALITY

Broadband Availability by Municipality*				
Municipality	Household Density**	Number of Households	% of Households Served	
			At ≥ 3 Mbps Down / 768 Kbps Up	At ≥ 10 Mbps Down / 1.5 Mbps Up
Adjuntas	102.1	6,851	47.0	34.2
Aguada	332.8	15,156	94.4	92.3
Aguadilla	311.6	23,552	98.4	98.1
Aguas Buenas	333.6	10,040	75.4	31.5
Aibonito	298.9	9,367	63.4	40.6
Anasco	243.6	10,942	83.1	80.1
Arecibo	213.7	36,579	89.2	75.8
Arroyo	201.7	7,191	88.3	85.8
Barceloneta	296.5	9,165	94.6	90.4
Barranquitas	297.3	10,191	63.5	50.6
Bayamon	1726.1	76,834	98.1	89.1
Cabo Rojo	111.7	19,816	91.3	87.4
Caguas	901.9	53,273	99.1	77.2
Camuy	205.8	12,752	75.2	61.1
Canovanas	502.3	16,579	96.1	66.7
Carolina	1113.9	67,192	98.0	91.6
Catano	1434.9	10,108	99.9	65.5
Cayey	340.3	17,681	94.0	66.2
Ceiba	32.8	5,213	89.0	83.7
Ciales	97.2	6,487	59.0	38.5
Cidra	415.2	15,135	96.0	50.6
Coamo	183.0	14,281	72.6	68.8
Comerio	248.8	7,097	69.9	53.5
Corozal	292.3	12,446	73.2	43.3
Culebra	4.4	749	48.7	0.0
Dorado	248.4	13,342	99.3	81.2
Fajardo	132.2	13,922	89.9	89.4
Florida	295.2	4,494	78.8	66.3
Guanica	90.9	7,223	91.2	86.8
Guayama	152.1	16,244	87.0	82.3
Guayanilla	116.8	7,503	76.8	72.2
Guaynabo	1347.1	37,402	97.0	82.9
Gurabo	556.4	15,753	99.5	70.8
Hatillo	261.8	15,386	88.3	74.2
Hormigueros	601.3	6,821	97.0	93.3
Humacao	305.1	21,780	97.7	79.1
Isabela	185.9	17,072	91.5	91.0
Jayuya	125.1	5,569	64.4	55.9



Broadband Availability by Municipality*				
Municipality	Household Density**	Number of Households	% of Households Served	
			At ≥ 3 Mbps Down / 768 Kbps Up	At ≥ 10 Mbps Down / 1.5 Mbps Up
Juana Diaz	161.0	17,252	93.7	85.1
Juncos	540.4	14,382	100.0	75.8
Lajas	95.6	9,670	87.9	85.6
Lares	181.0	11,154	55.8	40.2
Las Marias	76.6	3,561	40.1	34.5
Las Piedras	414.8	14,058	100.0	62.3
Loiza	154.4	10,130	98.8	83.5
Luquillo	156.9	7,302	82.0	80.3
Manati	230.7	16,309	85.3	78.3
Maricao	62.5	2,289	33.6	0.2
Maunabo	116.2	4,446	76.1	63.2
Mayaguez	130.6	35,805	96.3	93.9
Moca	285.1	14,360	88.2	86.2
Morovis	279.0	10,859	79.8	67.5
Naguabo	135.0	9,755	97.9	73.0
Naranjito	366.3	10,163	80.1	34.0
Orocovis	122.5	7,812	83.4	37.1
Patillas	96.6	7,271	72.8	70.8
Penuelas	115.9	7,863	78.9	74.4
Ponce	310.2	60,049	96.8	90.4
Quebradillas	274.9	9,442	92.8	89.0
Rincon	110.2	5,998	87.8	84.2
Rio Grande	210.8	18,869	85.4	78.0
Sabana Grande	261.5	9,372	85.8	82.0
Salinas	99.9	11,400	89.2	73.9
San German	248.4	13,542	79.4	73.3
San Juan	2148.2	165,316	100.0	99.0
San Lorenzo	277.2	14,746	99.8	38.1
San Sebastian	225.3	16,047	59.0	48.9
Santa Isabel	106.9	8,225	90.8	82.1
Toa Alta	889.5	24,515	95.9	57.2
Toa Baja	780.2	32,617	99.9	79.5
Trujillo Alto	1259.7	26,935	98.0	77.8
Utua	103.3	11,885	64.6	42.8
Vega Alta	371.3	13,925	93.2	75.2
Vega Baja	312.9	21,335	88.9	74.5
Vieques	13.9	3,666	43.2	0.0
Villalba	226.1	8,373	71.5	63.2
Yabucoa	162.3	13,507	77.7	46.1
Yauco	220.0	15,138	73.0	72.1

Source: Connect Puerto Rico inventory estimate as of June 30, 2014.

*Includes cable, DSL, fixed wireless and fiber platforms. Excludes mobile platforms

**Household density = average households per square mile in Municipality.



Broadband Availability by Municipality by Technology Platform

Municipality	% of Households Served at ≥ 3 Mbps Down / 768 Kbps Up					
	Cable	DSL	Fiber	Fixed Wireless	Mobile Wireless	All Except Mobile
Adjuntas	34.13	37.32	0.00	2.95	99.72	46.98
Aguada	92.31	53.92	0.00	0.00	100.00	94.41
Aguadilla	98.07	73.01	0.00	0.00	100.00	98.35
Aguas Buenas	30.94	36.59	0.00	65.98	100.00	75.36
Aibonito	39.04	52.46	0.00	13.37	100.00	63.43
Anasco	79.29	62.26	0.00	0.00	100.00	83.08
Arecibo	72.35	65.35	0.00	65.66	99.99	89.17
Arroyo	85.84	46.18	0.00	0.01	100.00	88.26
Barceloneta	87.66	80.80	0.00	1.29	100.00	94.62
Barranquitas	50.58	23.70	0.00	19.80	100.00	63.52
Bayamon	88.83	87.98	1.97	96.55	100.00	98.05
Cabo Rojo	87.19	66.05	0.00	0.00	99.98	91.25
Caguas	75.43	73.60	0.50	98.66	100.00	99.07
Camuy	60.80	47.63	0.00	43.13	100.00	75.16
Canovanas	66.61	10.19	0.00	80.72	100.00	96.07
Carolina	91.23	74.07	0.00	97.27	100.00	97.97
Catano	65.52	96.76	0.00	99.85	99.99	99.89
Cayey	66.16	62.44	0.00	92.01	100.00	93.98
Ceiba	83.74	30.29	0.00	6.39	99.98	88.98
Ciales	38.24	49.68	0.00	2.49	99.79	59.02
Cidra	50.05	41.60	0.00	88.86	100.00	96.01
Coamo	68.34	63.17	0.00	0.03	99.50	72.55
Comerio	45.04	56.52	0.00	11.16	100.00	69.87
Corozal	42.54	49.65	0.00	38.83	100.00	73.15
Culebra	0.00	48.74	0.00	0.00	99.10	48.74
Dorado	80.13	75.58	0.00	94.59	100.00	99.34
Fajardo	89.34	33.05	2.10	0.04	99.68	89.87
Florida	65.08	74.50	0.00	0.00	100.00	78.80
Guanica	86.77	72.99	0.00	0.00	99.96	91.19
Guayama	82.13	81.74	0.00	0.65	99.84	86.97
Guayanilla	72.22	64.70	0.00	0.00	99.75	76.84
Guaynabo	82.83	75.72	0.00	94.40	100.00	96.96
Gurabo	70.76	59.66	0.00	99.22	100.00	99.47
Hatillo	74.12	54.54	0.00	74.30	100.00	88.29
Hormigueros	93.26	70.63	0.00	0.00	100.00	96.99
Humacao	79.10	59.38	0.00	94.16	99.97	97.71
Isabela	89.31	57.97	0.00	0.00	100.00	91.49
Jayuya	55.87	50.76	0.00	0.00	99.75	64.43
Juana Diaz	85.09	74.70	0.00	80.85	99.98	93.71



Broadband Availability by Municipality by Technology Platform						
Municipality	% of Households Served at ≥ 3 Mbps Down / 768 Kbps Up					
	Cable	DSL	Fiber	Fixed Wireless	Mobile Wireless	All Except Mobile
Juncos	75.29	59.95	0.00	100.00	100.00	100.00
Lajas	85.61	43.89	0.00	0.00	100.00	87.91
Lares	39.57	40.78	0.00	8.12	100.00	55.78
Las Marias	30.58	31.09	0.00	0.00	100.00	40.13
Las Piedras	62.27	50.24	0.00	99.95	100.00	99.95
Loiza	83.06	70.83	0.00	65.98	100.00	98.81
Luquillo	80.30	11.48	0.00	0.00	99.99	82.03
Manati	77.93	71.70	0.00	23.25	100.00	85.28
Maricao	0.13	33.43	0.00	0.00	99.93	33.56
Maunabo	63.21	58.02	0.00	2.16	99.74	76.14
Mayaguez	93.45	79.95	0.00	0.00	99.99	96.29
Moca	86.20	41.62	0.00	0.00	100.00	88.19
Morovis	65.12	62.58	0.00	12.17	100.00	79.82
Naguabo	73.03	41.91	0.00	89.49	99.74	97.90
Naranjito	27.54	41.23	0.00	61.44	100.00	80.07
Orocovis	29.68	30.56	0.00	75.20	96.93	83.35
Patillas	70.82	25.95	0.00	0.95	96.04	72.79
Penuelas	74.39	60.60	0.00	1.47	99.98	78.88
Ponce	90.08	86.90	0.66	82.59	100.00	96.82
Quebradillas	88.41	58.75	0.00	3.80	100.00	92.81
Rincon	84.24	50.56	0.00	0.00	99.91	87.80
Rio Grande	78.03	29.26	0.00	30.91	99.98	85.42
Sabana Grande	82.00	65.70	0.00	0.00	99.99	85.78
Salinas	73.93	83.76	0.00	0.02	99.96	89.15
San German	73.27	57.51	0.00	0.00	100.00	79.42
San Juan	98.17	90.87	12.99	99.61	99.98	99.95
San Lorenzo	38.07	45.55	0.00	99.75	100.00	99.75
San Sebastian	45.63	45.61	0.00	0.00	100.00	59.00
Santa Isabel	81.14	82.38	0.00	0.00	100.00	90.75
Toa Alta	49.90	79.50	0.00	91.02	99.99	95.93
Toa Baja	74.92	84.83	0.00	99.34	100.00	99.86
Trujillo Alto	77.33	87.16	0.00	90.74	100.00	97.97
Utua	41.75	42.62	0.00	33.85	99.80	64.59
Vega Alta	75.20	67.97	0.00	54.79	100.00	93.18
Vega Baja	74.08	78.18	0.00	15.35	100.00	88.89
Vieques	0.00	43.15	0.00	0.00	99.81	43.15
Villalba	63.17	55.40	0.00	0.16	99.50	71.53
Yabucoa	46.09	37.67	0.00	41.68	100.00	77.65
Yauco	71.60	9.42	0.00	0.00	99.33	73.01

Source: Connect Puerto Rico inventory estimate as of June 30, 2014.



2012 BROADBAND STRATEGIC PLAN GOALS

The Puerto Rico Broadband Taskforce established aspirational broadband capacity goals in the 2012 Broadband Strategic Plan to ensure broadband access on the Island is sufficiently fast, robust, redundant, and ubiquitous to meet the economic challenges of the twenty-first century. The following segment revisits these targets and examines progress made toward their achievement. Since the 2012 Plan included aspirational targets for fixed broadband capacity in urban and rural areas, mobile broadband capacity, and competitive targets, each of these goals is examined in turn. Data presented in this section uses the most comparable speed tier information collected as part of the SBI program.¹⁹

2012 Broadband Strategic Plan Fixed Broadband Capacity Goals
By 2015, 98% of all households should have broadband available at actual minimum speeds of 4 Mbps download (DL)/1 Mbps upload (UL).
By 2015, all urban locations and 50% of all rural and remote areas should have access to broadband actual speeds of at least 10 Mbps DL/3 Mbps UL at affordable prices; 70% of urban locations should have access to at least 25 Mbps DL/10 Mbps UL; and 50% of urban locations should have access to at least 50 Mbps DL/10 Mbps UL.
By 2015, across the Island the average capacity available across all fixed broadband service offerings, provided through wireline or fixed-wireless networks, should be no less than 6 Mbps download speeds.
By 2020, at least 85% of all customers should have access to at least 100 Mbps DL/50 Mbps UL.

As demonstrated in the previous section on broadband infrastructure, there have been significant increases each year since 2011 in download speeds in Puerto Rico. The table below benchmarks the 2015 aspirational goals established in the 2012 Strategic Plan against Puerto Rico’s estimated broadband availability as of June 2014. The table presents estimated broadband availability at 4, 10, 25, and 50 Mbps download speeds and various upload speeds. The data reveals mixed results. While some download speed targets have been met, and in some cases surpassed, upload speeds in Puerto Rico remain short of the established 2015 goals.



2015 Broadband Goals & 2014 Fixed Network Broadband Inventory			
Metric (Down / Up Speeds)	Broadband Availability June 2014	2015 Aspirational Goals	Broadband Availability June 2014
Percent of Households Served by Speeds of At Least			
4 Mbps*	3 Mbps / 768 Kbps	4 Mbps / 1 Mbps*	
Total	90.77%	98%	90.77%
Urban	99.99%	N/A	99.99%
Rural	85.20%	N/A	85.20%
10 Mbps	10 Mbps / 1.5 Mbps	10 Mbps / 3 Mbps	
Total	77.87%	N/A	55.70%
Urban	98.87%	100%	87.09%
Rural	65.96%	50%	38.03%
25 Mbps	25 Mbps / 3 Mbps	25 Mbps / 10 Mbps	
Total	55.70%		
Urban	87.09%	70%	0.1%
Rural	38.03%		
50 Mbps	50 Mbps / 3 Mbps	50 Mbps / 10 Mbps	
Total	52.90%		
Urban	81.19%	50%	0.1%
Rural	36.29%		

Source: Connect Puerto Rico inventory estimate as of June 30, 2014.

*Broadband availability at speeds of 4/1 Mbps is estimated using the closest metric available through the SBI mapping grant program of 3 Mbps/768 Kbps.

The data reveals a remaining broadband gap at the speeds of 3 Mbps download and 768 Kbps upload, particularly across rural areas where almost 15% do not have access at this basic level.

Broadband in urban areas, however, has vastly expanded and approaches the goals established in the 2012 Strategic Plan - nearly 99% of urban households have access at 10 Mbps download; 87% at 25 Mbps download; and 81% at 50 Mbps download. As also discussed in the Infrastructure section, this represents a vast expansion in broadband capacity across the Island since 2011.

When focusing on upload speeds, however, broadband estimates fall short of the aspirational goals established in the 2012 Strategic Plan. Only 87.09% of urban households and only 38.03% of rural households have access available at speeds of 10 Mbps download/3 Mbps upload, falling short of the 2015 aspirational goals of 100% and 50%, respectively. Similarly, almost no households have broadband available at speeds of 25 Mbps download/10 Mbps upload.



Finally, the 2012 Broadband Strategic Plan projected that, by 2015, the average available download speed across all fixed broadband service offerings on the Island, whether wireline or fixed wireless, should be no less than 6 Mbps. Puerto Rico significantly exceeds this goal using two sources for measurement. Based upon Ookla speed data, a global leader in broadband testing and network diagnostics, the rolling mean speed of consumer download speed tests over 30 days in December 2014 resulted in an average of 14.39 Mbps download. In relationship to results from 194 countries performing the same tests in the same timeframe Puerto Rico ranked 68th. Second, using a midpoint scoring method on the NTIA-established speed tiers, the average capacity available across Puerto Rico would be 72 Mbps download. These results assume no available residential service faster than 100 Mbps download.

2012 Broadband Strategic Plan Mobile Broadband Capacity Goal
By 2015, mobile broadband offerings at next generation speeds will be available across at least 98% of the Island’s geography where the population resides.

While next generation mobile networks, including fourth generation (4G) and Long Term Evolution (LTE), are generally associated with fast service, there are no industry standards for speed thresholds to meet these definitions. As such, we cannot directly contrast this measure against the Connect Puerto Rico mapping data, which collects broadband inventory information by speed tier. That being said, the table that follows demonstrates penetration of fast mobile networks across Puerto Rico. These mobile metrics indicate that Puerto Rico mobile network penetration is comparable to overall U.S. estimates of wireless penetration. According to the National Broadband Map, 97.5% of U.S. households have wireless service at download speeds of 10 Mbps and 16.2% of U.S. households have wireless service available at download speeds of 25 Mbps.²⁰

Mobile Network Broadband Inventory	
Speeds Down/Up	Households Served June 2014
At ≥ 3 Mbps/768 Kbps	99.90%
At ≥ 6 Mbps/1.5 Mbps	99.88%
At ≥ 10 Mbps/1.5 Mbps	99.72%
At ≥ 25 Mbps/1.5 Mbps	0%

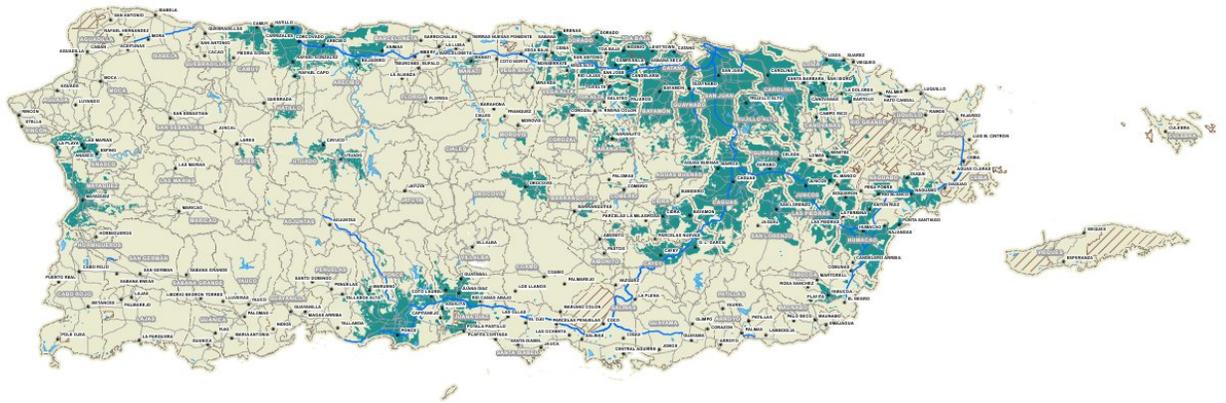
Source: Connect Puerto Rico inventory estimate as of June 30, 2014.



