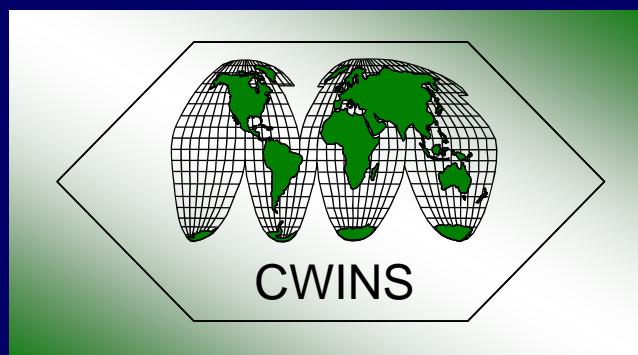


Boston, Massachusetts, September 6, 2015
IEEE Vehicular Technology Conference



Evolution of Wi-Fi Access and Localization – A Revolution in Wireless Networking

K. Pahlavan

September 6-9, 2015

©KP

What is a revolution?

“An unexpected success against the odds, which changes the paradigm!”

“He wrote in three scripts:

The one that he wrote and only he could read

The one that he wrote and he and others could read

And the one that he wrote and neither he nor others could read

I write the third way!”

Jalal ad-Din Muhammad Rumi,

Persian Poet, 1207-1273 C.E.

WHAT CAN I SHARE WITH YOU ?

"History is who we are and why we are the way we are."

David McCullough

Pulitzer Prize Winner Author

"The only thing new in the world is the history you don't know."

Harry S. Truman

"Any fool can make history, but it takes a genius to write it."

Oscar Wilde

PART I:
EVOLUTION OF WI-FI TECHNOLOGY

How did WLAN technology begin ?

■ AROUND 1980:

- IBM Rueschlikon Laboratory, Zurich, Switzerland: Infrared for Manufacturing floors
 - F.R. Gfeller and U. Bapst, "Wireless in-house data communication via diffuse infrared radiation," IEEE Proceedings, Dec.1979
- HP Palo Alto Laboratory, California: DSSS using SAW device as matched filter
 - P. Freret, "Application of spread spectrum radio to wireless terminal communication," Proceedings of the IEEE National Telecommunication Conference, Dec. 1980.

■ AROUND 1985:

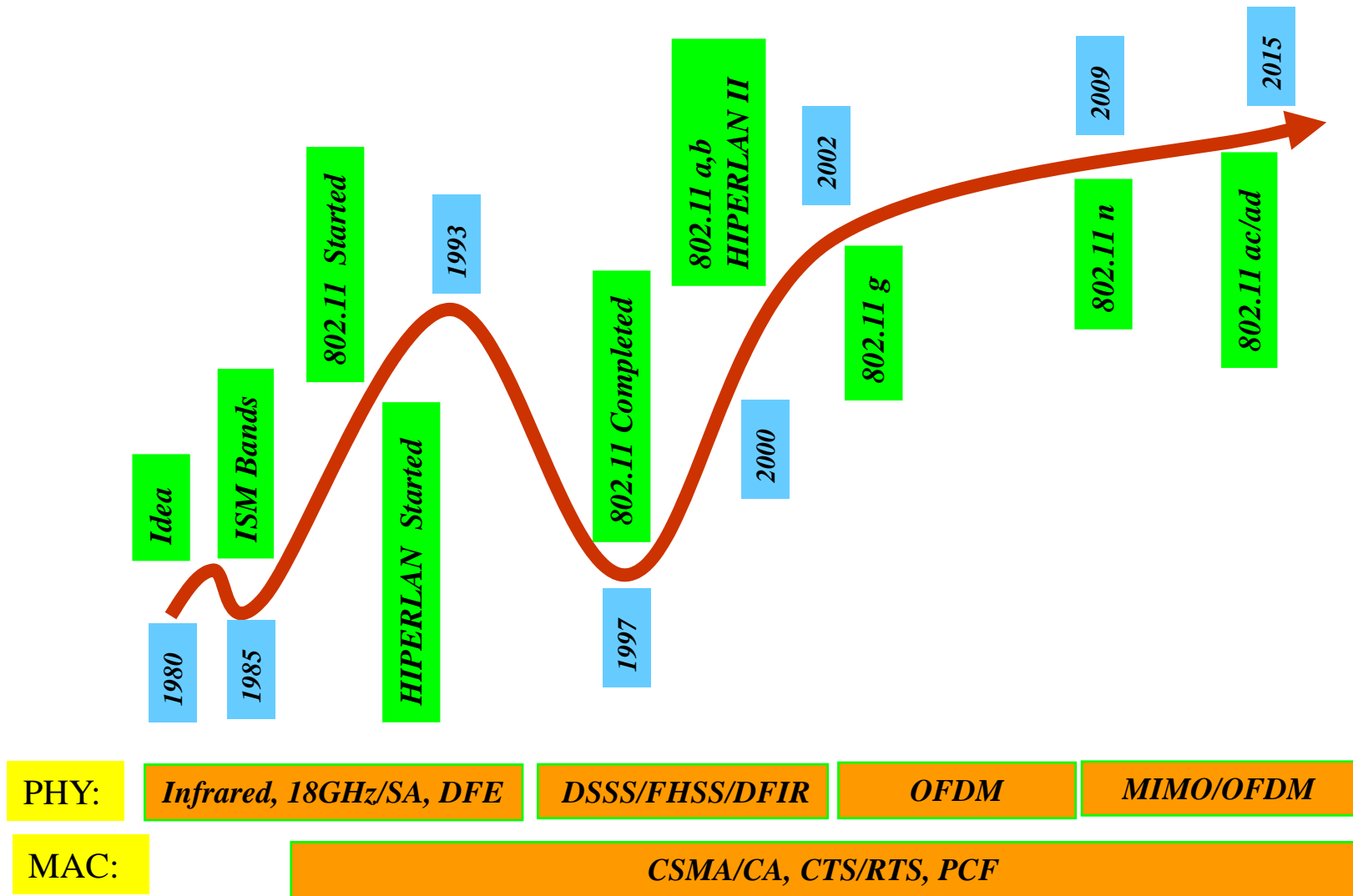
- Release of ISM bands
 - Mike Marcus, "Authorization of Spread Spectrum Systems Under Parts 15 and 90 of the FCC Rules and Regulations" Federal Communications Commission, June 18, 1985.
- Some visionary surveys:
 - K. Pahlavan, "Wireless Communications for Office Information Networks", IEEE Communications Magazine, June 1985.

■ BETWEEN 1985-1993:

