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Chaddick Institute for Metropolitan Development at DePaul University | Policy Series

THE DIGITALLY CONNECTED COMMUTER:

Tracking the Rising Use of Personal Electronic Devices on Chicago Suburban Trains

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EXECUTIVE SUMMARY

This report provides the results of newly-collected data about the growing dependence on electronic devices among commuter rail travelers in the Chicago region. Drawing upon past results of the Chaddick Institute's Technology in Intercity Travel study, this analysis shows how the growing importance of these devices to travelers is stimulating the demand for rail transit. The report is based on observation of 4,700 passengers on 43 trains in early

1

More than three times as many Metra riders observed are performing electronic tasks that are illegal while driving—such as texting and reading emails on phones—compared to five years ago. Less than 14% of passengers were performing such tasks at randomly observed points in 2010, compared to 44% this year *(Figure A)*.

2

Ridership on Metra has grown despite fare increases in 2012 that increased the average cost of travel by more than 25%, suggesting that other factors—including the value passengers place on using electronic devices while traveling—is offsetting some of the effects of rising fares.

3

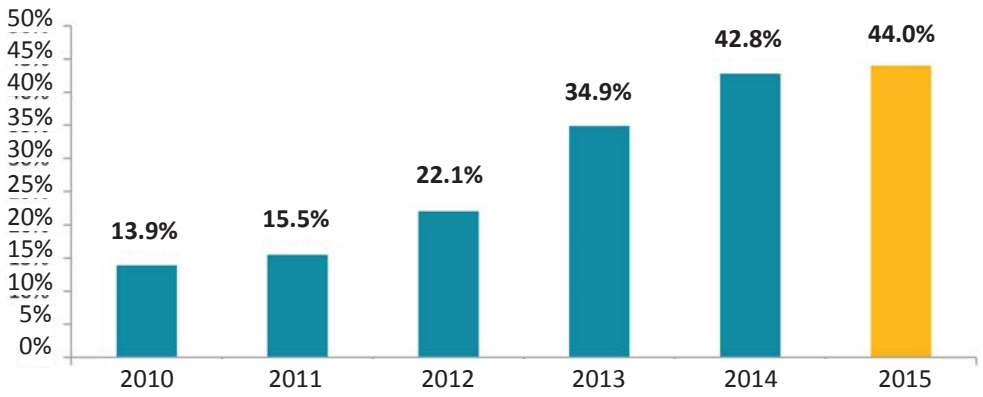
Metra is making progress in becoming more "tech friendly," but power outlets, Wi-Fi, and 3G/4G signals at downtown stations remain spotty. LaSalle Street and Union stations have the strongest 3G/4G signal strength, on average, among three major providers, AT&T, T-Mobile, and Verizon. Wi-Fi onboard trains remains in the developmental stage.

4

Millennium Station stands out as having the most tech-friendly features, offering passengers an airport-style waiting room with power outlets, Wi-Fi and a retailer with electronic accessories nearby. For smartphone users, Verizon signals are higher in the waiting areas and trackside at Millennium than at any of the other four stations, while AT&T signals are the third strongest.

Figure A

Percent of Metra Riders at Randomly Observed Points Engaged in Electronic Tasks that are Illegal When Driving



INTRODUCTION

This report explores how the growing prevalence and sophistication of personal electronic devices is changing the way Americans use and experience public transportation. These personal devices—whether used for business or pleasure—enable travelers to do many activities that were once impossible, including watching movies, preparing documents and presentations, as well as surfing the internet.

PART I

The first part of the report reviews the methodology on measuring technology use and the observed trends in usage.

PART 2

The second section explores the implications the upward trend has on transit ridership.

PART 3

The final two sections compare the five downtown stations on the basis of their tech friendly amenities and offer lessons for policymakers and transit planners.

CHARACTERISTICS OF SAMPLE + KEY FINDINGS

The Chaddick Institute's ***Technology in Travel*** study began in September 2009 and has grown to encompass more than 35,000 unique passenger observations—in which no passenger is counted more than once on a given trip—on 564 air, bus, and rail trips throughout the United States. Each year, passengers are observed by trained data collectors to determine how they spend their time while traveling. Among the passengers observed, more than 14,000 were commuter rail passengers in the metropolitan Chicago region. Complete results for intercity air, bus, and train travelers, as well as commuter rail passengers, will be summarized in a series of reports available for download on the Chaddick Institute website.

Researchers measured the use of three basic features of electronic devices:

Table 1: **Types of Activity Recorded**

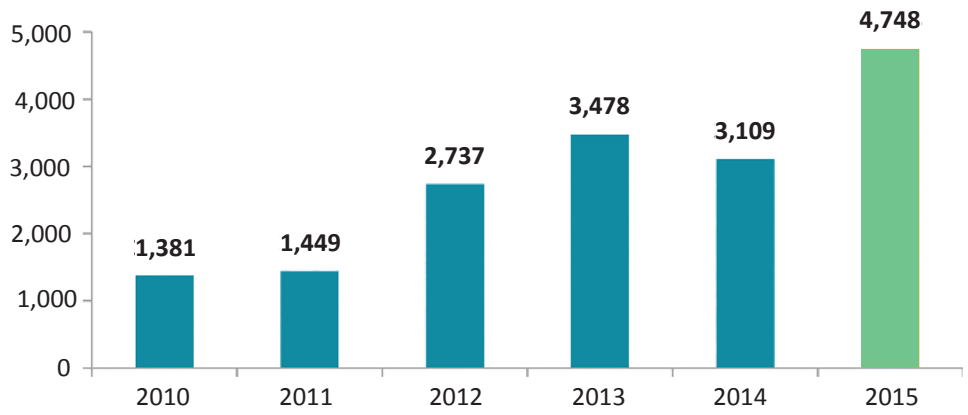
1. Audio Activities: Devices, such as cell phones or CD players (which can be used with earphones, speakers, or headsets) and are strictly used for an audio function.