As of June 2014, 98.74% of Puerto Ricans (1,359,134 households) had access to three or more fixed or mobile broadband provider offerings, and 54.15% of Puerto Ricans (745,366 households) had access to three or more fixed broadband providers. Multi-provider fixed broadband offerings are primarily concentrated in the most populous areas of Puerto Rico, as depicted in the map below.

REDUNDANT BROADBAND NETWORKS

JUNE 2014



Symbology

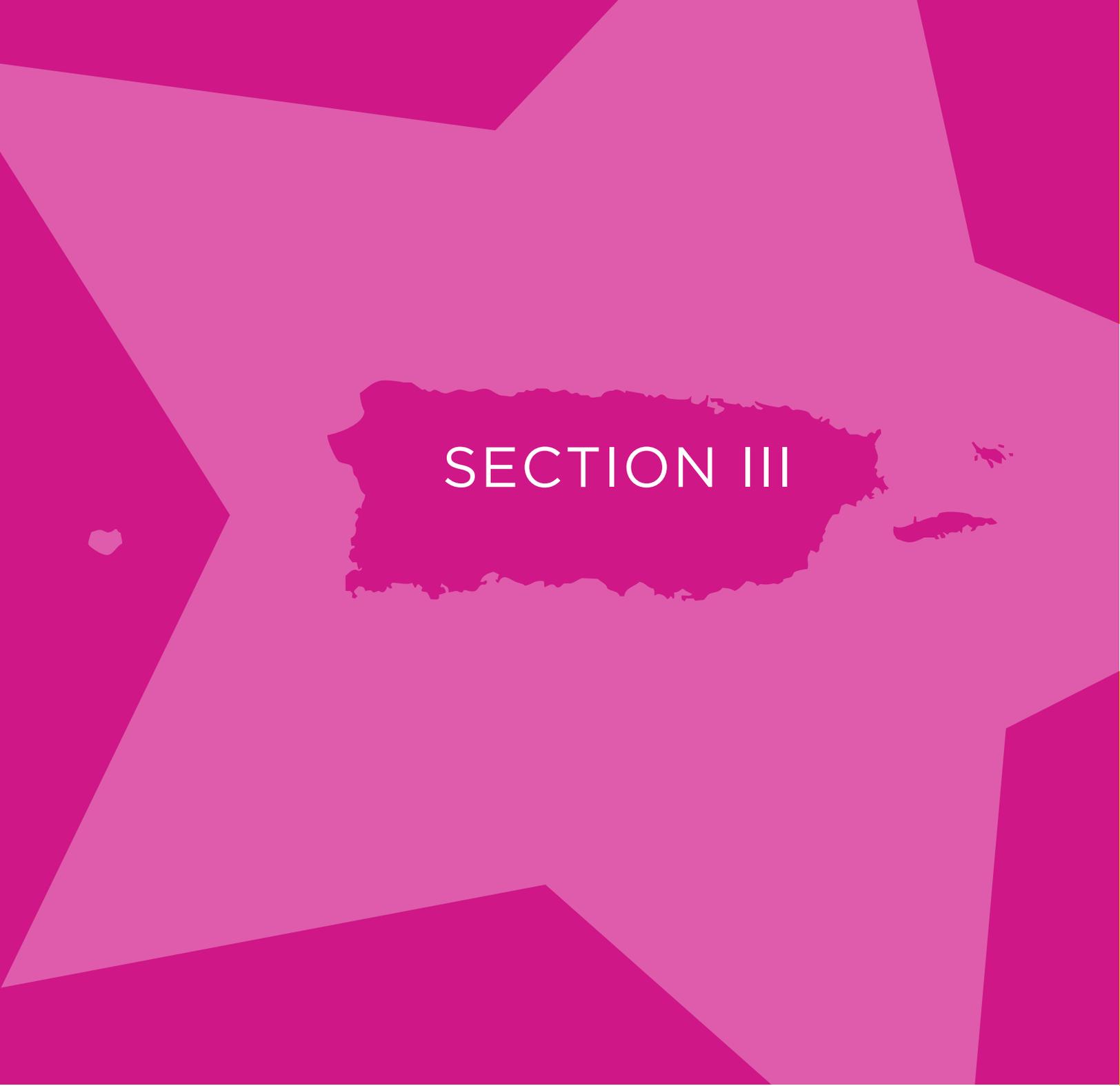
- City
- Primary Road
- Secondary Road
- Municipality Boundary
- Water
- National Lands
- 3 or More Providers



18. Federal Communications Commission, National Broadband Plan, <http://www.fcc.gov/national-broadband-plan>.

19. Data collected by Connect Puerto Rico follows the guidelines set forth by the State Broadband Initiative Notice of Funds Availability (SBI NOFA). For more information on speed tier data collected by Connect Puerto Rico, see the Technical Appendix of the SBI NOFA at http://www.ntia.doc.gov/files/ntia/publications/fr_broadbandmappingnofa_090708.pdf.

20. National Broadband Map, Dec. 31, 2013 estimates, <http://www.broadbandmap.gov/summarize/nationwide>.



SECTION III

BUILDING A GIGABIT ISLAND



As data from the previous sections demonstrate, the Puerto Rico broadband market is maturing. Broadband providers are reacting to market demand and competitive forces by investing in higher capacity networks, particularly across the more urban centers of the Island and expanding their networks into rural and remote areas previously unserved.

This investment has largely been driven by the private sector - including mobile, cable, and providers offering fiber, DSL, and fixed wireless service - and is delivering substantial value to Puerto Rico consumers.

In 2011, no residential broadband provider was offering service at download speeds above 25 Mbps; in 2014, 53% of households across Puerto Rico have the choice of subscribing to broadband at speeds of 100 Mbps. This includes most urban areas (81% of urban households) as well as a significant portion of rural households (36%). In parallel, mobile broadband networks in Puerto Rico continue to grow, offering higher broadband capacity and robust service.

While this growth is positive, there remains a gap to achieving the gigabit connectivity challenge proposed in this Plan. The question is, therefore, whether investment will continue to grow so that:

- By 2018, 90% of Puerto Rico households will have broadband available at download speeds of 10 Mbps.
- By 2018, 50% of Puerto Rico households will have broadband available at download speeds of 1 Gbps.
- By 2020, 99% of Puerto Rico households will have broadband available at download speeds of 10 Mbps.
- By 2020, 70% of Puerto Rico households will have broadband available at download speeds of 1 Gbps.

The 2012 Puerto Rico Broadband Strategic Plan outlined a series of policy recommendations that aimed to accelerate investment in broadband capacity. These policy recommendations and following principles remain relevant today.



A Gigabit Community - Urbana-Champaign, Illinois

In late May 2014, nonprofit consortium, Urbana-Champaign Big Broadband (UC2B), announced a public-private partnership with iTV3 to operate and extend gigabit fiber services in Urbana and Champaign, Illinois.⁹⁰ UC2B was founded in 2010 to build, operate, and expand the UC2B fiber-optic network.⁹¹ The UC2B network originally targeted low-income and low-adoption areas of the community and connected over 1,000 residences, 250 community anchor institutions, and 75 businesses using federal and state grants and local matching funds.⁹² Under the new public-private partnership, iTV3 will invest in gigabit fiber build-out throughout Urbana-Champaign to expand ultra high-speed service to additional residents, institutions, and businesses, as well as maintain the current UC2B fiber optic network and connectivity to existing customers. UC2B anticipates that this expansion will enable community growth as well as attract and retain businesses and University of Illinois faculty, staff, and students.

“Congratulations to Urbana-Champaign Big Broadband (UC2B) and iTV-3 on making gigabit services over fiber available throughout the community. This public-private partnership provides a valuable model for communities and companies throughout the country and a demonstration of the creativity that is stimulated when localities are free to work with the private sector to improve broadband offerings.”

-FCC Chairman Tom Wheeler



MONITOR, MEASURE, AND ASSESS THE IMPACT OF BROADBAND ACROSS THE PUERTO RICO ECONOMY

Over the last five years, in partnership with the federal government, public and private stakeholders have collaborated to assess, evaluate, and map various aspects of the Puerto Rico broadband market. Granular information collected and published by Connect Puerto Rico through broadband inventory maps and technology assessment research have enabled a better understanding of the Puerto Rico broadband market and proven to be effective tools to inform and help define public policy at the federal and local levels.

Transparent, accurate data is a key instrument to helping steer growth and investment in the Puerto Rico broadband market. As further described below, this data has resulted in unprecedented federal investment of more than \$31 million to support broadband network expansion to unserved areas of the Island.

In order to help meet and accelerate the Gigabit Island goals, it is imperative that Puerto Rico continues to monitor and measure developments in the broadband market. Further, broadband stakeholders should collaborate to develop additional tools and metrics to better understand market trends and the impact of broadband and the knowledge economy on the overall Island economy.

CONTINUE AND EXPAND BROADBAND MAPPING

Puerto Rico has benefited greatly from various federal and local efforts to measure broadband capacity, adoption, and use across the Island. The data and maps collected by Connect Puerto Rico, with the support of the federally funded State Broadband Initiative grant program and presented in this Plan, are the result of those efforts. These tactical instruments are essential to inform Puerto Rico broadband public policy and effectively leverage federal resources aimed at expanding broadband infrastructure in locations where it is lacking.

Local stakeholders and the Puerto Rico government should continue to support Island-wide broadband mapping. Moving forward, maps should track broadband developments that impact residential markets, similar to those created by Connect Puerto Rico, as well as the developments that impact the business sector and community anchor institutions. As such, maps should reflect middle-mile network infrastructure, both lit and unlit, in support of those connections.

“Since our confirmation to preside the PR Telecommunications Regulatory Board, we have reiterated the importance of mapping to better understand and plan for state actions with respect to broadband deployment. Connect Puerto Rico’s contributions to this project have been invaluable. We envision taking this roadmap to the next level by including broadband infrastructure adoption, not just on a residential level, but on the commercial side as well.”

Javier Rúa, President TRB



This interactive inventory will enable community stakeholders to better understand the broadband landscape and address residential and commercial concerns anecdotally. Similarly important, this information will enable communities to initiate informed discussions with local providers to address gaps in coverage and collaborative build-out plans.

MEASURE AND PUBLISH INDUSTRY-WIDE INVESTMENT TRENDS

Puerto Rico broadband stakeholders should track and publish aggregate data regarding industry-wide investment in broadband expansion. Timely release of such information, which is not currently available, will shed light on the significant financial commitments that telecommunications and broadband providers, both public and private, are making to strengthen Puerto Rico's infrastructure and create jobs.

Mindful of the commercial sensitivity of such data, this effort should aim to protect confidential, provider-specific data. All data should be collected and aggregated by a neutral, non-competitive entity to be defined by stakeholders who would protect individual confidential data while publishing meaningful, industry-wide investment metrics.

MEASURE AGGREGATE BROADBAND USE

To complement and encourage ongoing network development, Puerto Rico should also measure and publish aggregate broadband use patterns. Metrics on the overall Internet Protocol (IP) traffic across the Island will help public and private stakeholders better understand market trends and knowledge economy developments on the Island.

To do so, Puerto Rico broadband stakeholders should collect and release quarterly and annual metrics, such as:

- Total monthly or quarterly consumption of IP data across Puerto Rico for fixed and mobile broadband networks.
- Mean and median monthly or quarterly consumption of IP data for fixed and mobile broadband subscribers. Metrics should capture both download and upload data usage.
- Peak IP traffic composition data for fixed and mobile broadband networks, both download and upload. Categories of data to be monitored could include enterprise-to-enterprise traffic, entertainment, web browsing, social networking, and communications, among others.
- Top ten peak period applications used for both download and upload traffic.

Network solution management companies publish similar data and have demonstrated that doing so is feasible and does not reveal confidential company-level data about broadband network providers or Internet Service Providers.²¹ To date, however, these data sources rarely provide granular information pertaining to Puerto Rico, which is



instead typically bundled with U.S. or Latin America statistics. Puerto Rico-specific information would be a powerful tool for all broadband stakeholders and would significantly impact the industry's ability to monitor and project usage trends on the Island.

The broadband stakeholder community should, therefore, work together to define what ought to be measured and how to do so. Importantly, because of the data's commercially sensitive nature, protocols should also be developed to collect and protect confidential information. For example, aggregate data would provide meaningful market trend metrics while still protecting confidential data from any and all providers.

ESTIMATE AND MONITOR THE IMPACT OF BROADBAND ON PUERTO RICO'S OVERALL ECONOMY

As broadband and the knowledge economy continue to expand, metrics on aggregate broadband use can help uncover drivers of overall economic trends on the Island. Puerto Rico's economic indicators should be adjusted to reflect this new twenty-first century reality.

Assessing and monitoring aggregate broadband use for this purpose is not straightforward; indeed, determining the economic impact of Puerto Rico's IP traffic is a complex endeavor. Working under the umbrella of the current Puerto Rico Broadband Taskforce, a sub-committee of experts should be established to include public and private broadband stakeholders, residential and commercial broadband providers, the Telecommunications Regulatory Board, the Office of the CIO of Puerto Rico, as well as the Puerto Rico Institute of Statistics and the Planning Board.²² This committee should contemplate several possible strategies, including:

- Monitoring trends in IP traffic in and out of Puerto Rico in relation to import and export statistics. Outflowing IP traffic information, particularly if classified by category (e.g., enterprise-to-enterprise, entertainment, communications, etc.), could help predict trends in the Puerto Rico export market and the Island's overall economic growth.
- To achieve such metrics, the appropriate indicator would be a measurement of all IP traffic to and from the Island. Such information is obtainable from Internet Peering Exchange(s) on the Island and can be complemented and contrasted with overall IP traffic flowing through the relatively limited number of submarine cables to and from Puerto Rico.
- Based on this data, the impact of the knowledge economy in Puerto Rico could be measured by the ratio of IP traffic flowing in and out the Island. An underlying hypothesis is, therefore, whether growth in traffic leaving the Island (export data) relative to that consumed on the Island (import data) correlates with import and export metrics and/or other economic growth indicators. This data will also enable the ranking of the Puerto Rico knowledge economy worldwide and monitor growth relative to peer economies.



- One key challenge to building these metrics is the elimination of “noise” resulting from so-called “boomeranged traffic.” Boomeranged traffic refers to intra-Island traffic that originates and terminates within Puerto Rico; however, broadband network design is routed through Internet Exchange Points outside of the Island. Eliminating this circular traffic from overall IP traffic metrics would help derive more accurate information that better reflects Puerto Rico’s economic activity.
- This can be done by examining the network routes used by leading network providers and filter out those that are “boomeranging” their intra-Island traffic, or by looking at the source and destination IP addresses of all flowing traffic through Island Peering Exchanges and filtering out the intra-Island traffic. Such tools are routinely used by broadband network managers to help monitor traffic patterns and more effectively plan for network adjustments.
- For more granularity, a further refinement could include measuring traffic by the destination domains (e.g., amazon.com, youtube.com, etc.) using a network probe. Another refinement could include measuring IP traffic flows by category type or application groups, similar to those discussed above and periodically published by companies such as Sandvine, Cisco Systems, and others.

To achieve these goals, public and private stakeholders should work together to define meaningful broadband use metrics on the Island and develop clear protocols for how, what, and when such data should be collected. For this endeavor to fully reflect the impact of the broadband industry across the Island and serve as a meaningful tool for economic planners, it is imperative that data is collected from all major broadband providers on the Island, including all voluntary peering partners, as well as the cable and mobile industries, Claro, and PREPA Net.

LOWER COST OF BROADBAND BUILD-OUT

Building broadband infrastructure is costly. According to the National Broadband Plan, deploying fiber can easily cost more than \$100,000 per mile and “the largest element of deployment costs is not the fiber itself, but the placement costs associated with burying the fiber in the ground (or attaching it to poles in an aerial build).”²³ In certain cases, these placement expenditures can account for almost three-quarters of the total fiber deployment.

However, with adequate planning, these costs can be decreased substantially. For example, the National Broadband Plan noted that “the cost of running a strand of fiber through an existing conduit is 3-4 times cheaper than constructing a new aerial build.”²⁴ In addition, joint trenching of infrastructure projects can cut placement costs dramatically by distributing the costs of digging among broadband providers and other infrastructure projects.