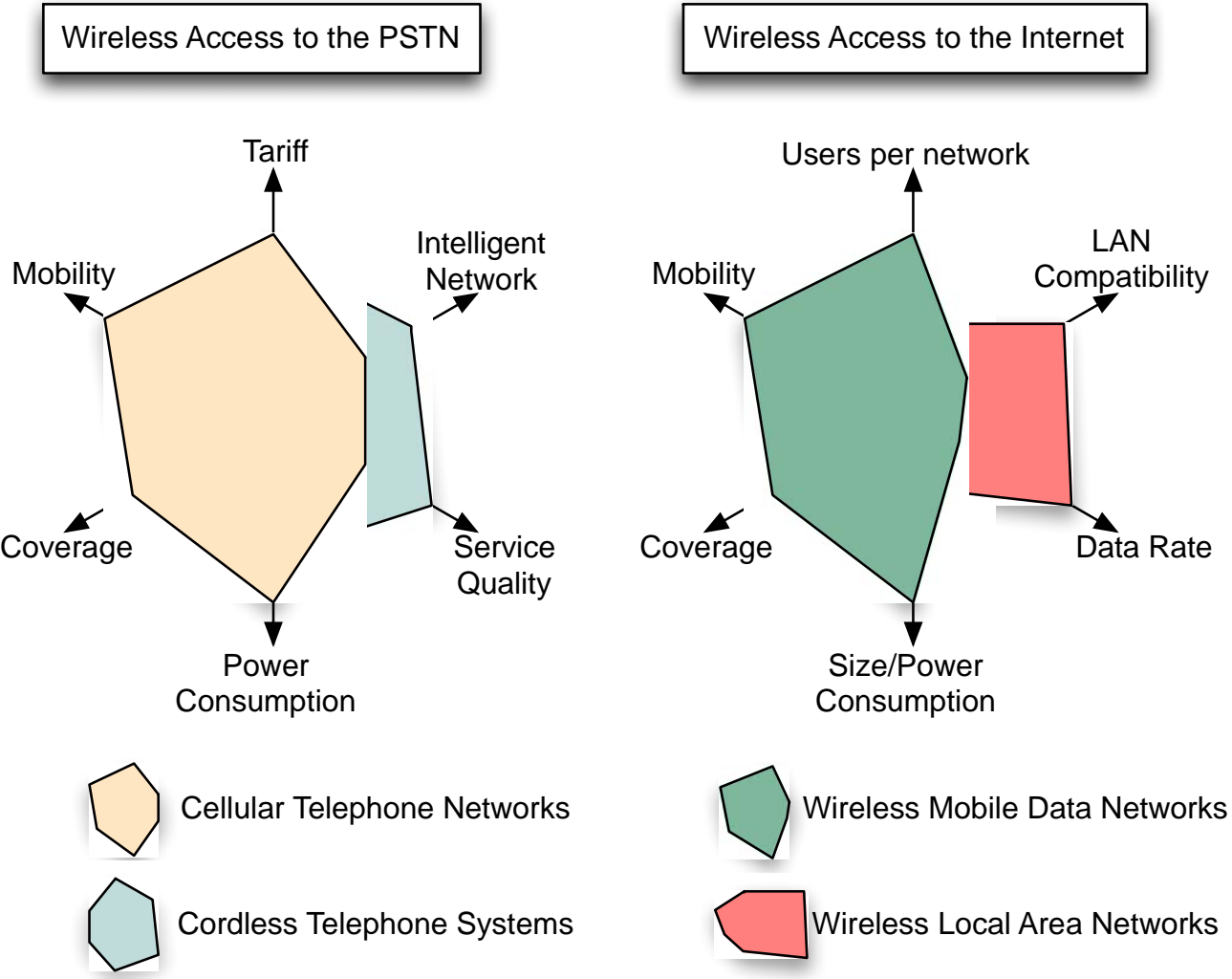
- Formation of the IEEE 802.11 from 802.4L.
- NCR, Netherlands and 20-30 start up companies/groups in N. America (Motorola/Altair, Photonics, Proxim, Aironet, Persoft, Hopper, WINDATA, DEC/Roamabout,)
 - The first IEEE Workshop on WLANs (collocated with IEEE 802.11 meeting), WPI, May 1991