2. Visual or Audiovisual Activities on Devices, not including iPads, Kindles, and other Tablet Use: Visual or audiovisual features, such as laptop computers, Blackberries and other smart phones, DVD players, and iPods. (This category includes any traveler looking at an LCD screen for the purpose of engaging in an activity more substantial than placing a phone call).

3. Visual or Audio-Visual Activities on iPads, Kindles and other Tablets: Same as Category 2 except focusing specifically on tablet usage. This final category was introduced in 2012 to better calculate how small and lightweight devices affect traveler behavior.

The study team observed 4,748 passengers on 43 departures operated by Metra between February and May, 2015 *(Figure 1)* using a data-collection process we describe in detail in the Appendix. The sample included nearly 500 passengers on trains operating south, southwest, west, northwest, and north from downtown Chicago, and included both rush hour and non-rush hour trips on these routes. As in past years, the entire sample was drawn on weekdays between 8 a.m. and 7:30 p.m.

Figure 1
Number of Commuter Rail Passengers Observed
Metra and South Shore Line



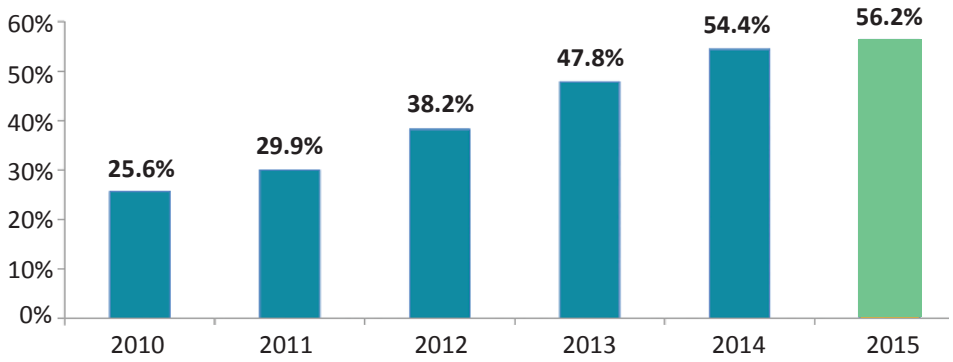
Four findings from newly collected data warrant emphasis:

FINDING 1: The trend of rising technology use among commuter rail passengers continued in 2014-2015, the fifth consecutive year of significant growth. Nearly three in five passengers are now engaged with personal devices at random points, compared to slightly over a quarter in 2010.

The upward rise in technology use shows no signs of abating, although growth rates have subsided as personal devices become almost universal. At randomly selected points, 56.2% of passengers were engaged with technology this year, compared to 54.4% last year, 29.9% in early 2011, and just 25.6% in 2010 (*Figure 2*). Technology use has grown more than 47% (or 18 percentage points) since 2012 and has more than doubled since 2010.

Figure 2

% of Communter Rail Riders Engaged with Technology

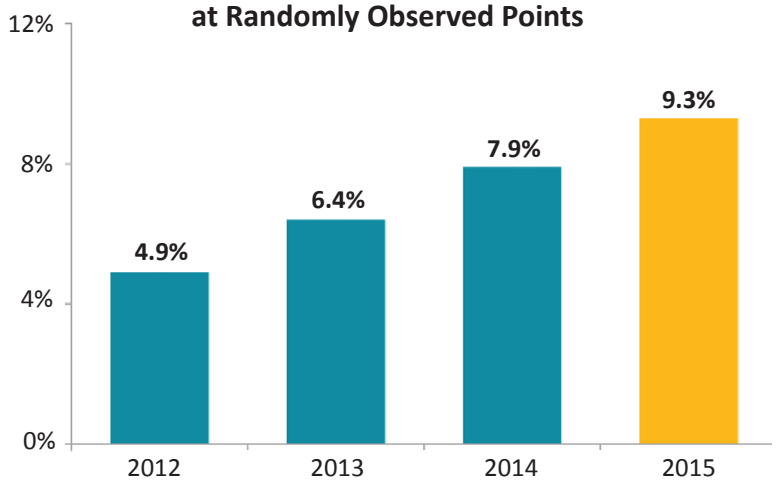


To appreciate the importance of this trend, it needs to be emphasized that this study's methodology, by measuring electronic usage at specific moments in time, provides a more accurate portrayal of the intensity of technological engagement than studies focusing only on whether a passenger is carrying or using a device at some point during the trip. A far greater share of passengers—perhaps as many as 80% —use electronic devices at some point during their journey. Indeed, consumers who do not own sophisticated electronic devices are now the exception. As of the beginning of 2015, more than 156 million Americans adults used tablets, up from 132.2 million in 2013, and this number is projected to grow to 168 million by 2016 (eMarketer, 2015). Nearly two-thirds of Americans had a smart phone in January 2015, compared to just 35% in May 2011 (Pew Charitable Trust, 2015).

FINDING 2: Tablet and e-reader use rose substantially between 2014 and 2015. More than one in 11 passengers (9.3%) are now using a tablet or e-reader at randomly observed points on commuter trains, compared to one in 13 last year (7.9%) and just one in 20 (4.9%) in 2012.

The rising prevalence of these devices reflects a gradual shift among passengers toward the use of sophisticated electronics that allow several tasks, such as listening to music while engaging in social media, to be simultaneously performed. Whereas the overall technology use rose by nearly 3% among commuter-rail passengers between 2014 and 2015, tablet/e-reader usage rose by 18% (or 1.4 percentage points)—an impressive increase considering it follows 13% growth observed between 2013 and 2014. This means that while slightly less than one in 20 passengers (4.9%) observed were using a tablet or e-reader three years ago, almost twice as many are using one today *(Figure 3)*.

Figure 3
% of Commuter Rail Passengers Using Tablets/e-Readers at Randomly Observed Points



As discussed in last year's *Digitally Connect Commuter* report, these devices represent a breakthrough in convenience for many commuters. Their space-saving qualities and ability to boot up quickly make them almost ideal for space-confined environments. Unlike laptops and notebook computers, tablets and e-readers can be stored in a briefcase or purse and take up much less room when in use.