The FCC’s National Broadband Plan also concluded that, “the rates, terms, and conditions for access to rights-of-way [including pole attachments] significantly impact broadband deployment.” The costs associated with obtaining permits and leasing pole attachments and rights-of-way are one of the most expensive cost functions in a service provider’s plans to expand or upgrade service, especially in rural markets where the ratio of poles to households is off the charts. Furthermore, the process can be time



consuming. For example, the process of attaching equipment to an existing pole, such as moving wires and other equipment and coordinating with electric and safety codes, can take months to complete.

Community and provider collaboration to problem solve around local pole attachment and other rights-of-way issues is one of the most effective opportunities to encourage faster, new deployment of infrastructure.

Placement costs, which include stringing fiber or attaching equipment to utility poles, are a significant component of broadband deployment expenditures. In addition, since these charges generally consist of per-pole or distance-based rental charges, high costs for leasing access to poles and rights-of-way affect deployment in distant, rural areas more than dense urban areas.

To facilitate broadband build-out, encourage higher investment, and invigorate more competition, the 2012 Broadband Strategic Plan recommended a number of strategies to help lower the cost of broadband network expansion, including to:

- **streamline construction permitting and planning;**
- **ensure ready and cost-effective access to poles, ducts, conduits, and rights-of-ways, both privately and publicly owned;**
- **leverage existing public assets to incent public and private broadband expansion; and**
- **establish a “Dig Once” protocol.**

These recommendations remain relevant today. Since publication of the 2012 Strategic Plan, public and private stakeholders have worked to advance these recommendations. The following ventures stand as examples of these efforts.

LEVERAGE UNUSED STREETLIGHT CONDUITS TO DEPLOY FIBER - PROJECT VIA DIGITAL

The Puerto Rico Department of Transportation and Public Works (DTOP) and the Telecommunications Regulatory Board (TRB) have established a new venture called Vía Digital that will make vacant underground duct infrastructure owned by DTOP available for broadband expansion. The vacant conduits were originally constructed to house infrastructure supporting the streetlight system across the Island but remained unused. The project was inspired by the Corredor Digital initiative, described in more detail in later sections, which seeks to bring faster connectivity to the Santurce neighborhood of San Juan with minimal disruption to residents.

Under the Via Digital project, DTOP will establish short- and/or long-term leases that will permit eligible entities to use these ducts to construct telecommunication systems that use fiber optic cable as their main transmission medium for deployment of broadband services. Participating providers would then invest their own financial capital to deploy fiber along these conduits and commercialize the network offering high-capacity broadband service to residential, corporate, and public customers.



In August 2014, DTOP and TRB signed a Memorandum of Understanding (MOU) outlining key aspects of Vía Digital. The project's primary objectives include:

- Establishing a fair and competitive qualification and bidding process to encourage active participation of qualified entities that operate and/or provide telecommunications, cable television, and/or Internet access services.
- Guaranteeing that the winning bidder selection process is made within a nondiscriminatory scope and allows for broad participation and fair competition.
- Maximizing the use of this infrastructure by installing inner ducts allow duct space capacity to quadruple, enabling up to 12 inner ducts for fiber installation across routes.
- Recovering part of the total capital investment made by DTOP in the construction of the duct infrastructure, estimated between \$4.5 and \$5 million.
- Reducing the impact and damage to public streets and sidewalks during construction by exercising policies that mitigate or eliminate excavation, commonly referred to as Dig Zero policy.
- Contributing to the improvement of the quality of life of the community by establishing new and advanced telecommunications technologies to allow for deployment of new and improved broadband services in the areas where the underground duct infrastructure runs.
- Encouraging the rebirth of commercial and economic activity of Santurce and surrounding areas.

In its initial phase, Vía Digital will focus on a pilot launch across areas of San Juan in the Rio Piedras, Hato Rey, Santurce, and Miramar neighborhoods. The pilot conduit included in this first phase extends approximately 55,000 linear feet and runs through the Ponce de León, Fernández Juncos, and Muñoz Rivera Avenues from Miramar in Santurce and to the Rio Piedras area. The nearby map illustrates the route of this first pilot (contour in red). The pilot route is a closed loop that enables connection with existing last mile broadband infrastructure across the entire route.



Lessons learned from this initial phase will help streamline expansion of the Vía Digital project across the Island.



LEVERAGE SEWAGE AND AQUEDUCT CONDUITS TO DEPLOY FIBER - PROJECT ZUM

The ZUM fiber initiative was developed through a partnership between the Puerto Rico Aqueduct & Sewer Authority (PRASA) and the Office of the Chief Information Officer of Puerto Rico to leverage existing public infrastructure and lower the cost of broadband build-out. Utilizing robotic technology, the initiative will install an underground fiber optic network through PRASA's existing sewage pipeline. Like the above mentioned Vía Digital project, ZUM embraces a “dig zero” policy. Leveraging existing conduit infrastructure, the project eliminates the need for costly excavation work, which will ensure a safe and expedited process that will minimize traffic delays and other inconveniences that impact public roads.

The first phase is expected to deploy in the Isla Verde neighborhood in San Juan in early 2015. This phase will supply an open access fiber network to Puerto Rico's Internet service providers and carrier operators, serving approximately 8,500 residential units and 140 businesses. The network, comprised of a mix of infrastructure elements, will be capable of delivering ultra-high-speed data, video, and voice services providing Ethernet access bandwidth from 10 Mbps up to 1 Gbps.

Although like Vía Digital, the ZUM fiber project leverages existing infrastructure to eliminate the need for excavation and construction, resulting in lower costs, the two projects propose significantly different business models and partnership arrangements.

Under Vía Digital, private partners will gain use rights of the DTOP signaling conduits in exchange for a fee, then will invest capital to lay down fiber infrastructure through these conduits. Further, the project is designed to incent competition and facilitate the build-out of up to 6 redundant cables. Providers would, hence, bear the financial risk of the fiber deployment and be able to freely commercialize the capacity as they see fit.

By contrast, under the ZUM project, PRASA will provide the capital to invest in its own fiber network and will resell wholesale service connectivity to participating broadband providers who would then commercialize the service in the retail market. Under this model, the private partner would bear low financial risk of the venture, but will be limited to commercialize services supported by the wholesale offerings of ZUM.



ADVANCE EFFECTIVE “DIG ONCE” LEGISLATION

The “Dig Once” concept and related policies aim to facilitate joint trenching cost savings and ensure that broadband infrastructure improvements are considered alongside other infrastructure and public works projects. To this end, Dig Once legislation aims to establish that every infrastructure project includes notification and facilitation of opportunities to lower the costs of broadband infrastructure investment. There are two main benefits to Dig Once legislation:

1. Lower costs of infrastructure deployment when completed in conjunction with other infrastructure improvements (such as highway construction).
2. Promote and facilitate integration of broadband infrastructure as part of local and regional economic development infrastructure initiatives.

On June 14, 2012, President Obama issued Executive Order (E.O.) No. 13616, “Accelerating Broadband Infrastructure Deployment,” to facilitate wired and wireless broadband infrastructure deployment on federal lands, buildings, and rights-of-way, federally assisted highways, and tribal and individual Indian trust lands, particularly in underserved communities. The E.O. specifically calls for increased accessibility and usability of federal broadband information to help promote and facilitate broadband deployment and encourages broadband infrastructure deployment by urging states to adopt policies that promote “dig once.”²⁵

Many states and municipalities have also adopted Dig Once policies. These policies range in scope and nature. The United States Department of Transportation, Federal Highway Administration has listed several best practices for Dig Once state and local policies, noting that “Dig Once and joint use of trenches have been practices recognized by state and local stakeholders as sensible solutions to expedite the deployment of fiber along main routes when implemented as part of a cooperative planning process.”²⁶

The U.S. Department of Transportation specifically noted the Utah Department of Transportation (UDOT) as an example. UDOT installs empty conduit suitable for fiber optic placement during highway construction, and then coordinates with providers on their need and demand for space in that conduit. UDOT meets with telecom companies every two months regarding infrastructure projects and has established a single point of contact for broadband providers. Annually, providers submit a list to UDOT with areas of need, and UDOT provides interactive online tools, maps of roads, fiber, and conduit.

Mirroring practices at the federal level and across many municipalities and jurisdictions, and heading recommendations of the 2012 Broadband Strategic Plan, the Puerto Rico Senate is also taking action. In October 2014, Senator Ramón Luis Nieves introduced a bill that establishes a Dig Once policy framework in Puerto Rico.²⁷ Debate of this bill is expected in the 2015 legislative session.



PROMOTE PUBLIC-PRIVATE PARTNERSHIPS TO STIMULATE AND AGGREGATE LOCAL DEMAND AND EXPAND MARKET OPPORTUNITIES

The 2012 Puerto Rico Broadband Strategic Plan recommended promoting public-private partnerships at the local and national levels to overcome barriers to broadband expansion and ensure that citizens and enterprises benefit from this capacity. Such public-private partnerships can showcase aggregate demand to potential investors and reduce the cost of network build-out by facilitating planning and partnerships across various agencies to leverage existing assets, such as public conduits and pole attachments.

Collaboration — among policy makers across every level of government, private firms throughout and beyond the broadband ecosystem, community leaders, consumer advocates, and consumers themselves— is essential to addressing the many barriers to more robust broadband adoption and use.

There are numerous examples of communities benefiting from more collaborative local leadership on these issues. Public-private (PPPs), for example, are bringing broadband networks to unserved areas, while direct engagement with service providers is yielding creative approaches to bolstering existing services. Similar efforts are also proving successful on the demand side, where communities are leveraging local social infrastructures to promote adoption and more informed use of broadband services. Such approaches allow local policy makers to take a more organic, data-driven assessment of broadband connectivity in their municipality and design strategies to address actual needs. As discussed here, embracing this model could yield enormous community benefits.²⁸

There are several examples of collaborative efforts in Puerto Rico that are leveraging broadband and other information technologies to reinvigorate local economic growth.

CORREDOR DIGITAL DE SANTRUCE

The Corredor Digital de Santurce initiative is a noteworthy example of private-public partnership between local stakeholders for economic and social growth.²⁹ Corredor Digital was formed in 2013 by local entrepreneurs and members of Puerto Rico's technology ecosystem to transform Ponce de Leon Avenue in the Santurce neighborhood in San Juan into an innovation district and business hub. Once the commercial heart of San Juan, Ponce de Leon Avenue has experienced great economic decline and is now surrounded by graffiti-filled walls and abandoned buildings, despite being located in the bustle of one of the most populated areas of San Juan. The vision of the companies and entrepreneurs behind Corredor Digital, a nonprofit corporation, is to revitalize and transform the former Theater District into a sustainable economic development model, utilizing the availability of broadband and recruitment of technology companies.



Inspired by projects in Medellín, Boston, Seattle, Charleston, and Barcelona, Corredor Digital will utilize the infrastructure, buildings, and activities available to transform Santurce into a “tech district.” One aspect helping attract businesses to the area is the high concentration of fiber optics that runs from Sacred Heart University to the residential area of Miramar. While technology companies on the Island continue to face broadband speed, price, and quality of service challenges, this fiber optics network rivals that of Google Fiber in Kansas City. Plus, leveraging the network of pipes readily available will avoid street trenching and additional disruptions that numerous other cities experience when installing fiber optics networking.

Redevelopment of the Santurce area is anticipated to spark the local economy, create new businesses, and open opportunities for permanent jobs. However, Corredor Digital has recognized that this dynamic transformation requires more than connectivity; it necessitates creativity and greater business integration with the local community and its residents. Therefore, funds garnered by the organization will be used to help emerging organizations create successful business models and offer better service delivery. Corredor Digital, organized under a 6-member board, is also:

- working with the owners of the abandoned facilities to rehabilitate, recondition, or make the facilities available for sale;
- advocating for improved lighting, signage, parking, and transportation legislation; and
- encouraging incentives offered to technology companies that locate in the area.

An ecosystem of digital companies has already located in the area - twenty companies reside from Park Street to Roberto H. Todd Avenue, offering services in design, content and publishing, communications media, Internet service, and more. The companies that have settled in the area appreciate the collaborative mentality, mutual purpose, and collective efforts to monitor local opportunities and demands. By promoting the district as the epicenter of technological innovation and creating a vibrant community with spaces for living, working, and socializing, this multi-sector initiative seeks to catalyze other signs of revitalization such as enhanced property values.

Corredor Digital serves as an example of public and private cross-sector collaboration to revitalize a community. Taking advantage of local information technology and broadband connectivity resources, Corredor Digital hopes to bring attention to the Island and showcase Puerto Rico as a potential location for companies wishing to establish services in the Caribbean and throughout Latin America. Although much remains to be done, the new digital infrastructure and joint initiatives among local government leadership and effective community planning are a strong foundation to achieving its objectives and setting a worldwide example.



Health-Tech Corridor - Cleveland, Ohio

Existing within The Cleveland Connected Collaboration Corridor (4Cs), the Health-Tech Corridor (HTC) encompasses over 40 city blocks and 9 neighborhoods in the MidTown area of Cleveland. While the HTC corridor already hosts a concentration of world-class healthcare and academic institutions, business incubators, and high-tech companies, HTC has become the focus of collaboration among the city, the Cleveland Foundation, and others to grow and develop the area to attract technology start-ups, healthcare “spin-offs,” and cloud service providers. Over 15 public institutions, developers, government, and business partners collaborated with the city of Cleveland to apply for a grant awarded through the U.S. Economic Development Association (EDA) to enable the installation and operation of 3 miles of fiber optic networking within the HTC at speeds up to 100 Gbps.⁹³ This award is part of a \$1,021,230 project anticipated to leverage \$35 million in private investment and create 115 jobs in Cleveland.

As demonstrated by these examples, gigabit connectivity is a key component to attracting corporate investment and retaining commercial and individual talent in Puerto Rico. The transition to a “Gigabit Island” stands to create local jobs, retain skilled workers, and enhance real estate values in Puerto Rico, leading to supplemented personal incomes, more spendable dollars on the Island, and long-term community and economic growth. Numerous industries in Puerto Rico stand to benefit from this economic development ripple effect.



LEVERAGE FEDERAL SUPPORT FOR BROADBAND EXPANSION

The Federal Communications Commission's 2011 reform of its Universal Service Fund (USF) transitioned the USF High Cost program, historically subsidizing telecommunications service in rural areas, to a new Connect America Fund (CAF) that aims to support broadband infrastructure in rural regions.³⁰ The FCC disburses approximately \$4.5 billion annually through the High Cost program across the nation.³¹

Puerto Rico has historically benefited from FCC USF support. In 2013, \$160 million in High Cost subsidies were committed across Puerto Rico. From 1998 to 2013, the total amount of subsidies committed to Puerto Rico under this program was \$2.22 billion.³² Historically these subsidies have supported the deployment of communications infrastructure for voice service, but beginning in 2011, with the FCC's creation of the CAF program, began transitioning to support for robust broadband network deployment. As the CAF evolves, Puerto Rico must be vigilant in ensuring that federal universal service funds support widespread broadband access to all Puerto Ricans.

The FCC allocates CAF funds based on need for robust broadband infrastructure that can sustain twenty-first century online activities, as determined by the National Broadband Map.³³ In Puerto Rico, broadband availability data is collected on behalf of the Puerto Rico government by nonprofit organization, Connect Puerto Rico, which aggregates broadband network data from an array of broadband providers on the Island. This collaborative effort has enabled a transparent, reliable database depicting the broadband landscape, and has supported quick decisions by the FCC to fund network expansion in underserved areas of the Island. While the Puerto Rico broadband map is an essential tool in this process, so too is the willingness of broadband providers to partner with the FCC and commit to broadband build-out in remote locations, fueled by federal subsidies.

The 2012 Puerto Rico Broadband Strategic Plan addressed the new Connect America Fund opportunity and urged stakeholders to work collaboratively to secure maximum benefit from the transition. Specifically, the report recommended that "all broadband providers ... collaborate with Connect Puerto Rico to ensure that broadband inventory data collected under the SBI (State Broadband Initiative) grant program and used by the FCC to determine the Connect America Fund transition is comprehensive and accurate."³⁴

The Puerto Rico government and Puerto Rico Broadband Taskforce have been working to provide timely information and strategic planning support to broadband providers who can leverage FCC funding opportunities. Below are two examples of the impact of this public-private partnership approach.



FCC GRANTS CLARO \$31.5 MILLION FOR BROADBAND EXPANSION IN RURAL PUERTO RICO

In May 2013, the FCC committed up to \$485 million in one-time, per-location payments through the Connect America Fund Phase I to eligible price cap carriers willing to upgrade their networks and provide broadband in areas identified by the Commission as unserved. Unserved areas were defined as those not having broadband service at speeds of at least 3 Mbps download and 768 Kbps upload.

The following October, the Commission approved \$31.5 million of second round Connect America Fund Phase I funding to Puerto Rico Telephone Company, or Claro, to connect underserved homes and businesses. Since the FCC determined eligible areas for these funds based

on data collected by Connect Puerto Rico for the National Broadband Map, the quick and decisive action in Puerto Rico speaks to the reliability of the underlying broadband maps in the area. Claro's request for funding was the second highest among the 44 applications received by the Commission, targeting 40,736 underserved homes and businesses across Puerto Rico.³⁵

"Our company has long been an advocate of broadband deployment in Puerto Rico and the region given the importance of Internet in the economic development, prosperity, and competitiveness of countries worldwide . . . This broadband investment marks an important day for all residents on the Island."