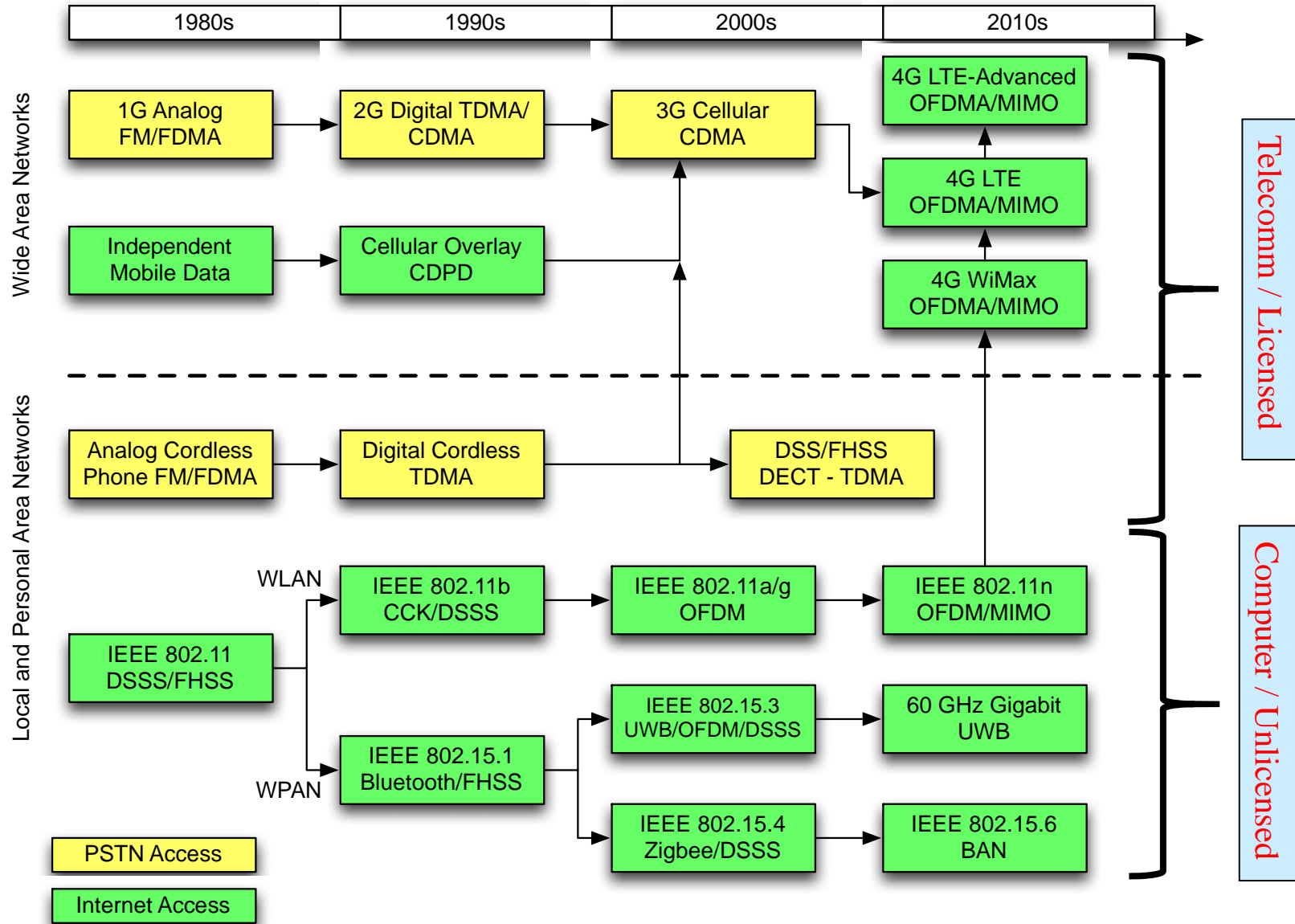
Evolution of the Technologies



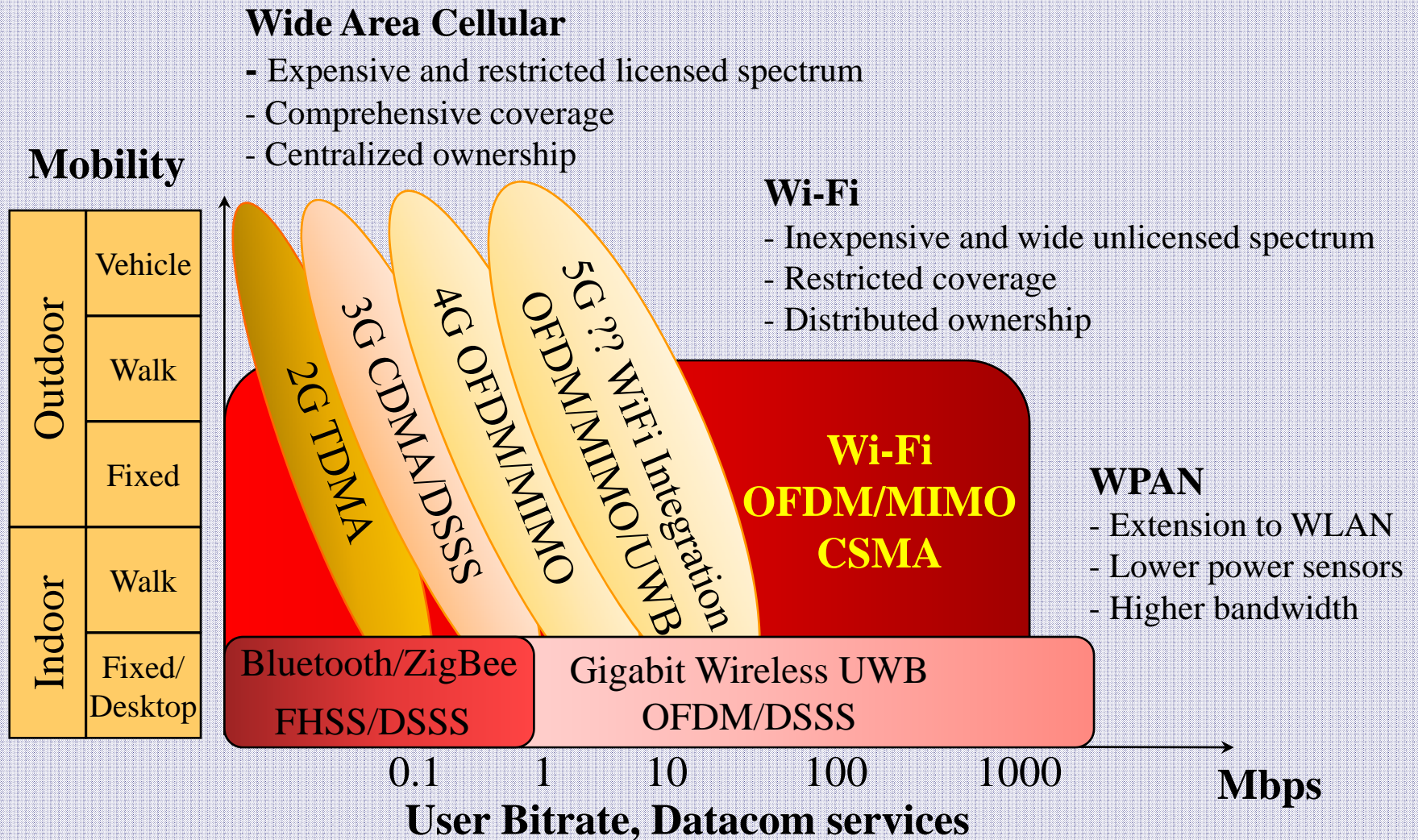
Four Pioneering Wireless Technologies



Evolution of Wireless Technologies

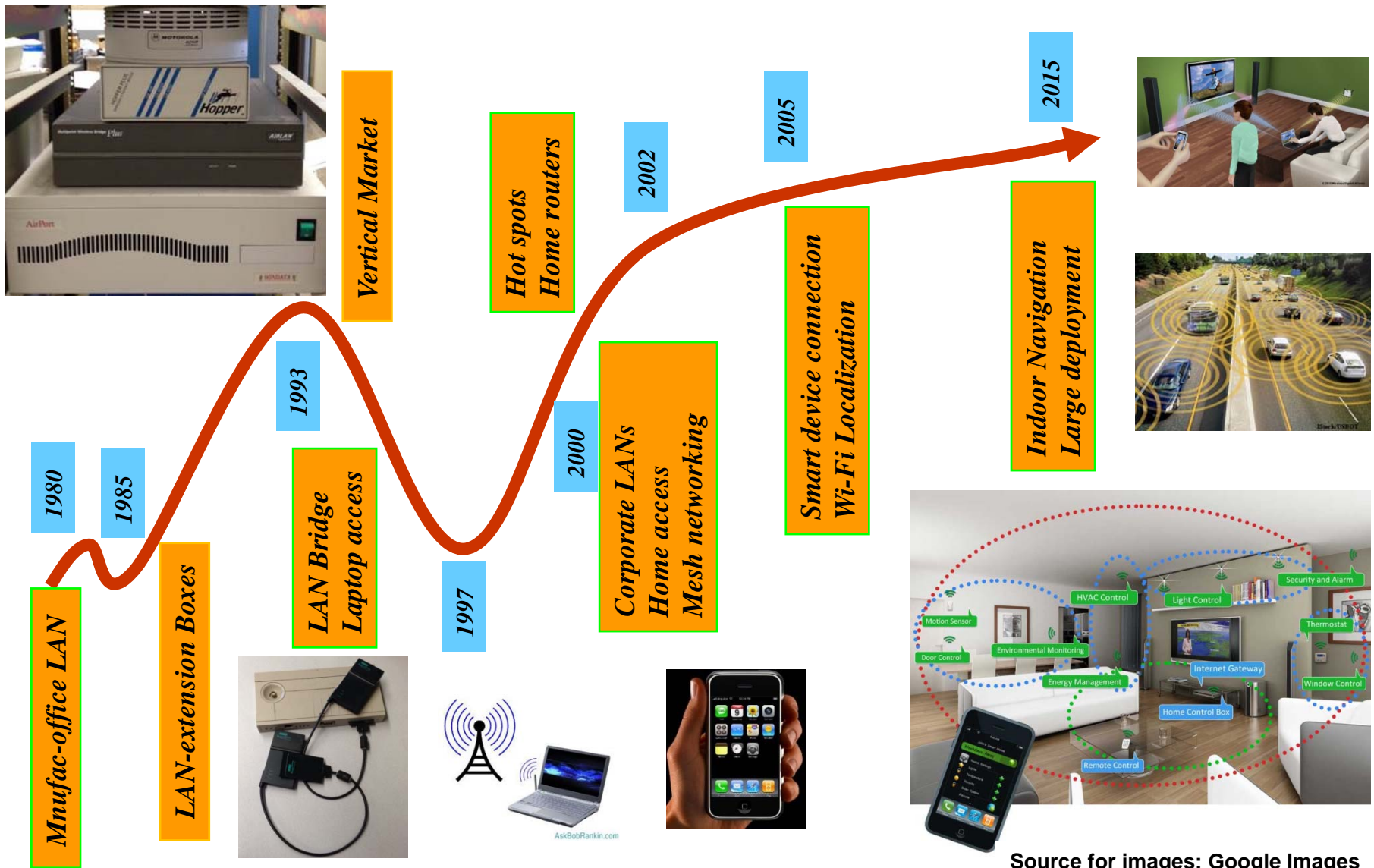


Overview of Wireless Networks

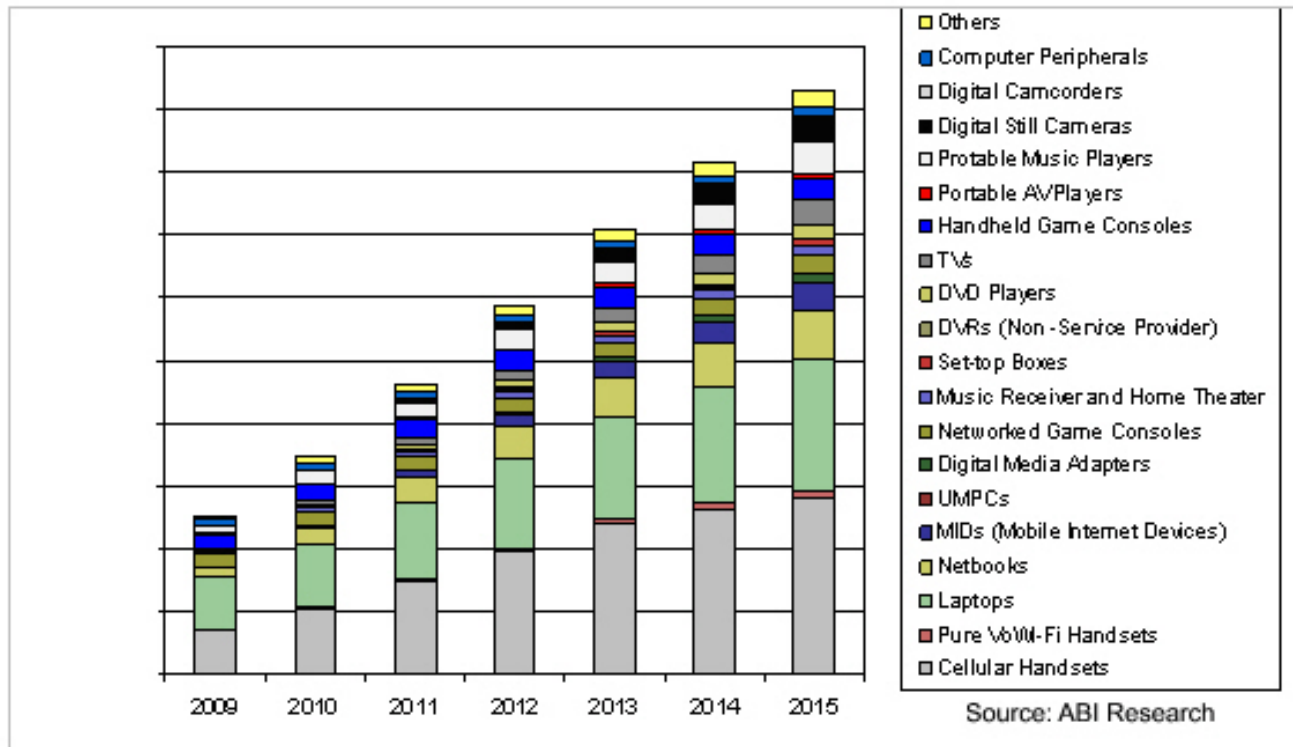