The long periods in which these devices can be used between battery charges is another advantage. Whereas power outlets are common on some intercity buses and trains, most commuter rail users must contend with the absence of auxiliary power supply, as many cars are not equipped with outlets. The long duration between charges is particularly advantageous on long commutes.

FINDING 3: **More than three times as many Metra riders are engaged in tasks that could not be safely performed when driving, compared to five years ago. Whereas only 13.9% of Metra passengers were performing sophisticated visual tasks involving LCD screens (which are illegal while driving) in 2010, that number is more than 44% today.**

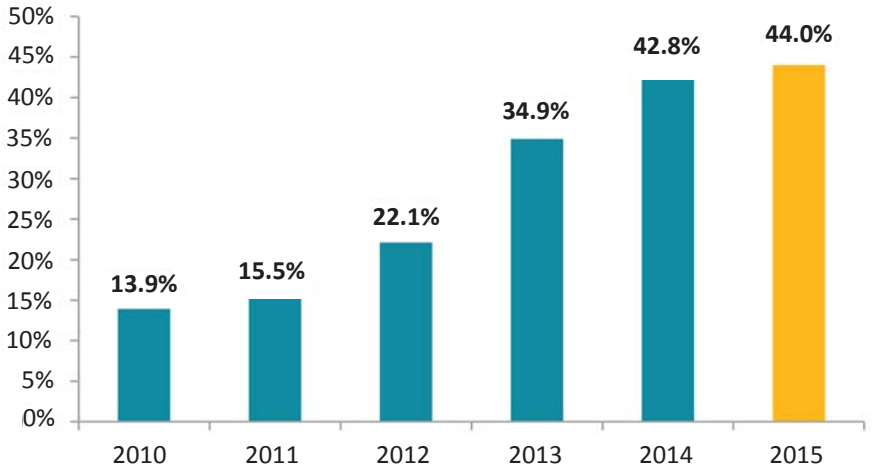
As more travelers turn to sophisticated devices such as tablets and e-readers, they increasingly diminish the time spent solely on "audio-oriented" functions, such as hand-free cell phone calls and listening to music, which can be done when driving. Travelers are now increasingly engaged in LCD-based tasks often conducting multiple tasks at once, adding to the advantages of using public transit.

As on January 1, 2014, Illinois has banned drivers from using nearly all visually-oriented electronic devices, except for those involving navigation tools. While laws vary between municipalities, drivers cannot engage in electronic messaging—e-mail or text message—or command/request to access an Internet site in any part of the state.

Using hand-held devices while driving is now completely banned. Only hands-free technologies such as speakerphones, Bluetooth, and headsets can be used, and even these technologies are prohibited while driving in school and construction zones, and among novice drivers. Drivers are permitted to use a GPS or navigation system or a device that is integrated into the motor vehicle.

The share of Metra riders performing tasks at randomly observed points that are now illegal when driving has risen by more than 20% in the last three years *(Figure 4)*. Clearly, for many travelers, the opportunity cost of being behind the wheel is growing. These figures may understate the true effects of the rising technological dependence since many passengers who might otherwise drive would need to purchase hands-free devices to make phone calls en route. Moreover, as previously noted, even phone calls are not permitted in construction or school zones.

Figure 4
Percent of Metra Riders at Observed Points Engaged in Electronic Tasks Illegal When Driving



FINDING 4: The "digital divide" that had previously been prevalent has largely disappeared among commuter train riders. Trains serving different parts of the metropolitan region now have similar rates of technological usage.

Between 2009 and 2014, a pronounced difference in usage existed between various parts of the metropolitan region. Rates of usage tended to be as much as 20% higher on some route than others, with income and education levels apparently explaining much of the difference. Nevertheless, over the past two years, these differences have largely disappeared.

All parts of the region now have usage between five percentage points of each other *(Figure 5)*. In 2015, an average of 60.3% of passengers were using technology at observed points on Northwest routes (Union Pacific Northwest and Milwaukee West Line trains), which had the highest usage. Rates were only slightly lower on North (55.9%), South (56.3%), Southwest (56.7%), and West (55.9%) routes. Median household income tends to be lower on the South and Southwest routes than on the other lines, but observed technology usage was virtually identically, with the exception of the Northwest routes, which had marginally higher usages.

The various commuter-rail lines were assigned to geographic regions, as noted in *Table 2*.

Table 2
Commuter Rail Line Classification by Region

Direction	Lines Included	# of Passengers Observed in 2015
North	Milwaukee District North and Union Pacific North	1,100
Northwest	Milwaukee West and Union Pacific Northwest	1,420
West	BNSF and Union Pacific West	1,023
Southwest	Rock Island District	485
South	Metra Electric and South Shore Line	720

Note: Metra's Heritage Corridor, Southwest Service, and North Central Service were not surveyed.