-Enrique Ortiz de Montellano,
President, Claro

PUERTO RICO BIDS FOR THE FCC RURAL BROADBAND EXPERIMENT PROJECT

In 2014, the FCC expanded the Connect America Fund to include a pilot "Rural Broadband Experiments" program. Under this program, the Commission invited interested parties to present projects for broadband build-out in unserved areas of the country in exchange for a subsidy. This \$100 million, one-time pilot program was designed to help the FCC better understand the type of companies that would be willing to invest in broadband build-out across rural America in partnership with the FCC and to better gauge the level of subsidies that would be needed to incent private construction in those remote - hence, more costly - rural areas. The Telecommunications Regulatory Board conducted various informational seminars regarding this opportunity and actively encouraged Puerto Rico broadband providers to leverage this opportunity.

The FCC received nearly 600 proposals from parties across the country. In December 2014, the FCC selected 40 of those projects to be funded. Among them, was a project submitted by Liberty Cablevision of Puerto Rico to expand very high-speed broadband in select unserved areas for a subsidy of just under \$42,000.³⁶ Subsequently, however, the FCC announced that several projects, including the Liberty Cablevision bid, would not move forward. Notwithstanding the particulars of this case, all eligible broadband providers should assess the possibility of partnering with the FCC to help bring more robust broadband to remote areas of the Island.



IMPLEMENTATION OF CONNECT AMERICA FUND PHASE II

The FCC is now implementing Phase II of the Connect America Fund, which will target up to \$1.8 billion in annual subsidies to support the deployment of 10 Mbps/1 Mbps fixed broadband infrastructure in underserved areas across the nation. Currently, Connect Puerto Rico estimates that approximately 300,000 households across Puerto Rico (22%) do not have access to 10 Mbps/1.5 Mbps fixed broadband networks.

As the incumbent local telephone company, Puerto Rico Telephone Company (Claro) will be given a right of first refusal to establish a partnership with the FCC. Under this partnership, in exchange for CAF subsidies, Claro would upgrade its network to meet the Commission's minimum fixed broadband availability target of 10 Mbps/1 Mbps to all households within its service footprint.

In December 2014, the FCC gave Claro the option to continue to accept the same subsidy levels it has been receiving under the High Cost USF program as “frozen support” in exchange for a commitment by Claro to upgrade its network across the Island to meet the minimum target of 10 Mbps/1 Mbps, as well as other service quality, capacity, and pricing commitments.³⁷ On December 22, 2014, Claro formally notified the FCC of its interest in the “frozen support” offer, pending details of that offer.³⁸

Within the next few months, the FCC will develop “tailored service options” for Puerto Rico that will identify areas eligible for the subsidy, as determined using data from the National Broadband Map, and the corresponding service obligations. Once the specifics of those service obligations are established, Claro will have an additional 60 days to evaluate and accept or reject the offer. If Claro rejects the offer, the FCC will extend the subsidy opportunity to alternative providers for broadband infrastructure build-out in eligible areas across Puerto Rico. Allocation of the subsidies would be determined through a competitive bidding auction.

Puerto Rico public and private stakeholders should actively engage in this process and work with the FCC as it establishes the rules associated with these subsidies. In early 2015, the FCC will determine the scope of service obligations, including speed, quality, and price, that it will associate with these CAF subsidies. Those decisions will substantially affect the broadband landscape in Puerto Rico for the next decade; as a result, public input into these decisions will be especially important. Robust and timely data on broadband infrastructure and use across Puerto Rico will be essential to ensure that as the FCC moves forward on the Connect America Fund project, it will do so in a way that helps the residents of Puerto Rico.



The FCC's Universal Service Fund reform will continue to impact Puerto Rico's broadband sector. Private and public stakeholders on the Puerto Rico Broadband Taskforce have monitored this reform as it has unfolded and sought to work collaboratively with the FCC to ensure fair and effective allocations to unserved areas in Puerto Rico.

While the FCC's Universal Service Fund program is the largest federal program supporting broadband and telecommunications infrastructure, other federal agencies offer opportunities for grants and/or loans to accelerate broadband expansion. Collaborative efforts between Puerto Rico broadband entrepreneurs, local stakeholders, and national policy makers are essential to ensure that the citizens of Puerto Rico fully benefit from these opportunities.

The American Recovery and Reinvestment Act of 2009 (ARRA) appropriated \$4.7 billion for the National Telecommunications and Information Administration (NTIA) to establish the Broadband Technology Opportunities Program (BTOP) to increase broadband access and adoption; provide broadband access, training, and support to schools, libraries, healthcare providers, and other organizations; improve broadband access to public safety agencies; and stimulate demand for broadband. In 2009 and 2010, NTIA invested approximately \$4 billion in 233 BTOP projects.³⁹ Two of these projects, amounting to over \$38 million, were awarded to entities in Puerto Rico: a project led by the not-for-profit regional development agency, INTECO, and the Puerto Rico Digital Bridge project.

INICIATIVA TECNOLÓGICA CENTRO ORIENTAL (INTECO)

The Iniciativa Tecnológica Centro Oriental is an economic development organization created in 2003 to improve the quality of life in nine Central Eastern Puerto Rico municipalities. INTECO received \$12.9 million through BTOP to expand broadband access by deploying a multifaceted 515-mile network that leverages both wireless and fiber connections. The project originally planned to directly connect nearly 250 anchor institutions, including higher education facilities, hospitals, municipal facilities, police stations, and libraries, as well as enable local service providers to connect to the project's open network. INTECO has also focused on the development of Wi-Fi hotspots to further promote digital literacy among low-income adults and youth.



THE PUERTO RICO BRIDGE INITIATIVE

In April 2010, Critical Hub Networks was awarded \$25.7 million under the American Recovery and Reinvestment Act for the creation of the Puerto Rico Bridge Initiative (PRBI), a project designed to bring fast, affordable broadband service to all of Puerto Rico, particularly underserved and impoverished areas. The overall goals of this network were to reduce the digital divide, boost economic growth, and improve broadband services on the Island.

Through the purchase of a 10 Gbps undersea fiber optic cable, the PRBI established a “broadband bridge” that linked Puerto Rico to Miami and connected to a high-capacity, middle-mile network back on the Island. This network created an ultra-high speed backbone connection, ensuring Puerto Rico’s broadband providers have sufficient capacity to offer fast, affordable service to residents, businesses, and community anchor institutions. During the 20-month project, the PRBI collaborated with government, the Puerto Rico Broadband Taskforce, and other ARRA-funded projects such as the Puerto Rico Health Information Network and Iniciativa Tecnológica Centro Oriental.

The PRBI also played an integral role in promoting local peering – or interconnection – between Puerto Rico’s broadband networks. Broadband providers now have 24 locations on the Island where they can interconnect their networks with PRBI’s. By expanding upon interconnection agreements with 17 providers, Critical Hub has delivered local peering advantages that reduce costs for transit services; improve quality of service, including increased redundancy and capacity; and promote competition.

PRBI’s initial project funding closed at the end of March 2013. That same month, Critical Hub Networks announced the project’s expansion through the reinvestment of ARRA dollars to include a 17-kilometer fiber optic middle-mile segment in the San Juan Metropolitan area using the Tren Urbano rail system. The project was implemented in two phases over eight months and was completed in November 2013.

THE RACE FOR FIBER-TO-THE-HOME BROADBAND SERVICE IN PUERTO RICO - OPTICO FIBER

Competition drives investment and innovation within the Puerto Rico Broadband market. As the data in the previous segment indicates, providers, especially among the mobile and cable industries, have significantly invested in the Puerto Rico broadband landscape in recent years. By significantly upgrading the capacity of their networks and expanding connectivity into areas previously unserved, these providers are directly impacting consumers through more robust and faster services. Small and large providers throughout the Island are responding to market pressures to do the same.



Optico Fiber is an example of competitive market forces working effectively to deliver gigabit connectivity in areas where there is sufficient demand. Harnessing this demand in advance of service delivery provides a clear return on investment as expected revenues justify the capital investment needed to construct FTTH networks. While these innovative fiberhood models have been developed and implemented elsewhere, Optico Fiber has demonstrated that consumers in Puerto Rico also have an appetite for gigabit service and that the private sector is willing and able to meet the challenge. Innovative ventures such as Optico Fiber are key to ensuring competitive market responses that, as has been the case in the U.S. mainland, will drive others to improve broadband capacity offerings and invest in network build-out, essential components to meeting the Gigabit Island goals.

Google Fiber

Google Fiber launched in Kansas City in 2012, delivering 1 Gbps, fiber-to-the-home connectivity.⁹⁴ This initiative demonstrated pent-up demand for gigabit connectivity in the home, and introduced an innovative marketing and deployment strategy that triggered a strong competitive response in the market. In 2010, Kansas City was selected among many candidate cities to launch the Google fiber pilot.

To guide service implementation, Google divided Kansas City into “fiberhoods” and dictated service delivery according to the fiberhoods that achieved a critical mass of pre-registrations over a 6-week period, with the highest pre-registration rates served first. Google Fiber offered residents three connectivity packages including: Gigabit + TV service, Gigabit Internet service, or free basic Internet service of up to 5 Mbps down/1 Mbps up.⁹⁵ Under Google Fiber’s “Community Connections” program, community buildings are also able to receive free gigabit service for a minimum of ten years.⁹⁶ One year after the launch, fiber connectivity was available in over half of the fiberhoods. Within 18 months, Google Fiber’s subscription rate was 75% in certain parts of Kansas City, typically those considered medium-to-high income, and around 30% among lower-income households.⁹⁷ Survey research estimates that Google Fiber could reach over 50% penetration among all Kansas City neighborhoods for its paid subscription services, with another 10% selecting the free monthly service, within 3-4 years.⁹⁸ Based on the success of the Kansas City pilot, Google is exploring 34 additional cities to expand this model.⁹⁹

Competitive forces did not take long to respond to the Google Fiber market challenge. In April of 2014, AT&T announced plans to launch AT&T GigaPower fiber-to-the-premises (FTTP) network service in potentially 100 cities, including 21 metropolitan areas.¹⁰⁰



STIMULATE BROADBAND ADOPTION TO ENCOURAGE FURTHER INVESTMENT

Ongoing growth is essential for the broadband market in Puerto Rico to sustain. The residential broadband subscription rate increase from 31% in 2010 to 46% in 2014, along with the growth in the business and mobile markets, has helped catalyze the broadband access and capacity growth observed during this period. Yet, broadband adoption in Puerto Rico still lags behind U.S. mainland trends in which 70% of U.S. households subscribe to broadband.

Demand for broadband services in Puerto Rico needs to grow in order to stimulate further investment and deliver gigabit speeds to Puerto Rico households. The following section comprehensively addresses the adoption challenge that Puerto Rico still faces, as well as opportunities to close this adoption gap, including expansion of education technology in the K-12 system.

THE GIGABIT ISLAND PLAN

STRATEGIES TO ACCELERATE BROADBAND INFRASTRUCTURE EXPANSION

SUMMARY RECOMMENDATIONS

This section provided an analysis of Puerto Rico's current broadband inventory and identified broadband infrastructure gaps, as well as recommendations for overcoming these challenges, in order for Puerto Rico to become the Gigabit Island.

Key Recommendations:

- Continue and expand Island-wide broadband mapping
- Monitor, Measure, and Assess the Impact of Broadband Across the Puerto Rico Economy
 - Measure and publish aggregate, industry-wide data regarding broadband investment trends
 - Measure and publish aggregate broadband use patterns
 - Adjust Puerto Rico economic indicators to estimate and monitor the impact broadband has on the overall economy
- Lower the costs of broadband build-out through community and provider collaboration, including:
 - Streamlining construction permitting and planning
 - Ensuring ready and cost-effective access to poles, ducts, conduits, and right-of-ways, both privately and publicly owned
 - Leveraging existing public assets to incent public and private broadband expansion
 - Advancing effective "Dig Once" legislation
- Promote public-private partnerships to stimulate local demand and expand market opportunities
- Leverage federal support for broadband expansion
- Stimulate broadband adoption to encourage further investment



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22. The Planning Board of Puerto Rico (Junta de Planificación) is charged with collecting and monitoring economic trends on the Island to project the overall health and sustainability of Puerto Rico's economy. For more information on the Planning Board see <http://www.jp.gobierno.pr/>.
23. Federal Communications Commission, National Broadband Plan, 2010, <http://www.fcc.gov/national-broadband-plan>.
24. Ibid.
25. For further information, see Successful Practices of Broadband Deployment in Highway Rights of Way; Summary Paper, May 2013, U.S. Department of Transportation, Federal Highway Administration, Office of Policy and Governmental Affairs, available at www.fhwa.dot.gov/policy/otps/successprac.cfm.
26. Ibid.
27. S. 1203, 17th Gen. Assemb., 4th Sess. (P.R. 2014).
28. Davidson, Charles M. & Santorelli, Michael J., Understanding the Debate over Government-owned Broadband Networks: Context, Lessons Learned, and a Way Forward for Policy Makers, June 2014, <http://www.nyls.edu/advanced-communications-law-and-policy-institute/wp-content/uploads/sites/169/2013/08/ACLP-Government-Owned-Broadband-Networks-FINAL-June-2014.pdf>.
29. For more information, see <http://www.corredordigital.com/realestate>.
30. Federal Communications Comm'n, FCC 11-161, Report and Order and Further Notice of Proposed Rulemaking (2011), available at https://apps.fcc.gov/edocs_public/attachmatch/FCC-11-161A1.pdf.
31. Universal Service Administrative Company, Frequently Asked Questions, <http://www.usac.org/about/about/universal-service/faqs.aspx>.
32. Universal Service Administrative Company, 2013 Annual Report, available at <http://www.usac.org/about/tools/publications/annual-reports/default.aspx>.
33. National Broadband Map, <http://www.broadbandmap.gov/>.
34. 2012 Broadband Strategic Plan, http://www.connectednation.org/sites/default/files/bb_pp/pr_bb_plan_final.pdf.
35. Public Notice, Over \$32 Million of Connect America Funding Authorized to Connect Unserved Homes and Businesses in Alaska, Hawaii, and Puerto Rico (Oct. 31, 2013), available at <http://apps.fcc.gov/ecfs/document/view?id=7520954334>.
36. For more information on the FCC's Rural Broadband Experiments see http://www.connectednation.org/sites/default/files/bb_pp/policy_brief_on_rbe_provisional_winners_12052014.pdf.
37. Connect America Fund, Report and Order, WC Docket No. 10-90, FCC 14-190, para. 45 (rel. Dec. 18, 2014).
38. Letter from Thomas J. Navin, Wiley Rein LLP, to Julie Veach, Chief, Wireline Competition Bureau, Federal Communications Commission, WC Docket No. 10-90 (Dec. 22, 2014).
39. For more information on BTOP-funded projects see <http://www.ntia.doc.gov/report/2014/twenty-first-quarterly-status-report-congress-regarding-btop>.

A stylized map of Puerto Rico is centered on a light blue background. The map is dark blue and has a torn-paper edge effect. The text "SECTION IV" is written in white, uppercase letters across the middle of the map. The background features several large, dark blue geometric shapes that resemble stylized buildings or abstract architectural elements.

SECTION IV

BROADBAND
ADOPTION ACROSS
PUERTO RICO



The 2012 Puerto Rico Broadband Strategic Plan set the strategic goal that “[a]ll Puerto Ricans, regardless of income, race, gender, age, or location should have access and the willingness to partake and benefit from the online opportunities available through broadband.”⁴⁰ While expanded access and enhanced investment in broadband infrastructure is encouraging, without corresponding broadband adoption among Puerto Rico consumers and businesses, further build-out could be deterred. It is in the interest of both private and public leaders to work together to bridge the remaining broadband adoption gaps and ensure that all Puerto Ricans are able to participate and compete in the twenty-first century interconnected, global economy.

This chapter examines the broadband adoption rates and gaps across Puerto Rico in its current state and over the past four years, providing trend data since 2010. The chapter also focuses particular attention on various demographics and corresponding

“The success of the digital age does not rest in more or better broadband ‘pipes’ and should not be measured in terms of access bits, but rather in terms of number of adopters and scope and quality of usage of the technology.”

-2012 Puerto Rico Broadband
Strategic Plan

barriers to broadband adoption. This segment includes information from two key data sources – the Connect Puerto Rico Residential Broadband Surveys in 2010, 2012, and 2014⁴¹ and the 2014 Digital and Mobile Behavior Study conducted by Estudios Técnicos. It then presents examples of existing programs, both in Puerto Rico and beyond, that have addressed broadband adoption gaps, and assesses the successes and shortfalls in these approaches. Building upon

this information, the section closes with a series of strategic policy recommendations to ensure that broadband adoption in Puerto Rico aligns with the goal of becoming a Gigabit Island.