PART II:
EVOLUTION OF WI-FI APPS AND MARKET

In Search of a “Killer Apps”

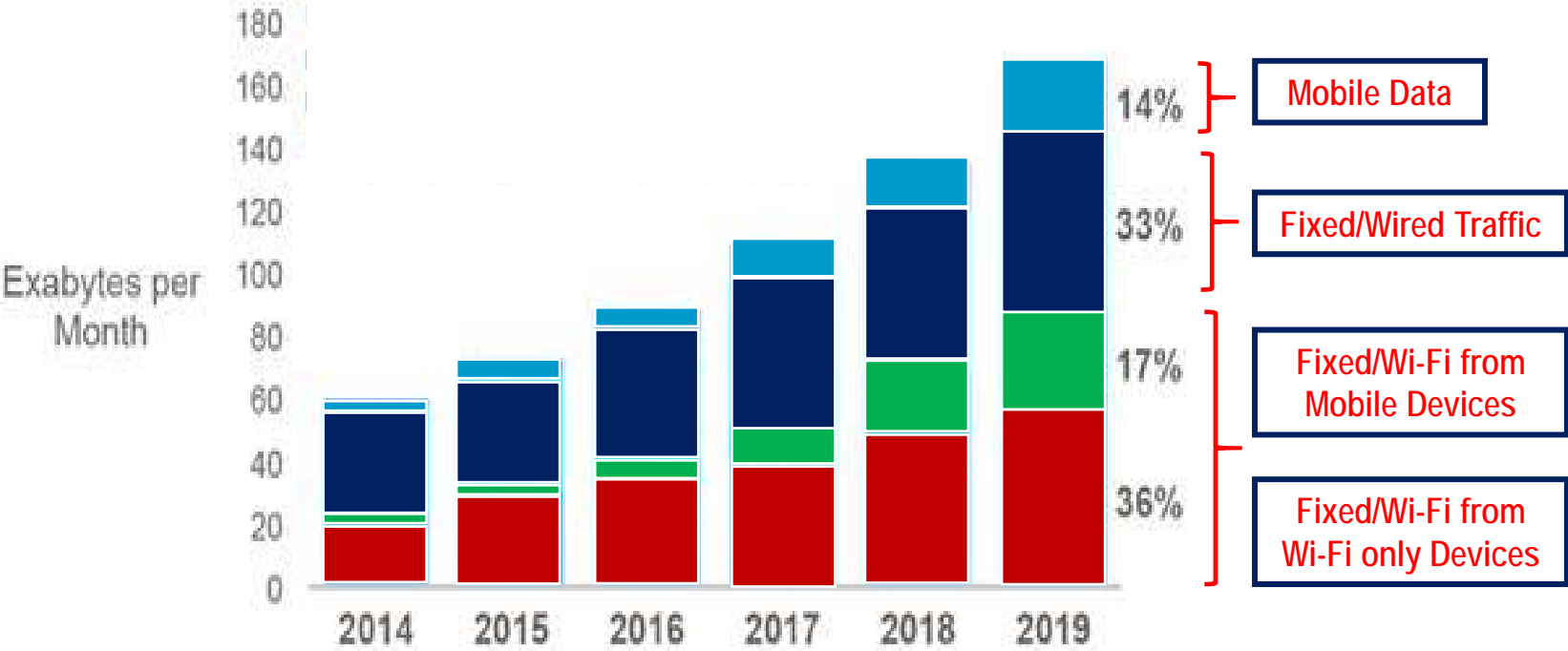


Today Wi-Fi is in numerous devices!



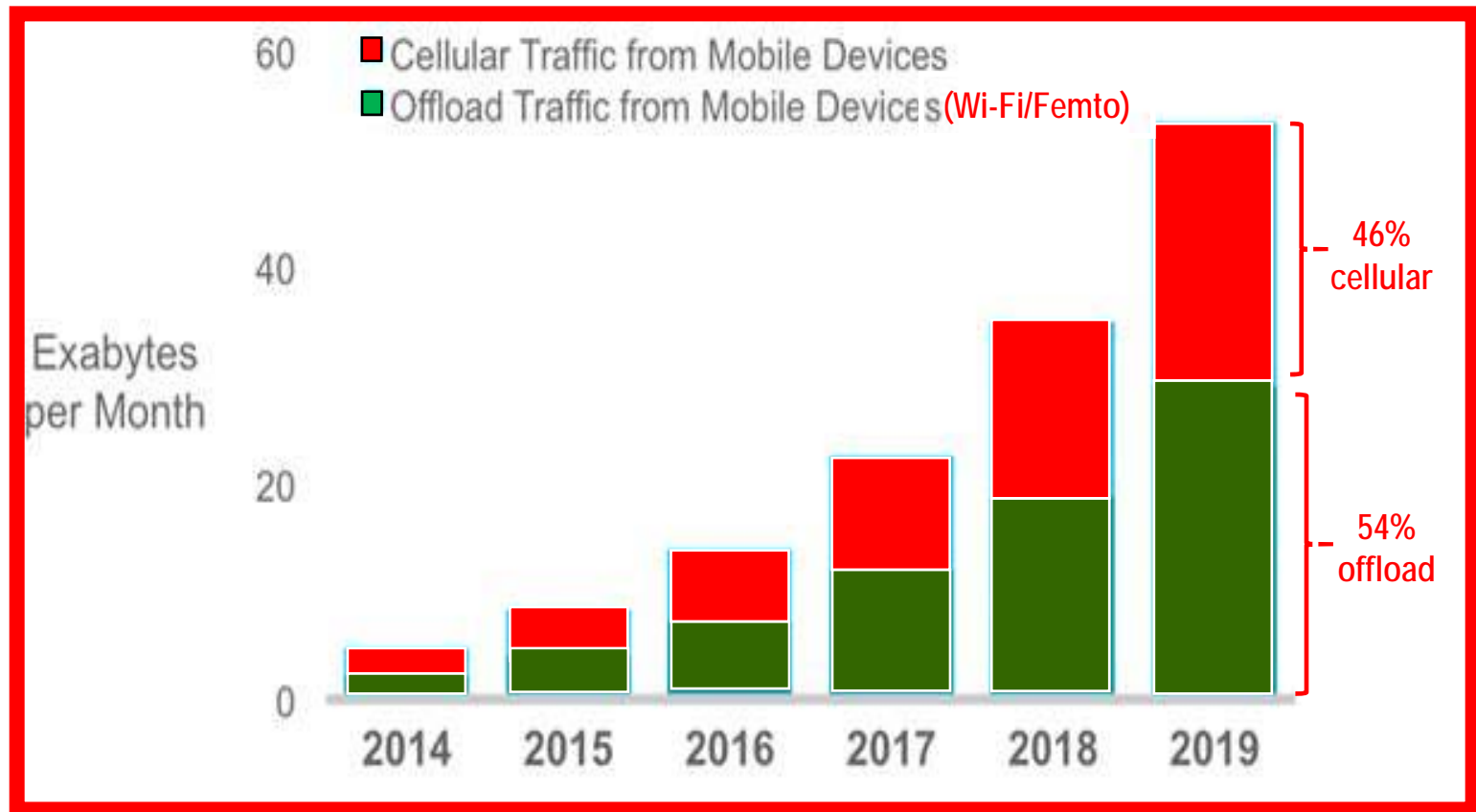
Global Wired and Wireless IP Traffic

By 2019 66% of IP traffic is Wireless (Wi-Fi and Mobile)