Figure 5
Technological Usage at Observed Points in Chicago

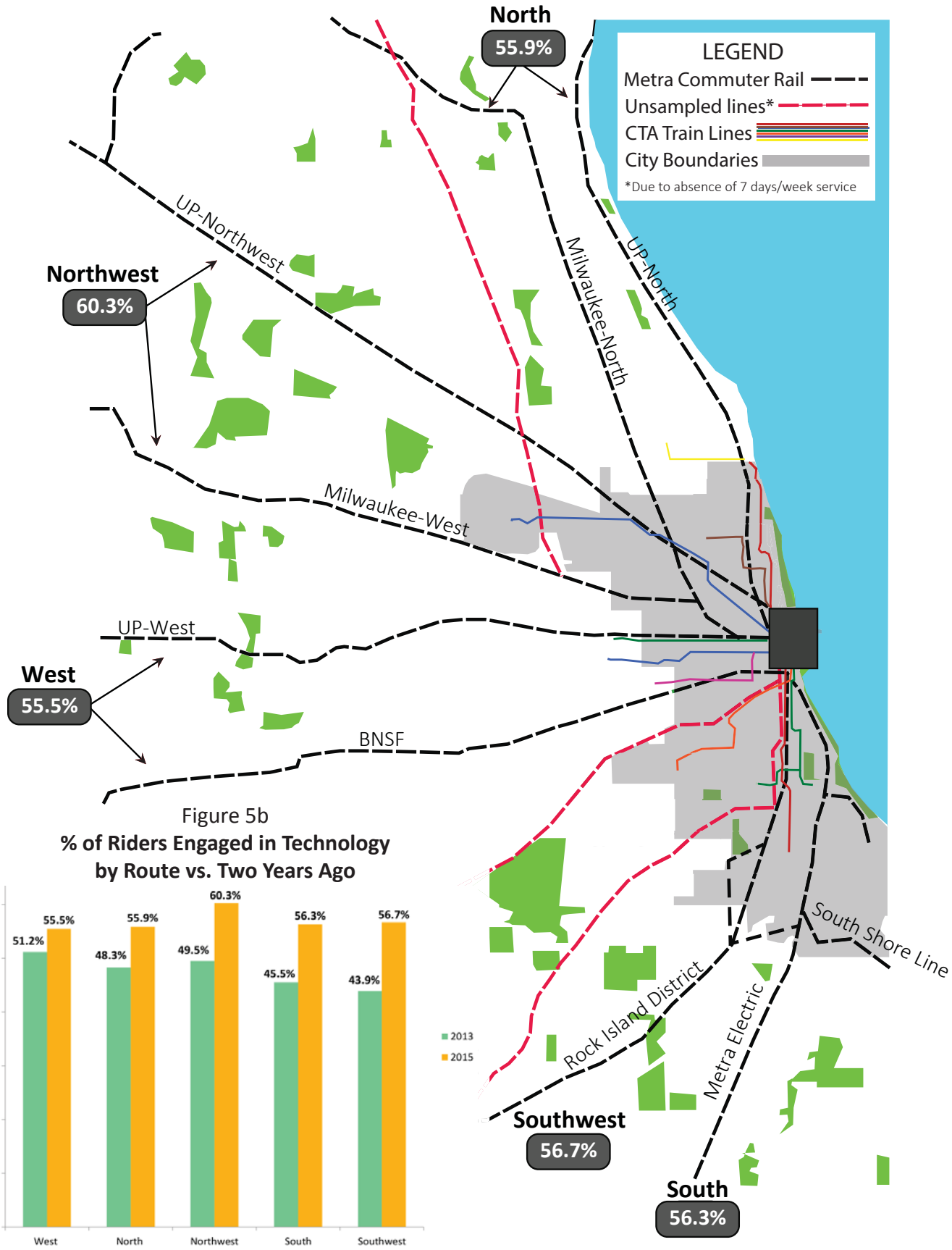


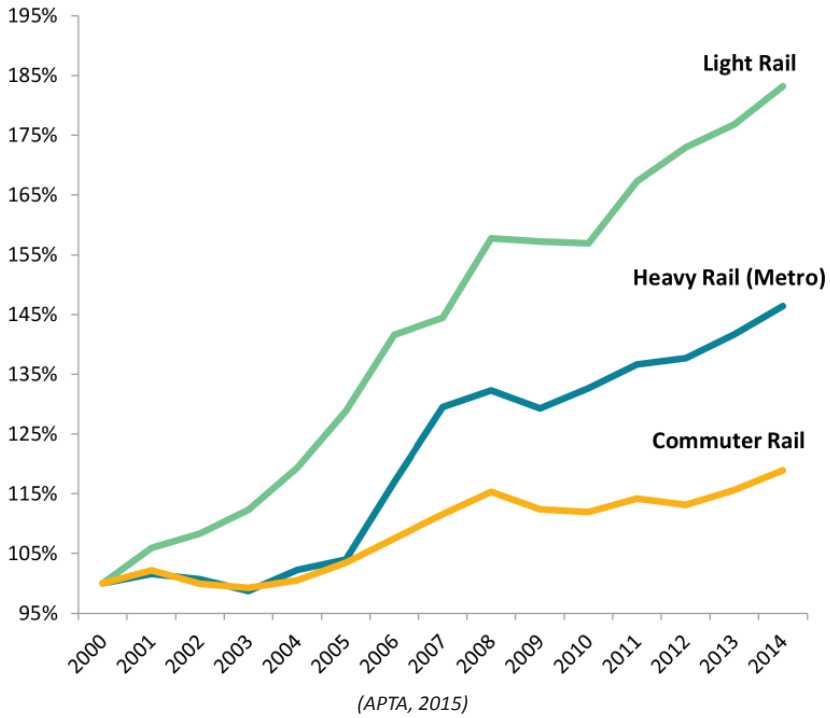
Figure 5b
% of Riders Engaged in Technology by Route vs. Two Years Ago

Is the Tech-Friendly Nature of Rail Transit Increasing Demand?

There is compelling evidence to suggest that the favorable onboard environment that trains provide to users of personal technology is increasing passenger demand. Our previous research suggests that crowding on trains is less of a deterrent to technology use than it is on buses and planes (Schwieterman, 2013). Trains provide passengers more room to interact with their electronic devices—including working on their laptops—as a result of wider aisles and more generous seat pitches than buses and planes. Although rush hour trains are often crowded, most passengers expect to find a seat, even when traveling at the busiest periods. Moreover, during off-peak periods, passengers on some routes can generally expect to travel with an empty seat next to them, providing space for personal belonging and making the use of larger devices, such as laptops, less cumbersome.

Recent ridership trends suggest that the rise in personal technology has favorable implications for rail travel.