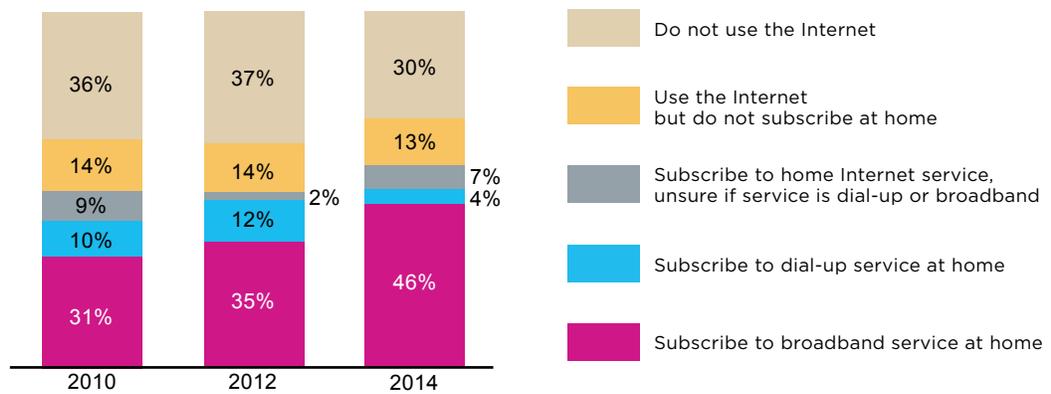


BROADBAND ADOPTION IN PUERTO RICO - 2010-2014

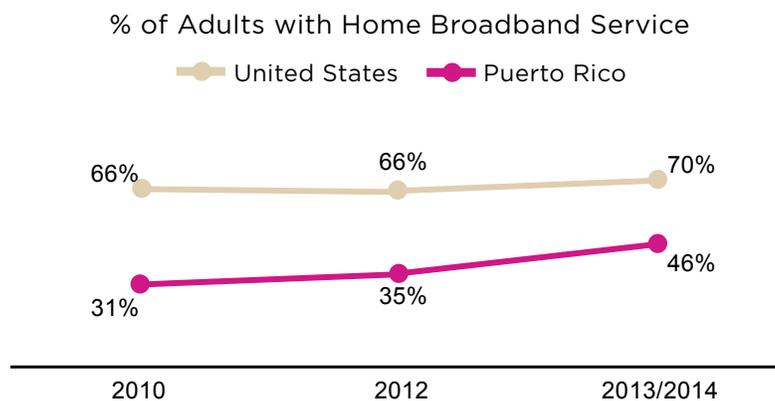
The 2012 Plan set goals that, by 2013, residential broadband adoption across Puerto Rico should be at least 50% and at least 70% by 2015. This section analyzes the progress toward meeting these goals and the remaining gap in fixed broadband adoption among Puerto Rico residents.

FIXED BROADBAND ADOPTION TRENDS

The residential broadband market in Puerto Rico has witnessed significant growth in the last four years. In 2014, 46% of Puerto Rico households subscribe to broadband service, up from 31% in 2010. This represents an increase of approximately 377,000 adults who now have at-home broadband service.



By comparison, home broadband adoption across the United States grew by just 4 percentage points between 2010 and 2013.⁴²

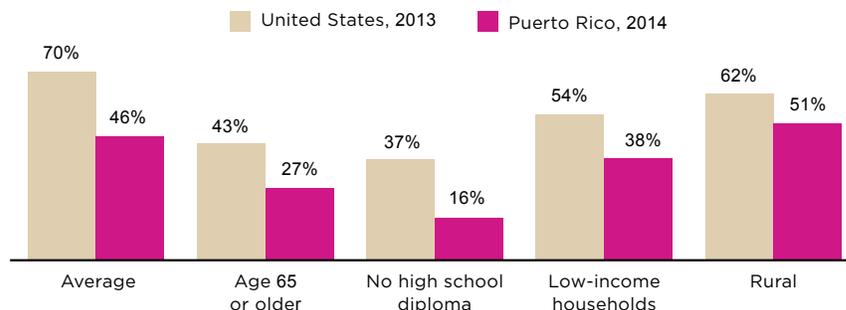




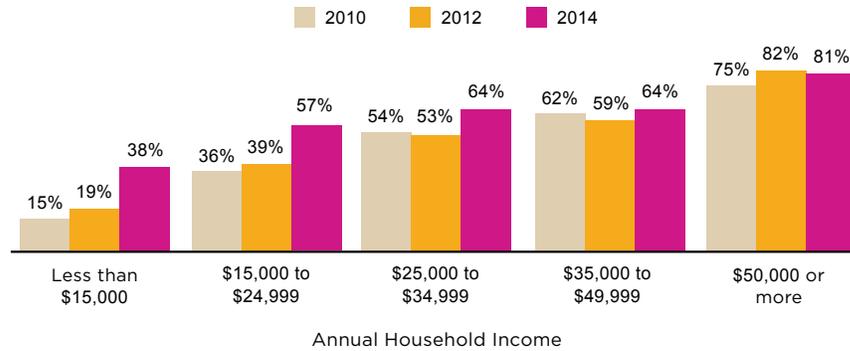
When Connect Puerto Rico began conducting its surveys in 2010, broadband adoption on the U.S. mainland was already more than double that of Puerto Rico, a substantial hurdle to overcome. As represented on the previous page, Connect Puerto Rico's 2010 residential technology assessment indicated that only 31% of Puerto Ricans had a broadband connection at home,⁴³ significantly below the U.S. mainland adoption rate at that time of 66%.⁴⁴ Notwithstanding Puerto Rico's rapid market growth over the past four years, broadband adoption on the Island still lags behind other U.S. jurisdictions. While broadband adoption growth is expected to continue, it is unlikely that this growth would be sufficient to reach the benchmark from the 2012 Strategic Plan of 70% of residents with an at-home subscription by 2015, or to bring the Puerto Rico broadband market in line with similar U.S. economies within the immediate future.

Home Broadband Adoption Rates in Puerto Rico			
	2010	2012	2014
Island-Wide	31%	35%	46%
Age 65 or older	5%	13%	27%
No high school diploma	7%	8%	16%
Low-income households	15%	19%	38%
Adults with disabilities	21%	18%	37%
Rural	34%	31%	51%

Broadband adoption figures across Puerto Rico also reveal a persistent gap among certain demographic groups. Broadband non-adopters in Puerto Rico are generally low-income, senior citizens, people with disabilities, and/or individuals with less education, which mirrors demographic trends on the U.S. mainland and elsewhere.⁴⁵ Similar to Puerto Rico's overall broadband adoption rate, these populations continue to have lower broadband subscription rates than their peers on the U.S. mainland.⁴⁶ However, unlike in the rest of the United States, rural residents in Puerto Rico tend to keep pace (or in some years, even surpass) the Island-wide average.⁴⁷



BROADBAND ADOPTION ACROSS PUERTO RICO



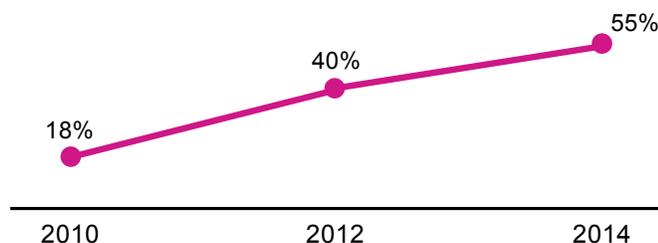
The broadband adoption gap remains particularly acute among low-income Puerto Ricans. Among Puerto Rico households earning less than \$15,000 annually, 62% of households do not have broadband in the home. Studies from Estudios Técnicos and the Puerto Rico chapter of the Internet Society also show that, while Internet usage is increasing among Puerto Ricans with annual household incomes below \$15,000, they are still using the Internet at a rate lower than those with higher annual household incomes.⁴⁸ A study by Estudios Técnicos also showed a slight downward trend in Internet usage – a decrease of 1.2 percentage points – between 2013 and 2014 among this group. This could reflect a contraction of the market among low-income households; however, it is too soon to know whether this is a one-year effect or whether the trend will continue.

Overall, studies from both Connect Puerto Rico and Estudios Técnicos indicate that income remains a critical factor in the growth of the broadband market in Puerto Rico.

MOBILE BROADBAND ADOPTION TRENDS

Advances in mobile technology continue to make Internet connectivity more accessible and affordable than ever before. As expressed in the broadband infrastructure chapter, 99.9% of Puerto Rican households had access to mobile broadband speeds of at least 3 Mbps/768 Kbps by June 30, 2014. Similar to fixed broadband adoption, mobile adoption in Puerto Rico has increased substantially - by 2014, 55% of Puerto Rico residents used mobile broadband. This percentage mirrors usage rates on the U.S. mainland.

% of Adults who Use Mobile Broadband Service in Puerto Rico





According to the Pew Internet Research Center, 90% of Americans own cell phones and 63% of adult cell phone owners use their cell phones to go online.⁴⁹ This amounts to 57% of American adults going online via cell phones, which is similar to the share of Puerto Rican adults who use a cellular network to connect to the Internet.⁵⁰

Computer Ownership in Puerto Rico			
	2010	2012	2014
Computer ownership	55%	60%	61%
Desktop computer ownership	34%	17%	22%
Laptop computer ownership	37%	34%	47%
Tablet computer ownership	n/a	2%	16%

This increased focus on mobility can be seen in computer ownership patterns between 2010 and 2014. Overall, computer ownership has only grown by 6 percentage points in Puerto Rico during this time. Further examination shows that a shrinking number of Puerto Ricans own desktop computers. Rather, laptop and tablet computer ownership has been on the rise, particularly since 2012. This may be boosting mobile Internet usage across the Island – the ability to use a tablet at Wi-Fi hotspots would allow an individual to stay connected to the Internet without the monthly cost of a home broadband subscription.

PRICES AND SPEEDS REPORTED BY HOME BROADBAND SUBSCRIBERS

Broadband costs and availability are instrumental to a household's ability to subscribe to service. As a result, these two factors must be explored as Puerto Rico aims to become the Gigabit Island.

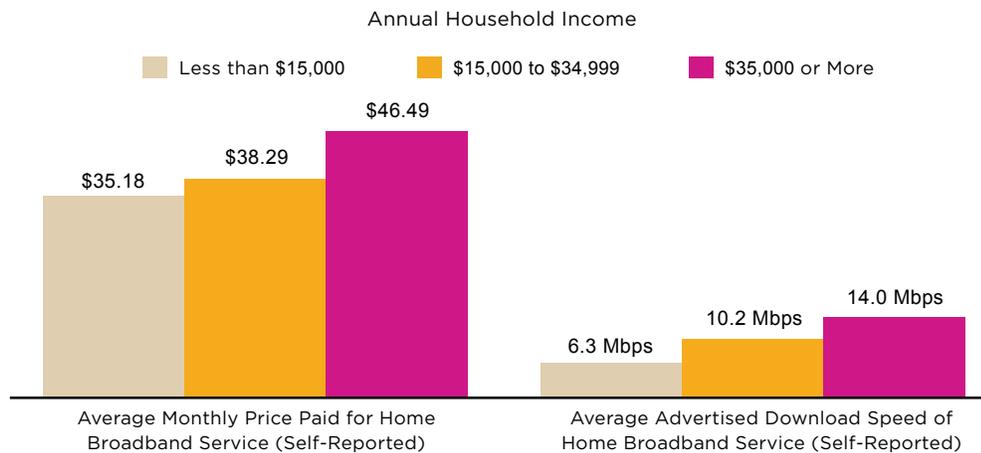
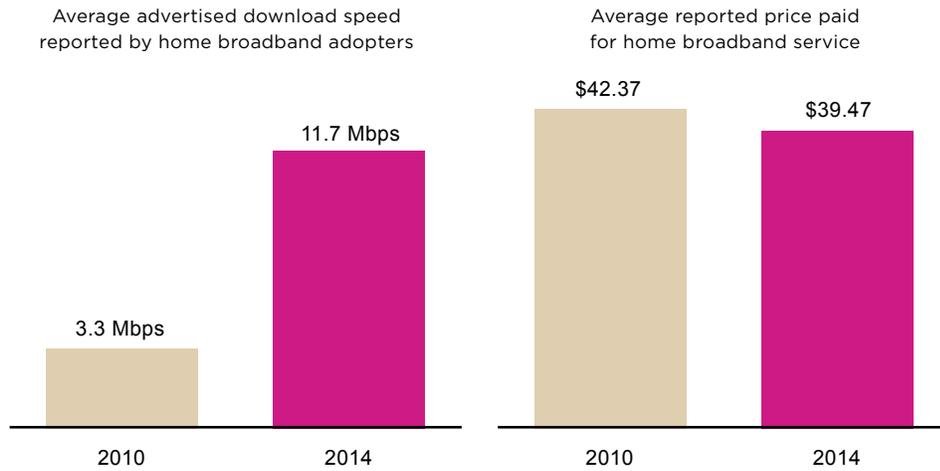
Across Puerto Rico, home broadband subscribers report that they pay \$39.47 per month on average for their home broadband service. This is down slightly from 2010 when broadband subscribers reported paying an average of \$42.37 for their monthly broadband service.⁵¹

Home broadband subscribers who know their current advertised download speed report it to be 11.7 Mbps, compared to 3.3 Mbps in 2010.⁵²

This self-reported information suggests that households in Puerto Rico are embracing increasingly faster broadband speeds, while paying less on average. This increase in speeds can be attributed to several factors, such as improved infrastructure making faster broadband available to more households and increased demand for content that requires higher bandwidth (such as streaming video).



As with home broadband adoption rates, income affects the speed and quality of broadband service to which Puerto Rican households subscribe. While broadband subscribers with annual household incomes below \$15,000 pay less than wealthier households on average, they report that their advertised broadband speeds are much lower.





BARRIERS TO ADOPTION

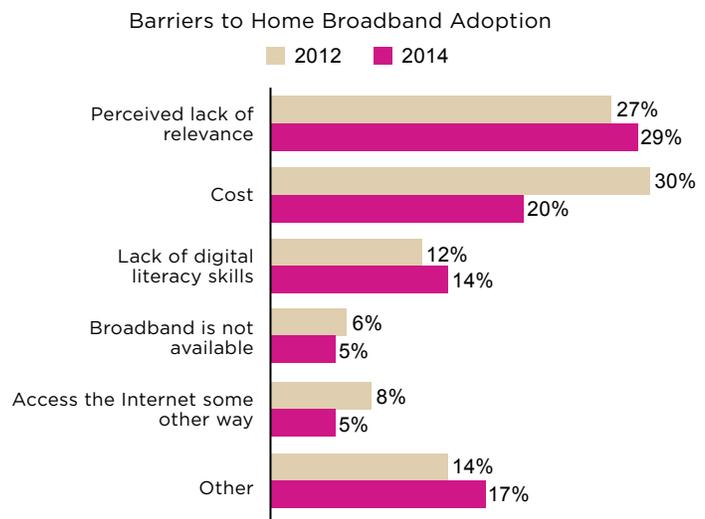
The barriers to at-home broadband adoption are consistently delineated into three main categories:

1. affordability of service and/or the device;
2. relevancy of online resources; and
3. digital skills to use the device and connectivity.

However, research demonstrates that the factors leading to non-adoption are not entirely independent and should not be considered in isolation. For example, while ensuring that broadband and related technologies are affordable is instrumental in bridging the digital divide, cost alone is insufficient to explain and/or address gaps in home broadband subscriptions. And, as

expressed in a recent report by McKinsey, “[d]espite the increasing utility of the Internet in providing access to information, opportunities, and resources to improve quality of life, there remain large segments of the offline population that lack a compelling reason to go online.”⁵³ Overall, “meaningfully addressing these barriers and boosting Internet penetration will require coordination across Internet ecosystem participants.”⁵⁴

Across Puerto Rico, over one-half of adults (54%) do not subscribe to home broadband service. Among the non-adopters, the primary reason for not subscribing is a perceived lack of relevance, or a belief that subscribing to home broadband service does not present enough of a benefit to be worthwhile - 29% (434,000 adults) cite this as the main reason they do not subscribe to home broadband service.

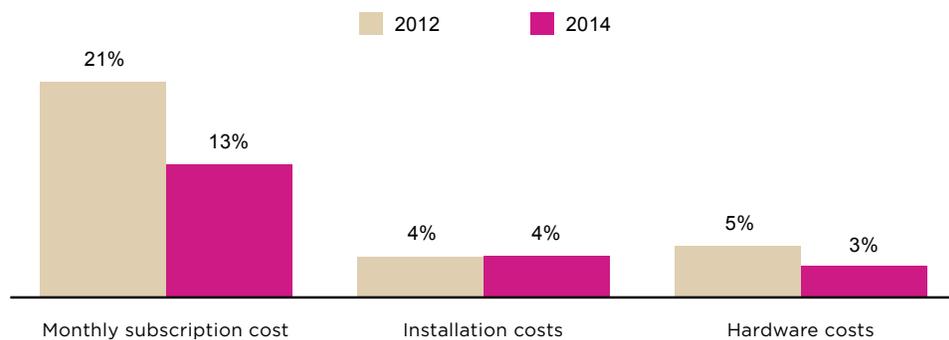




Cost, which represents both the monthly cost of home broadband service as well as the cost of the necessary equipment and installation, is the second most-cited barrier. Approximately one in seven non-adopters in Puerto Rico says that they lack the digital literacy skills to use a computer or access the Internet. Approximately 73,000 adults in Puerto Rico (5% of non-adopters) say that they cannot get broadband where they live or the available broadband service is unreliable. An additional 5% say they rely on other means to access the Internet, such as public computing centers, friends' or family members' homes, or their cell phones.

Although cost is the second-most-cited barrier to home broadband adoption, this issue has demonstrated the largest decrease since 2010 when 30% of non-adopters said that cost was their main barrier. In particular, the monthly cost of home broadband service has become less of a barrier for Puerto Ricans - while there were slight shifts in the share of non-adopters who cited the cost of a computer or installation costs, the biggest drop was among non-adopters who said that the monthly cost of service was their main barrier to home broadband adoption.