Source: Cisco VNI Mobile, 2015

Global Mobile Data Traffic



Source: Cisco VNI Mobile, 2015

Wi-Fi is Local Cellular is Wide Area

■ Comparison of technologies

- Assigned access (AA) vs random access (RA)
- Wide area is mostly mobile phone with many users
- Local is dominated by data with a few users

■ Evolution of Standards

- IEEE 802.11 started late 1980's (LRA)
- HIPERLAN-1 began early 1990's (LAA)
- ***Wireless ATM was mid-1990's (LAA)****
- HIPERLAN-II was late-1990's (LAA)
- Wi-MAX followed by 4G evolved (WAA)
- ***Femto-cell (LAA) - Is this wireless ATM coming back?!***

* K. Pahlavan, A. Zahedi and P.Krishnamurthy, "Wideband local access: Wireless LAN and wireless ATM", Communications Magazine, IEEE 35.11 (1997): 34-40.



**PART III:
FROM WLAN TO WI-FI LOCALIZATION –
EMERGENCE OF AN UNEXPECTED “KILLER APP”**

Evolution of Wi-Fi localization

- **Emergence of RF localization industry**
 - RF navigation for military applications (WW II)
 - Military GPS (mid 1970's)
 - Commercial GPS (early 1990's)
 - Non-GPS localization using signals of opportunity (late 1990's)
- **Wi-Fi localization: the technology that prevailed in commerce**
 - Using WLAN infrastructure for localization (2000)
 - Indoor RSS-based Wi-Fi localization: RTLS (2001)
 - RSS-based Wi-Fi localization for smart phones: WPS (2005)
 - WPS on iPhone (2008)
 - Today Wi-Fi localization is used in hundreds of thousands of applications on smart phones creating several billions of hits per day



Source: Skyhook Wireless

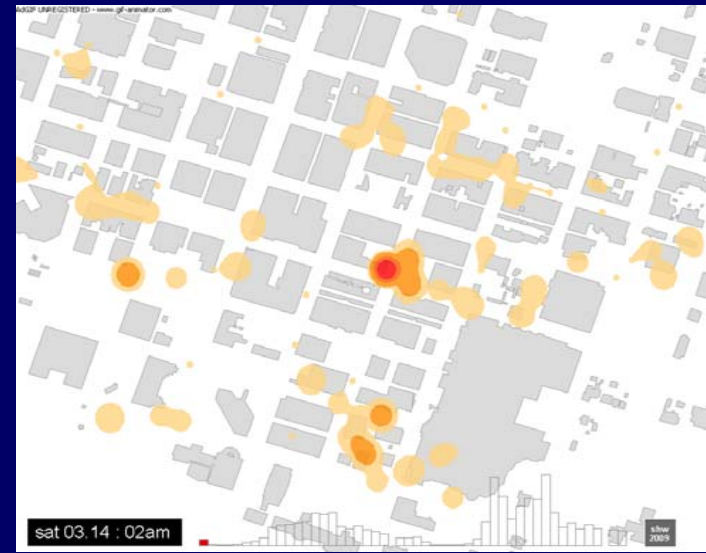
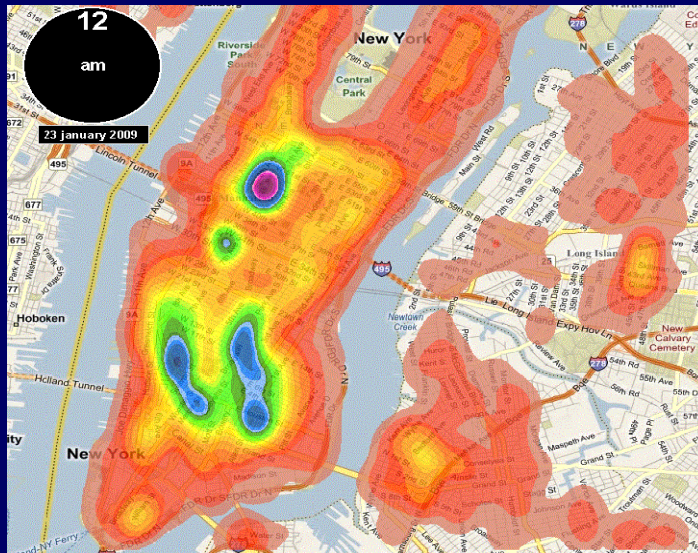
K. Pahlavan, F. Akgul, Y. Ye, T. Morgan, F. A.-Shabdiz, M. Heidari, C. Steger, "Taking Positioning Indoors: Wi-Fi Localization and GNSS", InsideGNSS, vol. 5, no. 3, May, 2010.

Localization for smart devices

- Billions of smart devices use location information for hundreds of thousands of Apps:
 - Directly: direction finding, Yelp, Kayak,
 - Indirectly: gaming, tracking customers,
- Precision requirements are quite diversified
 - Centimeters in gaming, meters in indoor geolocation, tens of meters in turn-by-turn direction, hundreds of meters for advertisement
- Smart devices carry a number of location sensors:
 - RF Based: GPS, Wi-Fi, Cell Phone, iBeacon,
 - Mechanical: magnetometer, barometer, accelerometer, ...
- Location sensor tracks are widely used for location intelligence



Location Intelligence



- Location-time traffic analysis
- Geo fencing (elderly, pets, children, prisoners,)
- Real world consumer behavior
- Location certification for security
- Positioning IP addresses
- Customizing contents and experiences

Source: Skyhook Wireless, Boston, MA

PART IV:

HOW CAN WE SUPPORT LARGE DEPLOYMENT ?

APs in California and NE



Bay Area

San Diego Area

North East

Billions of Wi-Fis worldwide mostly residential.

How can we coordinate/integrate them ?

Source: Skyhook Wireless

Community Hotspot

The screenshot shows a web browser window displaying a Fortune magazine article. The browser's address bar shows the URL: fortune.com/2013/10/23/fons-new-wi-fi-router-is-a-community-hotspot/. The page features the Fortune logo at the top left, with a subscription link. Below the logo, there are navigation tabs for NEWS, POPULAR, VIDEOS, and FORTUNE 500. The main headline reads "FON's new Wi-Fi router is a community hotspot" with a sub-headline "The sharing economy" seems to be working for cars and vacation rentals, so why not Wi-Fi?". The author is listed as Michal Lev-Ram, and the article is dated October 23, 2013. A social media sharing bar includes icons for email, Twitter, Facebook, and LinkedIn. The article text begins with "Buyers can use other FON routers anywhere, free of charge." and continues to describe the FON company's strategy. A photograph of the white FON Wi-Fi router is shown on the right side of the article. At the bottom of the page, there is a "RECOMMENDED FOR YOU" section with a link to "North Campus". The Windows taskbar at the bottom shows the date as 9/4/2015 and the time as 7:35 PM.