Figure 6
Trends in Rail-Transit Ridership, U.S. and Canada
2000 - Present



(APTA, 2015)

Recent ridership trends suggest that the rise in personal technology has favorable implications for rail transit:

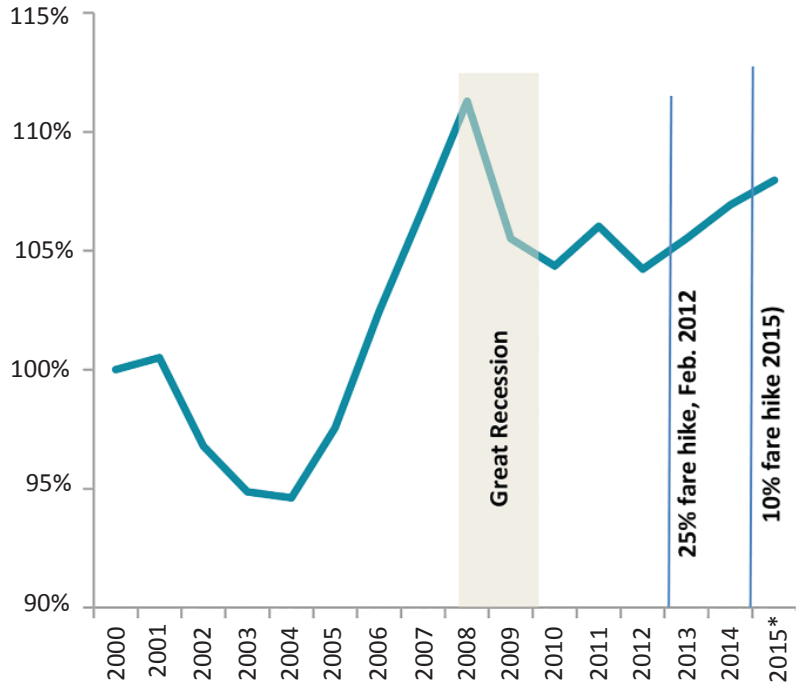
All three primary forms of rail transit—commuter, heavy, and light rail—are experiencing substantial gains in ridership. Light rail ridership is up 75% since 2000, while heavy rail (subway, 'L", and other types of rapid-transit train service) is up 46% *(Figure 6)*. Commuter rail traffic is up 18%. Since 2010, the first full year after the Great Recession of 2008-2009, travel on light, heavy, and commuter rail services have risen by 17%, 10%, and 6%, respectively. This data is from the American Public Transit Association's (APTA) ridership report, a data source updated monthly using information provided by transit agencies in the U.S. and Canada.

Many factors have no doubt contributed to this increase, including the rising gasoline prices and a rebound in central city employment. An improving economy is also a factor. However, only a small part of the increase can be explained by the introduction of new service. In fact, the rising number of travelers using rail-transit services appears to be closely linked to the premium these travelers place on the use of personal devices. CTA rail ridership, for example, has risen by 12.9% since 2010, compared to about 6% on Metra. Regional employment during this period has only grown by 3% since then, suggesting that non-economic factors—like technology use—may be having positive effects. The amount of service provided, meanwhile, has remained virtually unchanged over this period. Regional employment has only grown by 3%. This suggests that factors unrelated to regional population and economic growth, such as the benefits of traveling in a mode that is amenable to continuous technology use, are contributing to demand.

Ridership on Metra has grown despite a 25% fare increase in 2012. The effects of this fare increase were much smaller than would have been expected based on prevailing estimates of the price elasticity of demand, suggesting that there have been offsetting factors—including the growing importance of having time for digital activities—to limit the loss of riders.

The upward trend in Metra ridership over the past five years is evident in *Figure 7*. After initially declining by about 3% in 2012 due to the fare increase that averaged about 25% (which included the elimination of 10-ride discounts) in February 2012, ridership has grown in each period since then, increasing by 3% in 2013 and another 2% in 2014. (Metra's 83.4 million passenger trips in 2014 was the second highest ridership in the agency's 30-year history). Ridership was also up in the first quarter of 2015, despite dipping about 1.5% in the two months following another fare increase (averaging about 10%) on February 1. This latest increase was accompanied by the re-introduction of discounts for 10-ride tickets. The data on ridership is from RTAMs, a date set maintained by the Regional Transportation Authority.

Figure 7
Metra Ridership Trends
2000 - Present



*(RTAMs, 2015) *First 3 months*

The growing dependence on personal electronic devices appears to have altered the perceived "disutility" of spending time in a seat...

Microeconomic studies suggest that the demand elasticity for urban rail travel with respect to prices is in the -0.2 to -0.4 range (Litman, 2015). Each 1% increase in price can be expected to reduce ridership by between 0.2% and .4%, suggesting that a 25% fare increase would decrease ridership by between 5 to 10%. In 2012, the year in which fares were increased by 25%, ridership dropped by just 2% before beginning its impressive upward ascent. The recent boarding numbers have exceeded expectations—ridership in 2014 was 0.8% higher than Metra had forecasted.

These observations are not intended to suggest that other factors, such as a strengthening economy, are not important contributors to the ridership growth. Nevertheless, the data does suggest that fundamental changes are taking place in consumer perceptions about the desirability of traveling by rail. The growing dependence on personal electronic devices appears to have altered the perceived "disutility" of spending time in a seat. This has important policy ramifications for transit companies such as Metra.

Status of "Tech-Friendly" Amenities on Metra Trains

Metra has taken notable steps to cater to passengers using their electronic devices by:

Installing power outlets in new and refurbished cars

Metra is equipping its Amerail-built passenger car fleet with on board power outlets on a relatively ambitious timetable. Similarly, the new Nippon Sharyo cars placed into service on the Metra Electric routes have power outlets. Additional measures to make power outlets available on other equipment, even if only in selected cars, warrant serious consideration.

Making arrangements for electronic ticketing using the Ventra system

Later this year, passengers will be able to buy Metra tickets on their electronic devices through the Ventra website. A key benefit of this app will be to allow travelers to avoid paying the $5 surcharge for failing to buy a ticket before boarding.