% of Non-Adopters Who Cite the Following Costs as
Their Main Barrier to Home Broadband Adoption



As Puerto Rico charts its course toward becoming a Gigabit Island, the recommendations of the 2012 Plan to promote broadband adoption and Internet use remain viable. It is essential to tackle the persisting adoption gaps, especially among the particular demographic groups outlined earlier.



BROADBAND ADOPTION INITIATIVES FOR A SUSTAINABLE GIGABIT ISLAND

There is no silver bullet to addressing the digital inclusion challenges that vulnerable populations face in Puerto Rico and elsewhere. Successful models of digital inclusion include an assortment of strategies described in the 2012 Puerto Rico Broadband Strategic Plan, such as expanding public computing centers that offer free online access to vulnerable populations, enhancing digital literacy training resources to address the need for digital skills, and encouraging the relevance of online resources for those that remain disconnected. According to the NTIA Broadband Adoption Toolkit, effective broadband adoption programs generally follow a 4-step development process: (1) needs assessment, (2) stakeholder engagement, (3) program implementation planning, and (4) continuous improvement.⁵⁵

“No two broadband adoption programs can be exactly the same because no two communities are the same. Each has its own characteristics, needs, opportunities, and challenges.”

-NTIA Broadband Adoption Toolkit

There are many examples of initiatives in Puerto Rico and the U.S. mainland that are working to close the digital divide. In this section we highlight such examples and outline the effective strategies they use to promote digital inclusion, as well as the ongoing challenges they encounter. Many of these case studies center on public-private partnerships working at the state and local levels to expand public computing centers and training resources to help address key barriers to broadband adoption among vulnerable populations.

CENTROS TECNOLÓGICOS COMUNITARIOS (CTC) - COMUNIDADES ESPECIALES

The Centros Tecnológicos Comunitarios (CTC), or Community Technology Centers, were established in 2001 via funding under law for the development of the Comunidades Especiales (Special Communities) of Puerto Rico. The objective for each CTC is to provide public computing access and training to all residents of disadvantaged communities, as defined by factors including high unemployment rate, high percentage of the population below the poverty line, and high percentage of school dropouts. Over time, administration of the CTCs was transferred to municipalities, the Department of Education, public-private partnerships, or other entities to continue serving as a community resource.

As discussed above, a key challenge to encourage investment and ensure a sustainable Gigabit Island is expanding the demand and use of broadband infrastructure and related services across the entire population. The 2012 Plan encouraged public-private collaboration at the national and local level to expand existing public computing centers, such as the Centros Tecnológicos Comunitarios, and increase the training resources offered through these centers to catalyze such demand. Yet, the developments in public computing since 2012 have not been positive; since that time, there has been a reduction



in the overall number of CTCs and their offerings. Due to budget cuts, the CTCs have had to curtail services and even close facilities. For the active CTCs, resources and training for the community leaders serving as facilitators have been inconsistent and/or inadequate to fully leverage the CTC for economic and social change in the community.

A public-private initiative would be beneficial to understanding the gaps in public computing services across the Island, and working to address those gaps. Key steps should include: i) a comprehensive assessment and real-time database of the current state of CTCs' public computing centers addressing their presence and capacity, as well as the training resources offered to and through these centers; ii) determination of vulnerable communities lacking such infrastructure; iii) a proposal for a phased plan to expand and/or upgrade CTCs or other public computing centers in target communities; and iv) an assessment of potential expansion of services rendered through CTCs and possible interrelationships with other organizations and programs.

Connected - An Example of Community Engagement to Close the Broadband Adoption Gap

Michigan has emerged as a leader in broadband adoption projects through its success in the Connected Community Engagement Program ("Connected"). Based on national best practices, the Connected program engages and assists local communities to assess their broadband and technology status, develop a localized technology action plan, and catalyze community members to address the local broadband needs.

Connected community engagement teams convene leaders across multiple sectors including schools, libraries, local and county government, economic development, chambers of commerce, emergency services, healthcare, broadband providers, and others. These multi-dimensional groups are often the first gatherings of their kind and lead to natural collaborative models of broadband and technology expansion. From telework support centers, business website and social media classes, and digital literacy campaigns to expanding infrastructure, zoning ordinance review, and 1:1 educational device programs, Michigan's Connected communities are working to continually boost the state's standing in the digital economy.

Since the Connected program launch in fall 2011, Michigan has experienced a 10 percentage point increase in households adopting broadband, from 61% to 71%. The Connected program has directly impacted 26 communities, 1.1 million Michiganders, and 1,300 cross-sectorial community stakeholders and broadband providers statewide. Seven of these communities have achieved certified Connected community status; a designation verifying the community as a technology- and investment-friendly location to attract local entrepreneurs and outside companies to locate or expand their businesses in the area.



CENTROS DE INTERNET - A TELECOMMUNICATIONS REGULATORY BOARD INITIATIVE

Puerto Rico Law 101, enacted July 28, 2010, mandated the Puerto Rico Telecommunications Regulatory Board to establish a Free Internet Access Center (FIAC) in each of the 78 municipalities in coordination with central government agencies, the municipalities themselves, and other private, educational, and community entities as deemed necessary.

Connect Puerto Rico's 2010 Residential Technology Assessment confirmed the value of these Internet Access Centers. Community centers were identified as the 5th most popular place to access hot spots. Most of the thirty-two centers offer connectivity at speeds of 3 Mbps download and have 10 computer stations. These Internet Access Centers serve as public computer centers, making broadband access available to all citizens, specifically those who may not have access to the Internet through home, mobile, or other locations. As Puerto Rico sets its path toward becoming the Gigabit Island, the existence of these centers alone is insufficient to catalyze demand for broadband. Stakeholders must ensure that the Free Internet Access Centers offer a positive user experience to encourage, instead of further deter, broadband adoption.

In 2014, the Regulatory Board expanded digital literacy services offered at these centers through a program called "TecnoAbuelos." The initiative is part of the agency's Planning, Adoption and Access and Incentives for Broadband Services program, known in Spanish as "PAIS Banda Ancha."⁵⁶ The free workshops provided senior citizens with basic skills to access online resources through smartphones, tablets or computer equipment.⁵⁷

In the U.S. mainland, libraries help fill the void when broadband access or adoption is not prevalent in the home. Increasingly, these public libraries are taking a new role as a technology hub for their local community. However, such a widespread public library system does not exist in Puerto Rico; instead, the Centros Tecnológicos Comunitarios and the Centros de Internet must stand in their place. The progressive defunding of CTCs across Puerto Rico works directly against the stated goals for the Island and should be addressed by both private and public stakeholders.



Every Citizen Online (ECO)

Connect Ohio launched the Every Citizen Online (ECO) program in late 2010 to address the need for enhanced digital literacy skills and broadband adoption in Ohio. Every Citizen Online collaborated with community anchor institutions throughout the state to offer in-person and online basic computer and Internet instruction.

Initially, Connect Ohio had presumed that individuals would utilize the self-paced training over the in-person classes at a ratio of nearly two-to-one. However, many participants lacked the digital literacy skills to turn on a computer, let alone open a web browser, making self-paced instruction impossible. By the close of the program, more than 43,000 Ohioans had participated in Every Citizen Online training at over 400 community anchor institutions throughout Ohio, over 200 of which were libraries.

Research at ECO's launch demonstrated that only 38% of library patrons subscribed to home broadband and 27% of daily visitors to library computing centers did not have computer or broadband access at home.¹⁰⁰ Surveys at the close of the program showed that more than half of the ECO respondents intended to subscribe to at-home broadband service as a result of the training (58%) and 19% had already ordered a subscription.

FCC LIFELINE BROADBAND ADOPTION PILOTS IN PUERTO RICO

The FCC established the Lifeline broadband pilot program in 2012 as a competitive selection program designed to test how best to increase high-speed Internet adoption among low-income Americans. The \$14 million pilot program officially launched in May 2013 with 14 diverse provider projects offering discounted broadband service to targeted low-income households.⁵⁸

Because these pilot programs could help close the acute adoption gap in Puerto Rico, the Broadband Taskforce, supported by the CIO's office and the Telecommunications Regulatory Board, led a campaign to inform Puerto Rico broadband providers of the opportunity.

These efforts paid off; of the 14 provider projects throughout the nation, Puerto Rico was host to 3 projects with nearly \$3.7 million in total funding, as described below:

- **Open Mobile:** The Open Mobile project offered a flat subsidy of \$25 off of five different wireless broadband plans. Each plan came with the same end-user charge



and usage limits, but with access to different equipment (e.g., USB modem, hotspot modem (mi-fi), tablet, laptop, or desktop) that the subscriber would pay for at a discounted amount. The study collected data on the effect(s) of a subsidy on connectivity and how the type of equipment impacts data usage and adoption. The total funding limit for this project was \$661,613.

- **Puerto Rico Telephone Company (PRT):** PRT tested consumers' preferences for wireless or wireline broadband, speeds for wireline broadband, and usage limits for wireless broadband by offering subscribers the option to choose among four plans with differing end-user prices. PRT offered consumers the option of a \$5 subsidy off of the bundled wireless plan, or \$18.50 off of the stand-alone broadband plans. The funding limit for this project was \$2,500,000.
- **T-Mobile:** T-Mobile, in partnership with Sistema Universitario Ana G Mendez and Centro Para Puerto Rico, tested various advertising and outreach methods to determine what type of communication most effectively increased broadband adoption. T-Mobile also offered a flat-rate subsidy of \$20 off of broadband plans with varying usage limits. The funding limit for this project was \$505,400.

Results from these and the other Lifeline pilot projects are still being examined by the FCC. It is unclear at this point what the results of these pilot programs will be across Puerto Rico. Beyond the direct impact of the pilot programs, it will be important to assess how the three competitive, low-cost broadband offerings have impacted the market. In particular, to what extent has targeting one of the key disconnected demographics (low-income) helped spur broadband growth and contributed to the increase in broadband adoption in Puerto Rico over the last two years.

CAMPAIGNS TO PROMOTE DIGITAL LITERACY - EVERYONEON

In November 2013, the Puerto Rico Broadband Taskforce announced the launch of EveryoneOn in Puerto Rico,⁵⁹ a national public service campaign aimed at promoting the importance of digital literacy skills in the twenty-first century digital economy and increasing access to free computer and Internet training classes.

Through the collaboration, three public service announcements (PSAs) were distributed by the Ad Council in English and Spanish to help raise awareness and reach non-adopting populations in Puerto Rico. Callers who responded to the PSAs were provided information regarding free digital literacy training in their area.⁶⁰ The Puerto Rico Broadband Taskforce collaborated with government, community leaders, and nonprofit organizations to identify digital literacy classes for inclusion in the EveryoneOn database.

Many private sector organizations and local media members also recognized the importance in driving this program. Liberty, Choice, Claro, and Puerto Rico TV (WIPR) donated media time to the campaign to air the Spanish advertisements; Dish Networks ran the advertisements in English. In addition, Banco Popular aired the advertisements within its branches. Critical Hub Networks and Puerto Rico Bridge Initiative donated the local Interactive Voice Response (IVR) phone system to field responses from the ads.



Strategies to Promote Broadband Adoption in Puerto Rico

Summary Recommendations

As expressed throughout this section and showcased by the above examples, Puerto Rico has experienced important growth and multiple successes in recent years; however, broadband adoption remains a challenge. Ongoing broadband adoption among Puerto Rico consumers and businesses is vital to ensuring further broadband infrastructure build-out and investment on the Island.

Key Recommendations:

- Continue to expand public digital literacy, and workforce development programs by leveraging existing community resources, support from national non-profit organizations, and public institutions such as the University of Puerto Rico campuses.
- Leverage existing online digital literacy curricula in order to sustain resources, both personnel and monetary.
- Maintain targeted awareness campaigns promoting the benefits of online resources across vulnerable populations, and supplement this communication with in-person, on-the-ground outreach from familiar and trusted community organizations.
- Encourage the private sector, in partnership with public agencies including the Public Housing Authority, the Special Communities Administration, the Department of Labor, Economic Development, and the Department of Family Affairs to establish programs that offer basic broadband service at discounted prices to the most vulnerable citizens in Puerto Rico.



40. Puerto Rico Broadband Strategic Plan, May 2012, http://www.connectednation.org/sites/default/files/bb_pp/pr_bb_plan_final.pdf.

41. Connect Puerto Rico's Residential Broadband Assessment is a consumer survey implemented in 2010, 2012, and 2014 to understand demand-side trends and barriers in the Puerto Rico broadband market. These surveys were conducted by Connect Puerto Rico on behalf of the Office of the Chief Information Officer as part of the State Broadband Initiative federal grant program, funded through the American Recovery and Reinvestment Act. Data were collected by Estudios Técnicos in Puerto Rico and weighting and research consultation were provided by Lucidity Research, LLC.

42. US data source: 2010, 2012, and 2013 United States from Pew Internet and American Life Project <http://www.pewinternet.org/2013/08/26/home-broadband-2013/>. Puerto Rico data source: Connect Puerto Rico 2010, 2012, and 2014 Residential Technology Assessments.

43. 2010 Connect Puerto Rico Residential Technology Assessment www.connectpr.org.

44. Pew Internet & American Life Project, Home Broadband Adoption 2010, August 2010. Alternatively, in 2011, a report released by the U.S. Department of Commerce titled, Exploring the Digital Nation, reported that 68% of Americans subscribed to home broadband service in 2010.

45. A recent report from McKinsey & Company confirmed that those who remain offline are disproportionately rural, low income, elderly, illiterate, and female. http://www.mckinsey.com/Insights/High_Tech_Telecoms_Internet/Offline_and_falling_behind_Barriers_to_Internet_adoption?cid=other-eml-alt-mip-mck-oth-1410.

46. US data source: 2010, 2012, and 2013 United States from Pew Internet and American Life Project <http://www.pewinternet.org/2013/08/26/home-broadband-2013/>. Puerto Rico data source: Connect Puerto Rico 2010, 2012, and 2014 Residential Technology Assessments. "Low-income households" defined as those with annual incomes below \$15,000 in Puerto Rico and below \$25,000 in the United States.

47. Source: Connect Puerto Rico's 2010, 2012, and 2014 Residential Technology Assessments. "Low-income households" defined as those with annual incomes below \$15,000.

48. Internet Access and Economic Development, presented at the Encuentro de Centros Tecnológicos Comunitarios (CTCs) by Anitza Cox of the Internet Society of Puerto Rico. This study measured Internet usage among Puerto Ricans age 12 and older.

49. Pew Internet Research Project www.pewinternet.org/fact-sheets/mobile-technology-fact-sheet/.

50. Ibid.

51. Connect Puerto Rico 2010 and 2014 Residential Technology Assessments. Prices are self-reported among respondents who knew how much they pay per month for home broadband service.

52. Connect Puerto Rico 2010 and 2014 Residential Technology Assessments. Advertised broadband speeds are self-reported by respondents who stated that they knew their bandwidth.

53. McKinsey & Company, Offline and Falling Behind: Barriers to Internet Adoption, September 2014, http://www.mckinsey.com/Insights/High_Tech_Telecoms_Internet/Offline_and_falling_behind_Barriers_to_Internet_adoption?cid=other-eml-alt-mip-mck-oth-1410.

54. Ibid.

55. National Telecommunications and Information Administration, U.S. Department of Commerce, NTIA Broadband Adoption Toolkit, May 2013, http://www2.ntia.doc.gov/files/toolkit_042913.pdf.

55. See <http://www.wifi.irtpr.pr.gov/blog/apoyo-a-fundamental-proyecto-enfocado-en-la-economia-del-futuro-ley-de-acceso-a-banda-ancha/>.



57. See <http://www.wifi.irtpr.pr.gov/blog/tecnoabuelos/> and <http://tecnoabuelos.com/wp/>.

58. For more information on the FCC's Lifeline pilot programs see <http://www.fcc.gov/encyclopedia/low-income-broadband-pilot-program> and <http://www.usac.org/li/about/broadband-pilot/default.aspx>.

59. See www.everyoneon.org.

60. See www.everyoneon.org and <http://everyoneon.org/?lang=es>.

A stylized map of Puerto Rico is centered on a teal background. The map is rendered in a dark teal color and has a rough, torn-paper-like edge. The text "SECTION V" is written in white, uppercase, sans-serif font across the middle of the map. The background features abstract, geometric shapes in various shades of teal and dark teal, creating a modern, layered effect.

SECTION V

BUILDING GIGABIT CAPACITY
TO PUERTO RICO'S SCHOOLS



The 2012 Puerto Rico Broadband Strategic Plan set the ambitious broadband connectivity goal of 100 Mbps across the Puerto Rico K-12 education system by 2015. The Plan also called for always-on online access to all students, both in and out of the classroom; ongoing development of a robust online curricula; and reform of teacher professional development plans to fully leverage online technology resources that help students achieve stronger academic outcomes.⁶¹ These goals and recommendations put forth by the 2012 Broadband Strategic Plan remain keenly relevant today.

Information technology has and continues to fundamentally transform education. For multiple decades, IT solutions have been an instrumental part of the K-12 experience at school libraries, school technology labs and — for some lucky students - in the classroom. Yet, it is only recently that we began approaching a tipping point that could transform the basic paradigm of education.⁶²

Lower-cost tablets, sufficient broadband bandwidth, online content development, and innovative pedagogical models are generating a new vision for the K-12 education experience. In this vision, Internet-ready devices (e.g., tablets and/or computers) are available to each student both in and out of the classroom at a 1:1 ratio to enable a 24/7 personalized learning experience. This model has the potential to facilitate individualized learning plans, real-time assessments, and immediate feedback on a student's academic progress. Responding to this technology challenge, in 2013 the White House launched its ConnectED initiative and the FCC embarked on reforming E-rate, the largest federal program supporting education technology.