www.wpi.edu/Images/CI... TANSO SALON EXTREMI... CAS - Central Authent... FON's new Wi-Fi router is...
fortune.com/2013/10/23/fons-new-wi-fi-router-is-a-community-hotspot/
Apps Banner Blackboard Learn WPI eGrads Workbe... Editorial Manager Commons Login Solution book Solution to Access a... Solution Book 02 Google VPN-WPI WPI Proposal Notic... NSF FastLane Google Scholar Bank of America
TIME INC. NETWORK: FORTUNE MONEY TIME SPORTS ILLUSTRATED GOLF TRAVEL + LEISURE PEOPLE MORE
FORTUNE SUBSCRIBE
DOW 16,102.38 -772.38 NASDAQ 4,683.92 -49.58 S&P 1,921.22 -29.91
NEWS POPULAR VIDEOS FORTUNE 500
FON's new Wi-Fi router is a community hotspot OCTOBER 23, 2013
The unsung hero of meetings at Twitter is Google Hangouts 7:20 PM EDT
Toyota buckles down on artificial intelligence for safer driving 4:40 PM EDT
Uber could premiere same-day delivery service for retailers 2:54 PM EDT
Tell us what you think
Click Here
By participating in a short survey
VOICE FIVE
Here's why I expect Taylor Swift to sing at Apple's 9/9 event 3:41 PM EDT
This tech could make coal plants cleaner 3:34 PM EDT
Why Microsoft isn't developing Minecraft 2.0 2:14 PM EDT
Surfing with... Shift co-founder Minnie Ingersoll 2:09 PM EDT
Buyers can use other FON routers anywhere, free of charge.
FON — The "sharing economy" seems to be working for cars and vacation rentals, so why not Wi-Fi?
FON, a Madrid-based company, is trying to cash in on the growing collaborative consumption trend by offering a new, \$59 router that turns home Wi-Fi networks into community hotspots. Users open up their network to other FON members, and in turn are able to use any other FON Wi-Fi hotspot free of charge. "It gives you the ability
RECOMMENDED FOR YOU
North Campus
7:35 PM
9/4/2015

Giant Free Public Hotspots

The screenshot shows a web browser window with the URL www.vancitybuzz.com/2015/04/vancouver-free-public-wifi-telus-supplier/. The page features the Vancity Buzz logo and a navigation menu with categories like FOOD, EVENTS, LIFE, BUSINESS, NEWS, SPORTS, ARTS, CONTESTS, and MORE. A trending section lists topics such as Abduction Attempt, Best Hot Dogs, Cold Brew Bike, Hurricane Ignacio, and The Fair at the PNE. Below this is an advertisement for the Whistler Village Beer Festival, scheduled for September 16-20. The main article is titled "TELUS selected as Vancouver free public Wi-Fi supplier" by Kenneth Chan, dated 3:41 PM PDT, WED APRIL 29, 2015. The article has 5.9k shares and includes social media sharing options for Facebook and Twitter. The featured image is a red sign on a post that reads "WiFi HOT SPOT" with a Wi-Fi symbol in the center, set against a blue sky with white clouds. The browser's taskbar at the bottom shows various application icons and the system clock indicating 9:31 AM on 9/6/2015.

Massive citywide Wi-Fi deployment

Center for wireless... | TANGO SALON EXT... | CAS - Central Auth... | FON's new Wi-Fi rou... | The First IEEE Work... | www.eeefc.org/vic... | Cisco Visual Netwo... | www.cisco.com/Cen... | NYC wants to turn all... | CAGR - Google Sear... | KeyCh...

venturebeat.com/2014/05/01/nyc-wants-to-turn-all-of-its-payphones-into-a-massive-citywide-wifi-network/

Apps | Banner | Blackboard Learn | WPI eGrads Workbe... | Editorial Manager® | Commons Login | Solution book | Solution to Access a... | Solution Book 02 | Google | VPN-WPI | WPI Proposal Notic... | NSF FastLane | Google Scholar | Bank of America | Other bookmarks

BUSINESS

NYC wants to turn all of its payphones into a massive, citywide Wi-Fi network

HARRISON WERER | MAY 1, 2014 10:14 AM

TAGS: Wi-Fi




Image Credit: NPR

Trending Research

- Mobile App Analytics: What winning mobile developers use

mojela_on_2011.pdf | Show all downloads...

9:25 AM 9/6/2015

Wi-Fi Phone plans

The screenshot shows a web browser window with the URL www.nytimes.com/2015/01/26/business/media/cablevision-to-introduce-wi-fi-based-phone-plan.html?_r=0. The page is from The New York Times, dated January 26, 2015, by Emily Steel. The article title is "Cablevision to Introduce Wi-Fi-Based Phone Plan".

MEDIA

Cablevision to Introduce Wi-Fi-Based Phone Plan

By EMILY STEEL JAN. 26, 2015

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Cablevision Systems plans to announce on Monday the start of a low-cost mobile phone service that will use Wi-Fi for connectivity rather than standard cellular networks, the first such service to be introduced by a cable operator.

Called Freewheel, the service will offer unlimited data, talking and texting worldwide for \$29.95 a month, or \$9.95 a month for Cablevision's Optimum Online customers — a steep discount compared with standard offerings from traditional cellular carriers. Freewheel customers initially must use a specific Motorola Moto G smartphone, which is being sold for \$99.95. The service goes on sale next month, and no annual contract is required.

The service will not offer a seamless connection for people on the go. Freewheel only works when the device is connected to Wi-Fi. (One exception is for emergency calls, which will be placed regardless of whether Wi-Fi is available.)

Cablevision has spent the last eight years building out its Wi-Fi network, which now offers more than 1.1 million hot spots for both indoor and outdoor access in the New York metro region.

That period coincided with the introduction of smartphones and an explosion in the use of Wi-Fi rather than cellular connections for mobile activities like browsing the Internet and watching videos.

More than half of smartphone browsing now comes via Wi-Fi, with more than 93 percent of tablet browsing occurring that way, according to a recent Adobe Mobile Benchmark report.

"The big picture for us is the fundamental transformation in how people

Retirement.
It's a totally different beast.

We can help you prepare for what's ahead.

Claiming Social Security: Should you wait?
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10:09 AM 8/27/2015

What is the role of Wi-Fi Phones ?

The screenshot shows a web browser window displaying an article from The Wall Street Journal. The article title is "Project Fi Review: Google Masters Wi-Fi Calling, but Needs Better Phones". The sub-headline asks, "Can the search giant change the wireless business like it's changed high-speed Internet?". The main image shows a white smartphone in a colorful (yellow, green, blue) protective case, with a Project Fi logo on the back. A white charging cable and earbuds are also visible in the kit. A text box over the image reads: "When invitees sign up for Project Fi, Google sends a colorful welcome kit, which includes...". To the right of the article is an advertisement for IBM LinuxONE, titled "IBM LinuxONE: Linux without limits". Below the ad is a Twitter feed snippet showing tweets from @IBMzSystems. At the bottom of the page, there is a blue banner with the text "THE WALL STREET JOURNAL. \$12 FOR 12 WEEKS #MAKETIMEFOR THE JOURNAL DIGITAL+PRINT SUBSCRIBE NOW". The browser's address bar shows the URL: "www.wsj.com/articles/project-fi-review-google-masters-wi-fi-calling-but-needs-better-phones-1436285959". The browser's taskbar at the bottom shows various application icons and the system clock indicating 10:06 AM on 8/27/2015.

Project Fi Review: Google Masters Wi-Fi Calling, but Needs Better Phones

Can the search giant change the wireless business like it's changed high-speed Internet?

When invitees sign up for Project Fi, Google sends a colorful welcome kit, which includes...

IBM LinuxONE: Linux without limits

Introducing IBM LinuxONE

IBM's big bet on the open source economy

IBM z Systems @IBMzSystems 20h
#IBMz Customer Success Story!
twitter.com/IBMzvoice...