Taking steps to make onboard Wi-Fi available to its customers

Although an announcement about the agency's plans is expected this year, Metra has not recently communicated to the public an explicit timetable for rolling out Wi-Fi on any of its services. By way of example, Amtrak unveiled Wi-Fi on its Midwestern routes in 2014. Technical planning for the installation of onboard Wi-Fi is underway.

Among the more practical investments that Metra and allied organizations could make would be to invest in tech-friendly amenities at the downtown commuter rail stations. In suburban areas, the propensity for many suburban stations to close at midday and on weekends also limits their tech-friendly qualities. Although passengers waiting for flights have come to expect a comfortable seat next to or near a power outlet, this is not the case at many train stations, which have waiting rooms with highly restrictive hours (some of which close at noon). This not only exposes passengers to the elements, but it denies them an opportunity to charge their devices and engage in complex electronic tasks which are best performed while seated in indoor spaces.

Varying Levels of "Tech Friendly" Amenities at Downtown Stations

None of the five major downtown commuter-rail stations—Millennium, LaSalle St., Ogilvie, Union, and Van Buren St.—has a station-wide Wi-Fi system, airport-style work counters for passengers with larger devices, or dedicated charging stations. Although free Wi-Fi is available at coffee houses and fast-food restaurants at Millennium and Union stations *(Figure 8)*, the other three downtown stations lack this convenience. Nevertheless, Millennium is noteworthy for having a strong signal from a Starbucks directly beside the waiting room that is free and available both when the retailer is open or closed. Power outlets can be found in walls and restaurants at Millennium, Union, and Van Buren stations, but within or near waiting room seats only at Millennium and Ogilvie stations. Ogilvie has outlets in its small glass-enclosed waiting room but lacks this amenity as well as Wi-Fi in the food court, which is a common waiting are for passengers.

Signals by 3G and 4G providers also differ sharply between stations. To quantify these differences, our data team measured the signal strength in both waiting room areas and platform locations at each station *(Figure 9)*. Each station was sampled on two occasions, with signals measured for three providers—AT&T, T-Mobile, and Verizon—which together have about 82% of the national market. (See *Appendix* for a summary of the measurement tools). The results show that Verizon's signals tend to be consistently stronger than AT&T's, which, in turn, are consistently stronger than T-Mobile's. AT&T and Verizon's signal strengths are arguably more important to a station's tech-friendly qualities than T-Mobile's, as each as a market share of about 34%, more than twice T-Mobile's 14%.

Overall, LaSalle has the best coverage (i.e., the highest signal strength) on the three providers, followed by Union and Millennium stations (although the T-Mobile signal is quite weak in the latter station). Only LaSalle has an average strength of 80% or more in all areas surveyed—both at trackside and the main waiting area, while just three—LaSalle, Millennium, and Union stations—have waiting room strength above 50%.

MILLENIUM STATION: the most tech-friendly facility

Several features of Millennium make it downtown's most tech-friendly commuter-rail station:

Passenger enjoy the benefits of Wi-Fi from the station's Starbucks coffee house, which is situated adjacent to the Metra waiting room and can be picked up throughout much of the station at all hours of the day. This retailer is also clearly visible from the waiting area, thus alerting passengers to the availability of Wi-Fi as well as seating areas and/or tables (with power outlets nearby).

Verizon signals are higher in the waiting areas and trackside at Millennium than at any other station, while AT&T signals are the third strongest (when waiting and trackside measurements are combined.)

Power outlets are generously available along station walls, making this the only station in which passengers detraining will come across outlets (as well as Wi-Fi) simply by following the flow of traffic into the main terminal area.

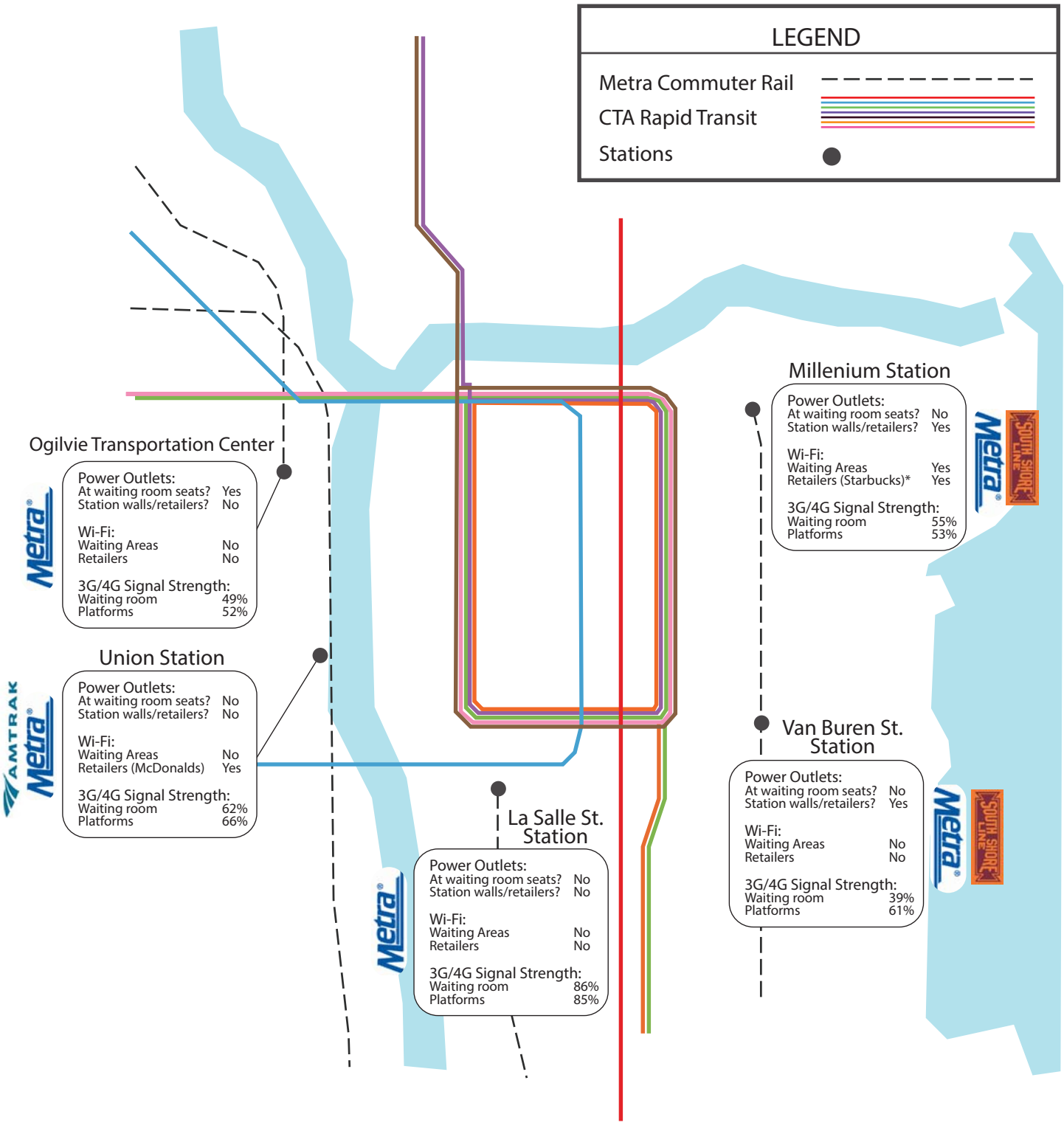
An airport-style layout allows passengers who are awaiting their departure to surf the Internet on Wi-Fi and charge their device within view of the boarding area and an electronic departure monitor—an arrangement that travelers take for granted at an airport but is not available at any other downtown train station.