This segment evaluates the current state of broadband and technology across Puerto Rico's K-12 system and the remaining challenges to meet the goals of the ConnectED initiative and the vision of the FCC. It then evaluates plans from the Puerto Rico Department of Education to expand Information technology throughout education, and compares those plans with similar strategies from other jurisdictions. Finally, we offer recommendations aimed at helping this important investment in education technology succeed.



The White House ConnectED Initiative

On June 6, 2013, President Obama announced his program to connect all U.S. schools to the digital age. ConnectED is a transformative education initiative with the goal of connecting 99 percent of America's students to next generation broadband at speeds of at least 100 Mbps, but with a target of 1 Gbps within five years. In order to create a "robust ecosystem for digital learning" and ensure equity for rural students, ConnectED will also invest in professional development opportunities for teachers and build on private-sector innovation to help bring twenty-first century educational resources to millions of K-12 students throughout the country.¹⁰¹

Private companies have pledged in-kind contributions equivalent to over a billion dollars in investment to support ConnectED's goals. Corporate partners of this initiative include:

- Apple is donating \$100 million in iPads, MacBooks, and other products, as well as content and professional development tools to enrich the learning experience in disadvantaged schools throughout the country.
- Microsoft will provide all U.S. public schools with significant discounts on its Windows operating system, which will decrease the price of associated Windows-based devices.
- O'Reilly Media is partnering with Safari Books Online to make more than \$100 million in educational content and tools available at no cost to every school in the U.S.
- AT&T and Sprint are each pledging approximately \$100 million in free mobile Internet connectivity for middle school students' educational devices.
- Verizon has announced up to \$100 million in monetary and in-kind support, including training for teachers on how to best leverage online content to educate the next generations, among others.

The President has also called upon the Federal Communications Commission to fundamentally reform the Schools and Libraries Universal Service Fund program, E-rate. The first phase of this reform was approved by the FCC in July 2014 and injects an additional \$1 billion per year over the next five years to support Wi-Fi connectivity across schools and libraries. This wireless capacity within the school and library premises is essential to support 1:1 devices for each student and education models that expand the possibilities for personalized education. The first phase of the E-rate reform will impact school and library budgets as early as 2015. Further information regarding this reform and implications for Puerto Rico are considered below.



PUERTO RICO DEPARTMENT OF EDUCATION TECHNOLOGY STRATEGY

The Department of Education of the Commonwealth of Puerto Rico (PRDE) recently released a revised five-year Technology Plan that drastically expands the reach and use of technology across the Island's K-12 system. According to the plan, at present "[v]ery often, only the teacher uses technology, such as a smart board; students do not have regular access to technology for learning. Where student technology access is available, it is often in a traditional "computer lab" setting rather than integrated into the everyday classroom curriculum."⁶³

Led by the Department's Chief Information Officer, the plan envisions an ambitious 5-year technology rollout to address the gaps across Puerto Rico public schools and "significantly improve educational outcomes."⁶⁴ The PRDE Technology Plan also addresses various reforms necessary to ensure that the new technology achieves its intended goals including curriculum integration, professional development, monitoring and evaluation of results, community and parental involvement, and infrastructure upgrades.

SCHOOL BROADBAND INFRASTRUCTURE UPGRADES

The PRDE's Technology Plan lays out an ambitious broadband infrastructure upgrade across all schools that will — in most cases — necessitate gigabit fiber connectivity to schools and back-offices in the system. "According to the PRDE Technology Plan, there is a broad consensus that Internet bandwidth is woefully inadequate, not only in the schools, but also in the regional offices, district offices, and even, to a lesser extent, at the department headquarters."⁶⁵ To address these deficiencies, key technology rollout goals include:

- Broadband access capacity to the school premise — Increasing from current levels to 10 Mbps per 1,000 students in 2015 and progressively up to 100 Mbps per 1,000 students by 2019.
- Robust wireless access capacity (Wi-Fi) within the school premise — Wi-Fi support to 25% of all classrooms by 2016 and 100% by 2019.
- 1:1 teacher and student educational devices
 - Starting in 2014, plans include pilot projects in which students can bring their own devices (BYOD) to the classroom.
 - By 2015 teachers will have a modern laptop or tablet at a 2:1 ratio (devices to teachers) and students will have use of a wireless device at a 5:1 (devices to students) ratio.
 - By 2016, all teachers will have a laptop.
 - By 2019, all teachers and each student will have access to their own device.



This technology rollout plan is highly ambitious and, if successful, will fundamentally transform Puerto Rico's education system and its technology capacity.

Top Five Largest School Districts in the United States Based on Pre-K to 12th Public School Enrollment

The Puerto Rico Department of Education is the third largest school district in the United States by public school enrollment in grades Pre-Kindergarten to 12th. One of the most glaring challenges with the Island's school population is that the vast majority of students are eligible for the free/reduced lunch program indicating that households are in a strained economic situation.

The Island also experiences the lowest high school completion rates compared to the other large school districts in the United States. Geographically speaking, the Puerto Rico Department of Education encompasses more square miles than the New York, Los Angeles, Chicago, and Dade County (Miami) school districts combined. Further, the rural population is the highest among all other districts included in the table below.

Rank	School District	Grades Pre-K to 12 Public School Enrollment ¹⁰²	Percentage of Students Eligible for Free/Reduced Lunch ¹⁰³	Pupil to Teacher Ratio	High School Graduation Rate ¹⁰⁴	Land Area of School District Per Square Mile ¹⁰⁵	Percentage of Population Living in Rural Areas ¹⁰⁶
1	New York City Department of Education	990,145	72.0%	15.9	61.3%	303.4	0.0%
2	Los Angeles Unified School District	659,639	61.7%	22.9	67.9%	640.9	0.1%
3	Puerto Rico Department of Education	437,744	95.1%	13.3	60.2%	3,423.7	6.2%
4	Chicago Public School District	403,004	86.3%	18.3	65.4%	227.1	0.0%
5	Dade County Public School District	350,239	71.9%	16.6	77.2%	1,893.3	0.4%
	United States Totals	48,212,483	45.1%	15.9	79.0%	3,532,292.4	19.3%



The table below provides statistics of broadband connections contracted across approximately 1,380 public schools in Puerto Rico's K-12 system in school years 2013-2014 and 2014-2015. The 2012 Broadband Strategic Plan reported that no school at that time had a broadband connection greater than 1.5 Mbps.⁶⁶ Median school broadband capacity in 2013-2014 was 3 Mbps. In line with the 2014-2019 PRDE Technology Plan, school connectivity in the current school year of 2014-2015 is expected to grow significantly.

The minimum planned broadband capacity per school for 2014-2015 is 5 Mbps, with a maximum planned connectivity of 150 Mbps. The median planned school connectivity across Department of Education school regions is 30 Mbps, with the exception of the Bayamón Region which will have median school capacity of 50 Mbps across all schools in the region.

This increased capacity translates into a drastic increase in bandwidth per student planned for the current school year. In 2013-2014, the average number of students per Mbps of capacity ranged from 92 to 112. Plans for 2014-2015 would result on average 6 to 10 students per Mbps of capacity. Once this level of connectivity to the school premises is achieved, plans for expanding wireless signals — or Wi-Fi service within the school premises - to enable 1:1 device educational models would become viable.

Puerto Rico Public School Bandwidth 2013-2014 School Year		
Connected Bandwidth	Number of Schools	% of Schools or Classrooms
T1 (1.55 Mbps)	137	9
DSL (2 Mbps)	275	19
3 Mbps	853	58
5 Mbps	113	8
10 Mbps	90	6

Source: PRDE request for E-rate funding to USAC, Funding Year 2013.



Puerto Rico Public School Bandwidth - 2014-2015 School Year		
Connected Bandwidth	Number of Schools	% of Schools or Classrooms
5 Mbps	4	
10 Mbps	53	4
20 Mbps	605	41
50 Mbps	357	24
100 Mbps	165	11
150 Mbps	1	
Classrooms with Wired Drops		22
Classrooms with Access to Wi-Fi Signal		16

Source: PRDE request for E-rate funding to USAC, Funding Year 2014.

The following table presents data of school broadband connectivity by each of seven education regions used by PRDE for planning purposes. Data for school year 2013-2014 is historical; data for school year 2014-2015 reflects planned connectivity. The table includes summary data of school connectivity for each of these school years and includes the median speed connectivity and average number of students per Mbps contracted in each region.

Puerto Rico Public School Bandwidth by Education Region 2013-2014 and 2014-2015 School Years							
		2013-2014 School Year			2014-2015 School Year		
Education Region	Number of Schools	Number of Students	Median Speed (Mbps)	Average Number of Students per Mbps	Number of Students	Median Speed (Mbps)	Average Number of Students per Mbps
Arecibo	179	58,755	3	109.41	56,965	30	10.61
Bayamón	171	57,945	3	112.95	56,153	50	6.57
Caguas	196	58,904	3	100.18	57,245	30	9.74
Humacao	184	59,363	3	107.54	56,888	30	10.31
Mayaguez	223	61,631	3	92.12	59,754	30	8.93
Ponce	221	65,479	3	98.76	63,102	30	9.52
San Juan	205	61,857	3	100.58	60,843	30	9.89

Source: PRDE.



The following table presents data of school broadband connectivity by municipality. Data for school year 2013-2014 is historical; data for school year 2014-2015 is planned connectivity. For each of these school years, the table includes minimum, maximum, average, and median bandwidth across all public schools in each municipality.

Puerto Rico Public School Bandwidth by Municipality 2013-2014 and 2014-2015 School Years										
			2013-2014 School Year Download Speeds (Mbps)				2014-2015 School Year Download Speeds (Mbps)			
Municipality	School Region	Number of Schools	Min	Max	Mean	Median	Min	Max	Mean	Median
Adjuntas	Ponce	10	1.5	10	2.95	2.25	30	100	46.00	30
Aguada	Mayaguez	20	1.5	10	3.53	3	30	100	48.00	30
Aguadilla	Mayaguez	22	3	10	3.41	3	30	100	41.82	30
Aguas Buenas	Caguas	12	1.5	10	3.71	3	30	100	45.00	30
Aibonito	Caguas	13	3	10	4.62	3	5	100	48.08	50
Anasco	Mayaguez	12	1.5	10	3.96	3	30	100	44.17	40
Arecibo	Arecibo	36	1.5	10	3.40	3	5	150	46.43	40
Arroyo	Caguas	10	3	10	3.70	3	30	100	43.00	30
Barceloneta	Arecibo	9	1.5	10	3.67	3	30	100	55.56	30
Barranquitas	Caguas	16	1.5	5	3.28	3	30	100	48.13	30
Bayamon	Bayamon	61	1.5	10	3.26	3	10	100	44.92	50
Cabo Rojo	Mayaguez	16	1.5	10	3.91	3	10	100	49.38	50
Caguas	Caguas	49	1.5	10	3.27	3	10	100	43.13	30
Camuy	Arecibo	13	1.5	10	3.96	3	30	100	52.31	50
Canovanas	Humacao	15	1.5	5	3.30	3	30	100	41.33	30
Carolina	San Juan	42	1.5	10	3.18	3	30	100	52.86	50
Catano	Bayamon	11	1.5	10	3.68	3	30	100	45.45	50
Cayey	Caguas	22	3	5	3.18	3	10	100	47.27	30
Ceiba	Humacao	5	1.5	10	4.10	3	30	100	48.00	30
Ciales	Arecibo	11	1.5	10	3.59	3	10	100	44.55	30
Cidra	Caguas	13	1.5	10	3.58	3	30	100	64.62	50
Coamo	Ponce	18	1.5	10	3.86	3	10	100	44.44	40
Comerio	Caguas	13	3	10	4.00	3	10	50	33.08	30
Corozal	Bayamon	14	3	5	3.14	3	10	100	50.71	50
Culebra	Humacao	1	10	10	10.00	10	10	10	10.00	10
Dorado	Arecibo	12	3	10	4.33	3	30	100	44.17	40
Fajardo	Humacao	11	3	10	4.27	3	30	100	61.82	30
Florida	Arecibo	5	3	10	4.40	3	30	100	56.00	50
Guanica	Ponce	10	1.5	5	2.90	3	30	100	39.00	30
Guayama	Caguas	19	1.5	10	3.24	3	30	100	53.68	50
Guayanilla	Ponce	9	1.5	10	3.61	3	10	100	51.11	30



Puerto Rico Public School Bandwidth by Municipality 2013-2014 and 2014-2015 School Years										
			2013-2014 School Year Download Speeds (Mbps)				2014-2015 School Year Download Speeds (Mbps)			
Municipality	School Region	Number of Schools	Min	Max	Mean	Median	Min	Max	Mean	Median
Guaynabo	San Juan	20	3	10	3.75	3	30	100	44.00	30
Gurabo	Caguas	10	1.5	3	2.85	3	30	100	54.00	50
Hatillo	Arecibo	14	1.5	10	3.39	3	30	100	43.57	40
Hormigueros	Mayaguez	6	3	10	4.17	3	30	100	60.00	50
Humacao	Humacao	26	1.5	10	3.10	3	10	100	44.23	30
Isabela	Mayaguez	19	1.5	10	3.21	3	10	100	46.32	30
Jayuya	Ponce	11	3	10	3.64	3	30	100	41.82	30
Juana Diaz	Ponce	20	1.5	10	3.38	3	10	100	50.00	50
Juncos	Humacao	13	3	10	3.54	3	30	100	56.92	50
Lajas	Mayaguez	11	3	10	5.18	5	10	100	46.36	30
Lares	Arecibo	15	1.5	10	3.53	3	30	100	43.33	30
Las Marias	Mayaguez	7	3	10	4.00	3	30	50	32.86	30
Las Piedras	Humacao	11	3	10	4.45	3	30	100	60.91	50
Loiza	Humacao	11	1.5	10	4.50	3	30	100	43.64	30
Luquillo	Humacao	8	1.5	10	3.50	3	30	100	52.50	40
Manati	Arecibo	20	1.5	10	3.13	3	30	100	48.00	30
Maricao	Mayaguez	6	3	10	4.17	3	10	30	26.67	30
Maunabo	Humacao	6	3	10	5.17	5	30	50	36.67	30
Mayaguez	Mayaguez	33	1.5	10	3.23	3	10	100	36.97	30
Moca	Mayaguez	17	1.5	10	3.29	3	10	100	40.59	30
Morovis	Bayamon	15	1.5	10	3.30	3	30	100	52.00	50
Naguabo	Humacao	11	1.5	10	3.36	3	30	50	39.09	30
Naranjito	Bayamon	15	3	10	4.07	3	30	100	47.33	50
Orocovis	Bayamon	16	1.5	10	3.41	3	10	100	35.63	30
Patillas	Humacao	10	1.5	10	3.40	3	10	100	41.00	30
Penuelas	Ponce	13	1.5	10	3.42	3	30	100	43.08	30
Ponce	Ponce	67	1.5	10	3.10	3	10	100	50.00	50
Quebradillas	Arecibo	10	1.5	10	3.60	3	30	100	62.00	50
Rincon	Mayaguez	7	3	10	4.00	3	30	50	38.57	30
Rio Grande	Humacao	15	3	10	3.60	3	10	100	50.67	50
Sabana Grande	Mayaguez	10	1.5	10	3.75	3	30	100	53.00	30
Salinas	Caguas	19	1.5	10	3.39	3	10	100	36.84	30
San German	Mayaguez	15	1.5	10	3.37	3	10	100	37.33	30
San Juan	San Juan	126	1.5	10	3.31	3	5	100	40.32	30
San Lorenzo	Humacao	14	1.5	10	3.82	3	30	100	54.29	40
San Sebastian	Mayaguez	22	1.5	10	3.07	3	10	100	47.27	30



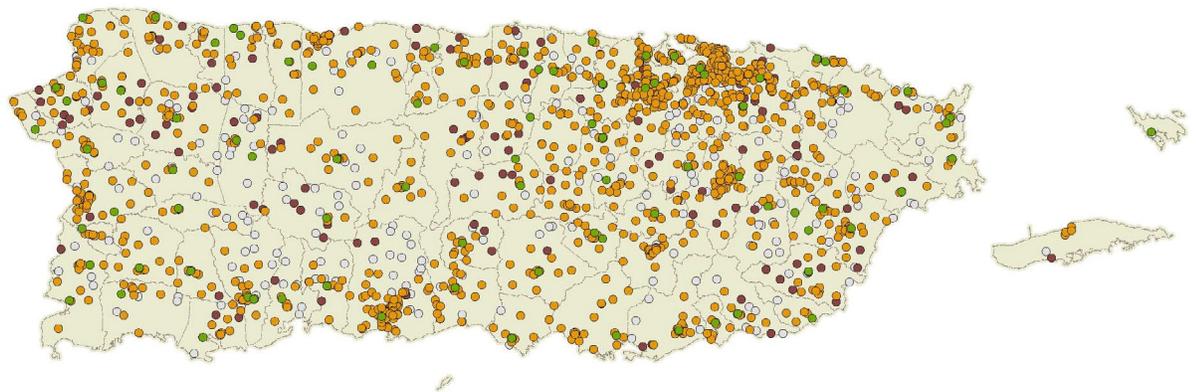
Puerto Rico Public School Bandwidth by Municipality 2013-2014 and 2014-2015 School Years										
			2013-2014 School Year Download Speeds (Mbps)				2014-2015 School Year Download Speeds (Mbps)			
Municipality	School Region	Number of Schools	Min	Max	Mean	Median	Min	Max	Mean	Median
Santa Isabel	Ponce	10	3	10	3.90	3	10	100	44.00	30
Toa Alta	Bayamon	16	1.5	10	3.47	3	30	100	53.75	50
Toa Baja	Bayamon	23	3	10	3.65	3	30	100	51.30	50
Trujillo Alto	San Juan	17	1.5	10	3.44	3	30	100	40.00	30
Utuado	Ponce	16	1.5	10	3.25	3	10	100	48.75	30
Vega Alta	Arecibo	12	3	10	4.33	3	30	100	61.67	50
Vega Baja	Arecibo	22	1.5	10	3.61	3	10	100	51.82	30
Vieques	Humacao	7	1.5	10	3.79	3	10	50	27.14	30
Villalba	Ponce	15	1.5	10	3.43	3	10	100	49.33	50
Yabucoa	Humacao	20	1.5	10	2.90	3	10	100	39.00	30
<i>Yauco</i>	<i>Ponce</i>	<i>22</i>	<i>3</i>	<i>10</i>	<i>4.27</i>	<i>3</i>	<i>10</i>	<i>100</i>	<i>38.18</i>	<i>30</i>

Source: PRDE.