IBM z Systems @IBMzSystems 21h

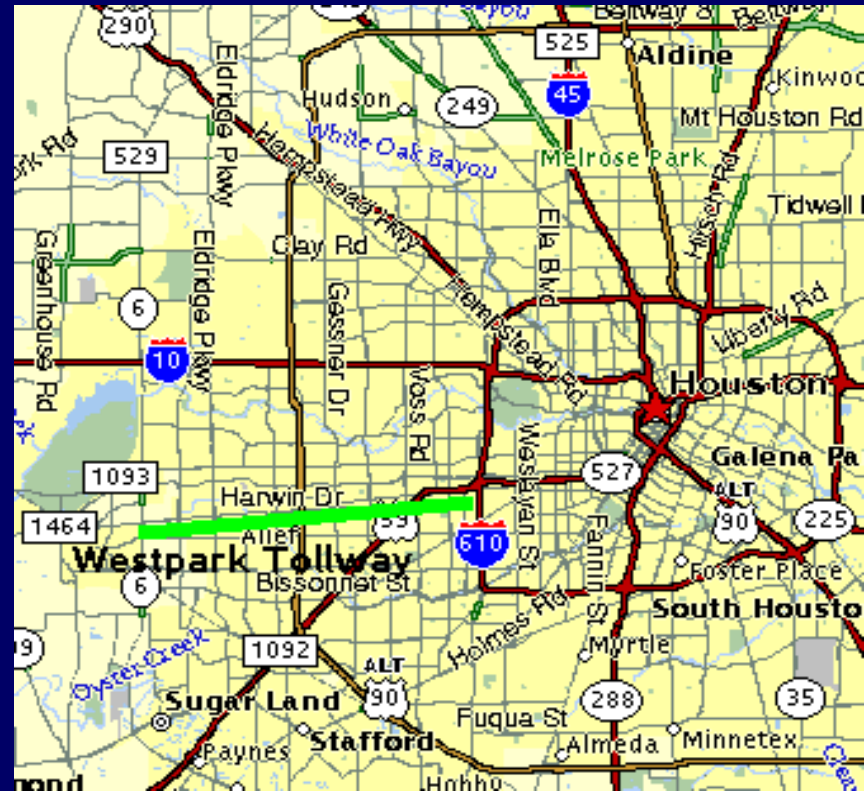
McKeogh, Ruth Anne
2 book shelves-free
Hi everyone, We have two book shelves for the taking-free.

THE WALL STREET JOURNAL. \$12 FOR 12 WEEKS #MAKETIMEFOR THE JOURNAL DIGITAL+PRINT SUBSCRIBE NOW

10:06 AM 8/27/2015

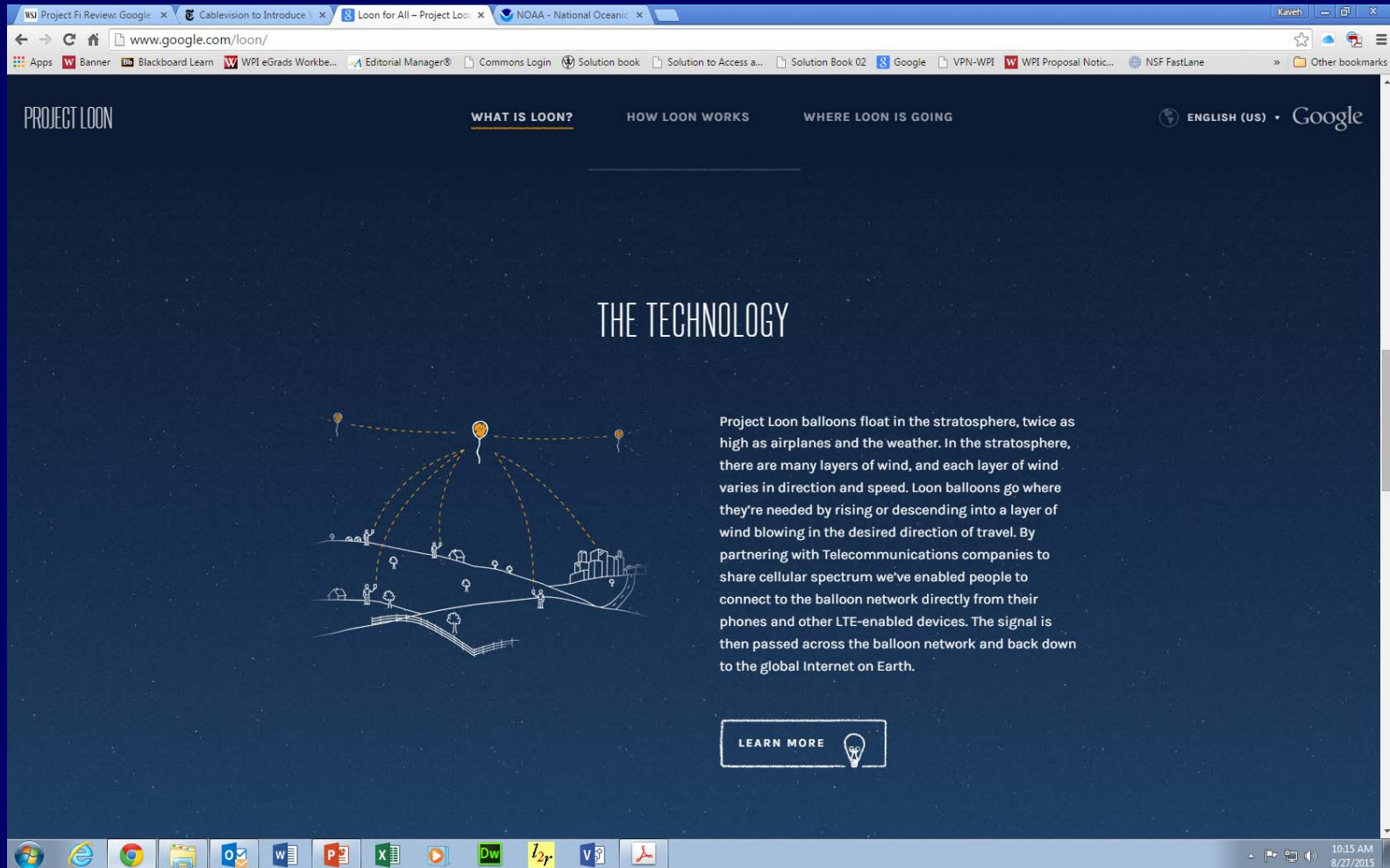
Wi-Fi vs Cellular

- **Cellular looks like the toll roads**
 - Good for outdoor wide areas
 - User should pay
 - Has comprehensive coverage
 - Higher total capacity by a single provider
 - Owned by large organization
 - Planned deployment and controlled QoS
 - More complex architecture
- **Wi-Fi is the back roads**
 - Good for indoor local
 - Free access most of the time
 - Has small coverage area
 - Higher capacity per user
 - Owned by small organization
 - Random deployment
 - Simple architecture



**PART V:
SOME CHALLENGES**

Wi-Fi in Balloons for Remote Areas




The screenshot shows a web browser window displaying the Project Loon website. The browser's address bar shows the URL www.google.com/loon/. The website's navigation menu includes "WHAT IS LOON?", "HOW LOON WORKS", and "WHERE LOON IS GOING". The main content area is titled "THE TECHNOLOGY" and features a diagram of balloons in the stratosphere connected to ground stations and users. A text block explains the technology, and a "LEARN MORE" button with a lightbulb icon is positioned below the text. The Windows taskbar at the bottom shows various application icons and the system clock indicating 10:15 AM on 8/27/2015.