Electronic accessories, batteries, and power cords can be purchased nearby. Although none of the downtown stations has retailers with an extensive stock of electronic items, the walk to one is shorter from Millennium than from the other stations. A traveler on foot can reach the CVS in the Illinois Center complex (205 N. Michigan) in less than two minutes without ever leaving the building, or can walk a slightly longer distance to Walgreens at 300 N. Michigan.

A notable limitation of Millennium is a weak T-Mobile signal, particularly the platforms adjacent to tracks 3 -6. T-Mobile signals are nonexistent on tracks 5/6 and at only 11% strength on tracks 3/4. Signals are also relatively weak in the concrete-enclosed South Water entrance at the north end of the station. Overall, however, Millennium offers the most comprehensive amenities for tech-savvy travelers.

Figure 8

Amenities and Signal Strength for Users of Personal Technology at Downtown Metra Stations



* Although there is no general Wi-Fi system for the station, Starbucks provides a strong Wi-Fi signal that can be used in waiting areas both when the retailer is open and closed.

Signal strength is the unweighted average of the % network signal for three large providers, AT&T, T-Mobile and Verizon. See Methodology section for details.

Figure 9

Signal Strength at Downtown Commuter Rail Stations

Average Signal Strength on Three Service Plans

LaSalle Street	Verizon	T-Mobile	AT&T	Total
Waiting Room	71%	96%	90%	**86%**
Track 1	72%	89%	91%	84%
Middle Track	83%	95%	81%	86%
Avg.-track locations	78%	92%	86%	**85%**
Millennium Station				
Pedway waiting Area	81%	16%	37%	45%
Track 2	96%	21%	30%	49%
Track 3/4	100%	11%	45%	52%
Track 5/6	93%	0%	46%	46%
Waiting Area (Metra)	100%	30%	34%	**55%**
Avg., track locations	96%	11%	40%	**49%**
Oglivie Station				
Food Court	76%	37%	50%	54%
Track 3/4	65%	25%	37%	42%
Track 7/8	79%	32%	39%	50%
Track 11/12	86%	28%	38%	51%
Waiting room	87%	21%	39%	**49%**
Avg., track locations	76%	28%	52%	**52%**
Union Station				
Track 5/7	90%	23%	51%	55%
Track 13/15	95%	29%	61%	61%
N Waiting Area	94%	41%	62%	66%
Track 6/8	100%	77%	50%	76%
Track 14/16	100%	46%	68%	71%
S Waiting Area	84%	30%	75%	63%
Great Hall	74%	46%	53%	58%
Food Court	100%	35%	63%	66%
Avg., track locations	96%	43%	58%	**66%**
Avg., waiting areas	88%	35%	63%	**62%**
Van Buren Station				
Waiting Room	49%	30%	37%	**39%**
Track 1 Platform	66%	43%	59%	56%
Island Platform	68%	72%	61%	67%
Avg.,track locations	67%	57%	60%	**61%**

Union Station: a Rapidly Improving Transportation Gateway

Union Station stands out as the second most tech-friendly facility, having consistently strong signals on AT&T and Verizon, and workable signals on T-Mobile. This station also has power outlets and Wi-Fi in food court restaurants, most notably in McDonald's, as well as in Amtrak's new opened Legacy Lounge, which can be used for a $10 fee. Electronic items can also be purchased at a CVS, which is a relatively short distance away, outside the station on Clinton Street. Moreover, recently announced plans to greatly improve the Great Hall with enhanced amenities and new retail spaces suggests that newer tech-friendly conveniences, such as Wi-Fi, could be coming to the station in the near future.

Opportunities at the Other Stations

Ogilvie's image among tech users could be dramatically improved through the installation of Wi-Fi in the main passenger concourse and food court. This station's AT&T and T-Mobile signals remain disappointing, considering that this is an above-ground facility. Travelers can buy electronic items at CVS (400 W. Madison) in the walkway linking the station to the Daily News Building. **LaSalle St.**, meanwhile, lacks power outlets, and, along with **Van Buren St.**, is challenged by the absence of space for restaurant and coffee houses, which are of considerable value by people heavily dependent on devises. Considering the small size of the waiting rooms, Wi-Fi might be a relatively inexpensive amenity to install.