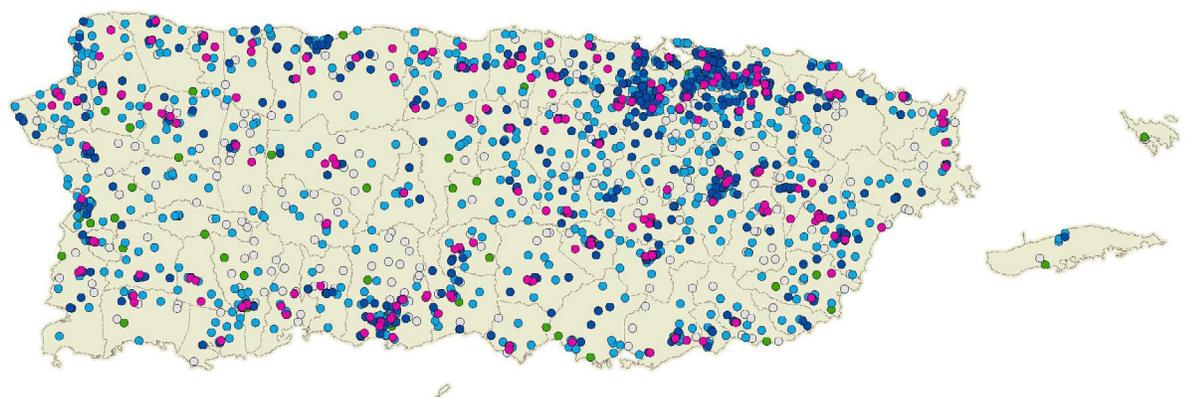


The following maps depict all public schools in Puerto Rico classified by contracted or planned broadband connectivity for each school. In line with the above data, the two maps show a marked increase in planned school connectivity in school year 2014-2015 relative to the connectivity available in year 2013-2014.

Puerto Rico Public Schools - Contracted Bandwidth, 2013-2014 School Year



Puerto Rico Public Schools - Contracted Bandwidth, 2014-2015 School Year



Symbology

- Download speed of at least 100 Mbps
- Download speed of at least 50 Mbps
- Download speed of at least 30 Mbps
- Download speed of at least 10 Mbps
- Download speed of at least 3 Mbps
- Download speed of at least 768 Kbps
- Unknown download speed
- Municipality Boundary



Meeting the K-12 system's connectivity demands will require additional broadband capacity build-out. The investment and timeframe to accomplish this will be significant and require collaboration between multiple parties.

In order for the technology to fully impact student academic achievement and empower teachers, multiple transformative processes will need to occur simultaneously. Online content will need to be developed, teachers will need training, parents and communities will have to ensure off-campus access, and best practices must be developed to safeguard the security and privacy of every student. Bottom line, while robust broadband pipes serving Puerto Rico schools and wireless connectivity within those schools are necessary conditions for the success of this Plan, they alone are insufficient.

As the Department of Education has rightfully recognized, all of the components addressed in the PRDE Technology Plan are essential to better prepare Puerto Rico public school students to compete in the twenty-first century. For this reason, it is imperative that each of these aspects are re-assessed and revised on an ongoing basis. Likewise, a key recommendation from the 2012 Puerto Rico Broadband Strategic Plan is now even more important than before — it is imperative to promote collaboration across private and public stakeholders, both local and Island-wide.⁶⁷ Publicly elected officials and the Department of Education will need to lead and collaborate with private and public broadband stakeholders, including the Telecommunications Regulatory Board, Puerto Rico Office of the CIO, and Puerto Rico Broadband Taskforce for successful implementation of these plans. These stakeholders should collaborate with the PRDE's Evaluation Committee in its annual assessment of the Technology Plan's goals and progress. Support could include:

- Conducting an independent annual inventory of fiber optic availability to public and private schools across Puerto Rico. Such inventory should be reflected in publicly available, easy-to-use maps.
- Conducting an independent annual inventory of the broadband capacity contracted across Puerto Rico schools, including capacity to the premise and wireless capacity per student and staff at each institution.



THE COST OF REVAMPING TECHNOLOGY ACROSS THE K-12 PRDE SYSTEM

Budget estimates for the PRDE technology rollout through 2019 build upon past PRDE data and assume the continuation of historical E-rate rules. The recent FCC reform of the E-rate program, described further in the following section, directly impacts these estimates, and they will need to be revised. Notwithstanding these adjustments, the PRDE budget estimates provide a benchmark for understanding the cost of these plans.

The PRDE Technology Plan estimates the total technology-related expenses over the 5-year rollout period to be \$236.5 million or just over \$573 per student user in the system.⁶⁸ The PRDE Technology Plan estimates E-rate contribution to this 5-year budget to be \$125,259,749, which is projected to be complemented with \$111,294,094 in funding provided from other sources. The majority of this match, over \$97 million, of the non-E-rate supported budget would fund the purchase of teacher and student devices.⁶⁹

On a per student basis, these PRDE estimates are consistent with cost estimates of a robust 1:1 educational program in other jurisdictions. For example, the FCC estimates \$150 per student over a 5-year period to support robust Wi-Fi connectivity within the school premise,⁷⁰ coming in lower, but not too far off the PRDE 5-year estimate costs for Wi-Fi connectivity of \$179 per student.

Similarly, recent estimates from the Nevada Department of Education and the Nevada Commission on Educational Technology assume a cost of \$610 “per seat” to cover the costs of internal infrastructure (Wi-Fi), devices, classroom management software, professional development, and state leadership necessary to coordinate these efforts.⁷¹ This estimate excludes the cost of providing broadband access and telecommunications service to the school premise. By contrast, the PRDE estimates a 5-year cost of \$428 per student for devices and internal connections — an estimate that does not consider the cost of professional development.

However, these estimates may be conservative when factoring in the unique complexities facing the PRDE relative to other school districts in the U.S. As noted in this chapter, the geographic scope and topography of the schools managed by the PRDE implies more complex network rollout plans than those needed for other school districts in large metropolitan areas. Further, because current broadband access across PRDE schools is lagging behind many comparable systems, the PRDE’s gigabit gap is significantly greater and closing it will require more financial resources.

PRDE estimates a technology rollout budget of \$236.5 million over five years. The E-rate contribution to this 5-year budget is estimated at \$125 million to be complemented with \$111 million in funding to be provided by other sources.

The aggressive PRDE technology rollout will be expensive and need support from both federal and local funding sources. It is imperative that Puerto Rico’s publicly elected officials acknowledge the need for financial investment and work with the Department of Education to ensure adequate funding is available to support this critical technology investment.



RE-EVALUATE PRDE'S IP STRUCTURE IN ORDER TO ENCOURAGE MORE COMPETITION IN BROADBAND PROCUREMENT

PRDE currently operates an integrated WAN solution that links each school to both the Internet and each other through a hub and spoke approach that utilizes one centralized network – the PRDE Data Center.⁷² This IP structure choice has historically led to PRDE partnering with just one broadband provider who offers broadband service to the Department throughout the entire Island. Consistently, the winner of this all or nothing PRDE broadband procurement process has been the telecommunications incumbent carrier Puerto Rico Telephone Company, or Claro.

This centralized IP design could imply that smaller, possibly local and regional providers offering robust and cost effective service may be effectively barred from competing for the contract because, unlike Claro, they lack the ability to make an Island-wide offer. As a result, this centralized IP topography may be hampering – instead of encouraging – competitive bids to support the Department's broadband needs. Further, such a centralized IP network injects rigidity into the technology design, which could delay and increase costs for the PRDE Technology Plan phased rollout.

The PRDE acknowledges these potential constraints and calls for an evaluation of alternate options, such as “[r]edesigning the network to include intermediate aggregation points, which in turn aggregate into the PRDE Data Center.”⁷³ This assessment of current PRDE IP topography is critical as the Department plans its ambitious technology rollout over the coming 5 years.

Public and private broadband stakeholders, including the Telecommunications Regulatory Board, Puerto Rico Office of the CIO, and Puerto Rico Broadband Taskforce, should work with the PRDE to evaluate its IP topography structure and assess whether a less centralized and more regional approach can result in more competition in broadband procurement that helps rein in the costs of meeting the new, ambitious PRDE broadband targets.

E-RATE MODERNIZATION - IMPLICATIONS FOR PUERTO RICO

The Schools and Libraries Program, or E-rate, is one of four Universal Service Fund programs managed by the FCC and the largest educational technology program in the U.S.⁷⁴ E-rate aims to provide support for telecommunications and broadband service to private and public schools and libraries across the nation. Since its inception, E-rate has provided up to \$2.4 billion in annual subsidies to over 100,000 schools and over 10,000 libraries across all U.S. states and territories. A total of \$240 million E-rate subsidies were disbursed in Puerto Rico between 1998 and 2013. In 2012, over \$15 million in E-rate funds were disbursed to Puerto Rico eligible entities, and over \$23 million in 2013. In short, E-rate represents an important funding source for Puerto Rico schools and libraries.⁷⁵

On July 23, 2014 and December 19, 2014, the FCC released two E-rate Modernization Orders marking the most significant reform to the E-rate program since its inception



in 1997.^{76,77} The E-rate modernization process had commenced a year prior following President Obama's announcement of the ConnectED initiative that aims to accelerate deployment of education technology across the nation, and of which reform to the E-rate program is a key component.

The first E-rate Modernization Order is an important step in refocusing the program on broadband capacity, particularly by providing immediate, substantial support for on-campus wireless networks within schools and libraries. The Order provides for up to \$2 billion in funding over the next two years to on-campus wireless networks that will, in particular, help schools deploy 1:1 device learning models and enhance public wireless Internet access at libraries. The FCC has budgeted \$5 billion for this fund over the next five years; this effectively increases available funding under E-rate by an additional \$1 billion over the next five years. These funds will be allocated to schools and libraries based on a per-student and per-square foot formula, respectively. The goal for these funds is to bridge the "Wi-Fi gap" that, according to the FCC, is present in at least three out of five schools.

The Order also marks a key milestone in the Commission's efforts to revamp and reorient all four of its universal service subsidy programs away from legacy services and toward broadband services. In particular, the E-rate Modernization Order phases out support for legacy services such as dialtone voice service. The Order also streamlines the application process and makes better, more transparent data on the E-rate program available.

E-rate Discount Rates Applicable to PRDE					
	School Year starting in				
	2015	2016	2017	2018	2019
Telecommunications Service	70%	50%	30%	10%	0%
Broadband Access To School Premise	90%	90%	90%	90%	90%
Equipment and Maintenance of Wireless LAN Capacity	85% Capped at \$30 per student per year				
Teacher or Student Devices	0%	0%	0%	0%	0%
Fiber build-out to schools	90% 95% if the Government of Puerto Rico finances the remaining 5%				

E-rate subsidies are based on a percentage discount (or reimbursement) over retail prices paid by the school or library for telecommunications and broadband services, both broadband to the facility's premise and wireless broadband service within the premise. Schools and libraries are offered different discount rates based on income metrics of the population they serve, as well as whether the institutions are located in areas designated as rural. Due to the relatively high poverty levels across Puerto Rico, all of the schools managed by the Department of Education of Puerto Rico qualify for the highest discount rates. For 2015, these rates include a 90% discount off of retail prices



on broadband services to all schools in the system, an 85% discount for services and equipment supporting Wi-Fi connectivity within the school premise, and a 70% discount for legacy services such as traditional dial-up or mobile services. Under the FCC's Order, the PRDE discount rate for legacy services will decrease annually as reflected in the discount rate table below.

Subsidies for eligible telecommunications and broadband services are not capped at either the applicant level or the specific school recipient level. If funding requests by all eligible entities surpasses the E-rate annual cap, funding priority is given to those entities with the greatest need, or highest discount rates. This rule implies that PRDE and other eligible entities across Puerto Rico have historically had priority access to scarce E-rate funds.

Budgets for broadband and telecommunications service and the portion that would be financed via E-rate are projected in the PRDE Technology Plan. Funds available to support Wi-Fi connectivity are capped for each school based on the number of students enrolled. Each school's budget eligible for Wi-Fi E-rate support is capped at \$150 per student over a five-year period. For PRDE schools, 85% of this budget, or \$127.50 per student, would be funded via E-rate. Based on PRDE 2014 student enrollment numbers of approximately 412,000 students, this implies an E-rate eligible Wi-Fi budget of approximately \$62 million over five years. Of this, approximately \$52.6 million (or 85%) would be funded via E-rate. The remainder, or \$9.3 million, would need to be financed through other sources. In short, these additional funds offer a significant opportunity for PRDE. Successful application for E-rate funds will mark a critical step to help meet the very ambitious broadband goals set by PRDE in its Technology Plan. Broadband stakeholders should support PRDE as it makes plans to leverage this opportunity and ensures an efficient rollout of broadband resources to all PRDE schools throughout the ensuing five years.

The second E-rate Modernization Order establishes a permanent and significant expansion in E-rate funds. The Order raises the program's annual cap from \$2.4 billion to \$3.9 billion starting in 2015. The Order further aims to support expansion of fiber connectivity to schools and libraries where it is lacking. To do so, it streamlines the rules to request funding for one-time capital investment projects to bring fiber access to schools and libraries lacking the infrastructure. These additional resources signify an important opportunity for PRDE and other private and public eligible entities across Puerto Rico.

The second Order also incentivizes states to help finance these infrastructure projects by creating a matching mechanism that will expand the amount of E-rate subsidies to support these construction projects where states and territories are willing to inject local funds. For Puerto Rico, these new rules could imply an increase in the effective E-rate subsidy rate from 90 to 95 percent, significantly reducing PRDE's matching needs to fund fiber construction projects to unserved schools.



E-rate Modernization changes will impact E-rate funding starting in school year 2015-2016. It is unclear at this stage the full impact of the program changes on school and library available funding via E-rate and, ultimately, its impact on school and library technology choices. However, the impact of this federal funding opportunity will certainly be significant for the institutions eligible for the funding and the communities they serve. It is therefore important for public and private broadband stakeholders to monitor future E-rate developments and work with PRDE and other schools and libraries to ensure that all Puerto Rico eligible entities will be prepared to fully leverage this opportunity.



E-STRATEGIES TO BRING GIGABIT CAPACITY TO PUERTO RICO SCHOOLS

SUMMARY RECOMMENDATIONS

Advances in education technology are transforming schools across the nation and the world. To ensure that Puerto Rico students can benefit from this transformative innovation, it is imperative that schools have access to ultra-high-speed broadband, both at the school premise and wirelessly within the school. The Puerto Rico Department of Education and other stakeholders are working to meet this challenge and offer strategic recommendations to help bring Gigabit capacity to all Puerto Rico students. This chapter addresses these developments and offers strategic recommendations to help bring Gigabit capacity to all Puerto Rico students.

Key Recommendations:

- The Telecommunications Regulatory Board, Puerto Rico Office of the CIO, and Puerto Rico Broadband Taskforce should collaborate with Puerto Rico's Department of Education to support its annual assessment of the Technology Plan's goals and progress. Support could include:
 - Conducting an independent annual inventory of fiber optic availability to public and private schools across Puerto Rico. Such inventory should be reflected in publicly available, easy-to-use maps.
 - Conducting an independent annual inventory of the broadband capacity contracted across Puerto Rico schools, including capacity to the premise and wireless capacity per student and staff at each institution.
- Puerto Rico should support the financial needs of the Department of Education to ensure adequate funding to meet its broadband expansion plans.
- Broadband stakeholders, including the Telecommunications Board, the CIO's office and the Puerto Rico Broadband Taskforce should support the PRDE and other eligible entities to ensure they effectively leverage E-rate and other federal funding opportunities.
- Public and private broadband stakeholders, including the Telecommunications Regulatory Board, Puerto Rico Office of the CIO, and Puerto Rico Broadband Taskforce, should work with the PRDE to evaluate its IP topography structure and assess whether a less centralized and more regional approach can result in a more efficient competitive offering that helps rein in the cost of meeting the new, ambitious PRDE broadband targets.



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