When interpreted broadly, the results from last year's *The Digitally Connected Commuter* report suggests that the growth in rail-transit ridership in Chicago and the rest of United States is being fueled in part by the advantages of train travel to those who put a premium on using electronic devices. Passengers who would otherwise drive alone, and thus would need to limit their technological activity, have particularly strong incentives to take the train. Public agencies have much to gain by providing tech-friendly amenities—and airport-style waiting room environments—that leverage the desire of passengers to use electronic devices in the most enjoyable and productive manner possible over the course of their trip.

APPENDIX

METHODOLOGY + SAMPLE

DATA RECORDING PROTOCOL ONBOARD TRAINS: Data is recorded as a code, based on the type of device each passenger is using, by a trained data collector using "counter" app on a smart phones. Please reference *Table 1* in this report for details on how we assign codes to each type of electronic device. The Institute purchases tickets for data collectors—who travel as regular fare-paying passengers on buses, planes, and trains—and collect data in real-time settings.

TIMING ON TRAINS: Data collectors gather information 5 to 10 minutes after leaving downtown terminals and immediately upon departure on return trips from inner-ring suburbs. We assume that technology users are randomly distributed throughout trains. Only when clear and unobstructed views are possible does the data team record data of passengers sitting on upper levels of gallery cars. In many cases, this was not the case, resulting in observations on the lower level being more prevalent than those on the upper level.

SPECIAL CIRCUMSTANCES: Data collectors develop a consistent response to these situations:

- When two passengers are using the same device, only the passenger most closely situated to the device is counted as using a device.
- When a passenger is judged to be below grade-school age (5th grade or less), that passenger is excluded, al though we have observed heavy usage among many younger passengers. When a passenger is using a set of earbuds or headphones that is plugged into an electronic device, but that passenger appears to be sleeping, we classify that passenger as using an "audio device."
- The sample size differs by train, depending on the passenger load and time available for data collection. The number of observations is limited so that no train accounts for more than 5% of all observations in the sample.

MEASURING 3G/4G SIGNALS AT DOWNTOWN STATIONS:

The signal strengths shown are the unweighted average of the strength of two large providers (AT&T and Verizon) and mid-size provider (T-Mobile). Measurement for the AT&T and Verizon were made using Android devices using the "Network Signal Info" app by KAIBITS Software, available at https://play.google.com/ store/apps/details?id=de.android.telnet&hl=en. Measurements for AT&T were made using an Apple device using the dial *3001#12345#*feature. This provides measurements in dBc, which were converted to percentages using the www.stackoverflow.com website. The locations in which measurements were taken can be found in *Figure 9*. Platform measurements were made at a variety of locations adjacent to the second car at the back of the train. Waiting room measurements were measured at the center of these facilities.

APPENDIX

RECENT CHADDICK STUDIES ON TECH USE

2015 Independence Day Holiday Travel Overview: U.S. Intercity Bus Industry

This Intercity Bus Briefing summarizes estimates of travel on scheduled intercity bus lines in the United States over the 2015 Independence Day holiday period. Released July 2015.

Adding on Amenities, Broadening the Base: 2014 Year-in-Review of Intercity Bus Service in the US

The seventh in an annual series, summarizes changes to the sector during the 2014 calendar year, including review of the expansion of the intercity, notable amenities and new luxury offerings, and new routes added to the network. Released January 2015.

The Digitally Connected Commuter: The Rapidly Rising Use of Personal Electronic Devices on Chicago's Suburban Trains: 2014 Update

This report explores the manner in which the growing prevalence and sophistication of personal electronic devices is changing the way Americans experience public transportation. Released July 2014.

The Traveler's Tradeoff: Comparing Intercity Bus, Plane, & Train Fares across the United States

This study evaluates the prices of travel on various modes of transportation—air, bus, and rail—in 52 city pairs in the United States with travel distances between 100 and 500 miles. Released July 2014.

The Personal Tech Tidal Wave: The Rising Use of Electronic Devices on Intercity Buses, Planes, & Trains

Our 2014 study showing how the growing use of portable electronic technology among intercity air, rail, and bus passengers changing travel behavior. Released July 2014.

The Motor Coach Metamorphosis 2012: Year-in-Review of Intercity Bus Service in the United States

Summarizes changes to the sector during the 2012 calendar year by reviewing: the expansion of the intercity network, the industry's rate of growth, and notable initiatives undertaken by traditional bus lines as well as discount operators emphasizing city-to-city service. Released January 2013.

Tablets and E-Readers Leap Past Music Players and Regular Cell Phones as "Technologies of Choice" on Commuter Trains

A detailed look at the type of devices used by more than 2,000 travelers on Chicago commuter trains. Released on May 23, 2012.

The Top 20 "Top Transit Suburbs" of Metropolitan Chicago:" An Index Approach

An evaluation of dozens of amenities and characteristics of Chicago suburbs in order to identify the most attractive places to live for people seeking lifestyles built around commuter-rail service. Released on July 26, 2012.

For free downloads of these studies, please visit the Research & Publications page of the Chaddick Institute website at: http://las.depaul.edu/chaddick

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[1] Chaddick Institute surveys show that nearly 90% of intercity bus passengers use some form of technology on intercity trips. See "Who Rides Curbside Buses: A Survey of Passengers on Curbside Bus Lines in Six East and Midwest Cities," available at las.depaul.edu/chaddick. Although we have not conducted a similar survey of airline passengers, the socioeconomic characteristics of commuter train riders suggest these travelers use technology at an even higher percentage.

[2] A notable exception is the south branch of the CTA Red Line, which was closed from May through October, 2013.

[3] Market shares for the 4st quarter of 2014 were taken from http://www.statista.com/statistics/199359/market-share-of-wireless-carriers-in-the-us-by-subscriptions/

[4] Market shares for the 4st quarter of 2014 were taken from http://www.statista.com/statistics/199359/market-share-of-wireless-carriers-in-the-u by-subscriptions/