PROJECT LOON


WHAT IS LOON? HOW LOON WORKS WHERE LOON IS GOING

ENGLISH (US) Google

THE TECHNOLOGY



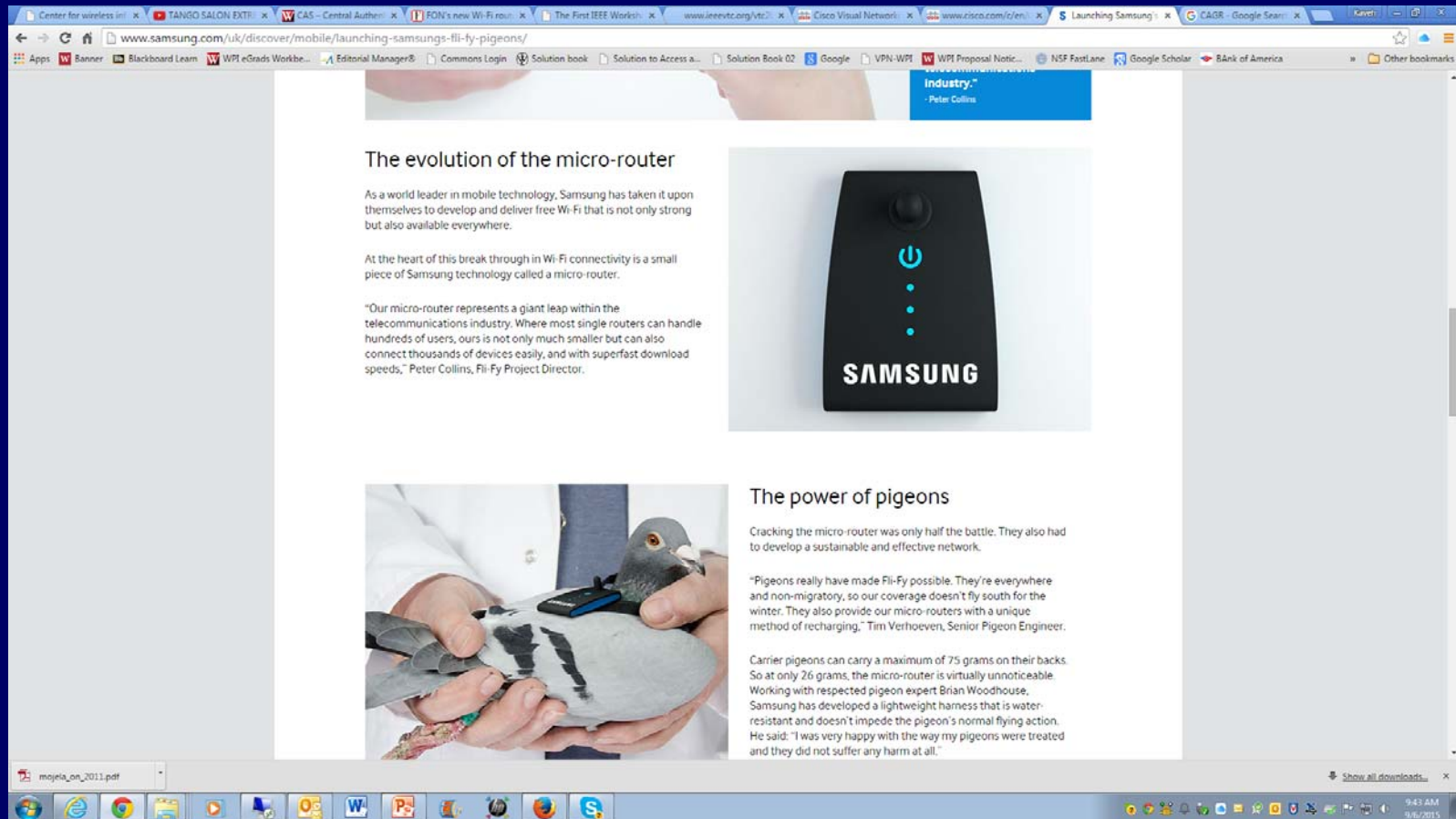
Project Loon balloons float in the stratosphere, twice as high as airplanes and the weather. In the stratosphere, there are many layers of wind, and each layer of wind varies in direction and speed. Loon balloons go where they're needed by rising or descending into a layer of wind blowing in the desired direction of travel. By partnering with Telecommunications companies to share cellular spectrum we've enabled people to connect to the balloon network directly from their phones and other LTE-enabled devices. The signal is then passed across the balloon network and back down to the global Internet on Earth.

LEARN MORE 

Wi-Fi in Drones for Trains

The screenshot shows a web browser window with the URL www.railway-technology.com/features/featurewifi-drones-uk-considers-radical-approach-for-coverage-on-trains-4610638/. The page title is "WiFi drones: UK considers radical approach for coverage on trains". The article is dated 29 June 2015 and written by Gary Peters. The main text discusses an open consultation from the UK Government, launched in June by the Department for Transport, seeking views on how to improve on-board mobile network coverage across the rail network. One idea is using unmanned aerial vehicles or tethered balloons to follow trains, but how plausible is this and what other avenues exist? A large image shows a white drone in flight against a blue sky. Below the image, it states: "Using drones to follow trains is just one option being considered by the UK Government to revolutionise mobile connectivity on the rail network and reduce WiFi blank spots. Rail minister Claire Perry said: 'Dropped calls and intermittent access to the internet are frustrations felt by many rail passengers.'" To the right of the article, there are social media sharing icons (Facebook, Twitter, Google+, LinkedIn, Pinterest, YouTube, Dribbble) and a count of 12. Below the article, there are three smaller images with captions: 1. A portrait of Rail minister Claire Perry with the caption: "Rail minister Claire Perry has said that the aim is to future proof mobile connectivity for passengers." 2. A drone in flight with the caption: "Facebook's Connectivity Lab has been testing drones and satellites for internet connection." 3. A train with the caption: "The government plans to invest £30m in a roll-out of free WiFi." To the right of the article, there are two advertisements: 1. "nationalgrid" with the tagline "HERE WITH YOU. HERE FOR YOU." and "Find energy saving solutions". 2. "MyTRANSITGuide" with the tagline "Get Free Bus & Train Directions". The browser's address bar shows several tabs: "Wi Project Fi Review: Google", "Cablevision to Introduce", "rt Wifi drones: UK considers", "NOAA - National Oceanic", and "Kaven". The browser's search bar contains "Enter Keyword" and a "Search" button. The browser's navigation bar includes "Home", "Products & Services", "Company A - Z", "Projects", "Features", "Videos", "White Papers", "News", "Events", "Advertise With Us", and "Report Store". The browser's status bar shows the time "10:17 AM" and the date "8/27/2015".

Can pigeons help coverage?




The screenshot shows a web browser window displaying a Samsung article. The browser's address bar shows the URL: www.samsung.com/uk/discover/mobile/launching-samsungs-fli-fy-pigeons/. The article is titled "The evolution of the micro-router" and "The power of pigeons".

The evolution of the micro-router

As a world leader in mobile technology, Samsung has taken it upon themselves to develop and deliver free Wi-Fi that is not only strong but also available everywhere.

At the heart of this breakthrough in Wi-Fi connectivity is a small piece of Samsung technology called a micro-router.

"Our micro-router represents a giant leap within the telecommunications industry. Where most single routers can handle hundreds of users, ours is not only much smaller but can also connect thousands of devices easily, and with superfast download speeds," Peter Collins, Fli-Fy Project Director.




The power of pigeons

Cracking the micro-router was only half the battle. They also had to develop a sustainable and effective network.

"Pigeons really have made Fli-Fy possible. They're everywhere and non-migratory, so our coverage doesn't fly south for the winter. They also provide our micro-routers with a unique method of recharging," Tim Verhoeven, Senior Pigeon Engineer.

Carrier pigeons can carry a maximum of 75 grams on their backs. So at only 26 grams, the micro-router is virtually unnoticeable. Working with respected pigeon expert Brian Woodhouse, Samsung has developed a lightweight harness that is water-resistant and doesn't impede the pigeon's normal flying action. He said: "I was very happy with the way my pigeons were treated and they did not suffer any harm at all."



The browser's taskbar at the bottom shows various application icons including Internet Explorer, Google Chrome, and Microsoft Office. The system tray on the right indicates the time is 9:43 AM on 9/8/2015.

Wi-Fi in crowded areas ?

The screenshot shows a web browser window displaying the Wall Street Journal website. The browser's address bar shows the URL www.wsj.com/articles/demand-for-wireless-signals-pressures-concert-promoters-1417722615. The page features a navigation bar with the site's logo, a search bar, and a menu of categories. Below the navigation bar, there are several article teasers. The main article is titled "Concert Crowds Flounder in Digital Dead Zones" and is categorized under "MUSIC". The sub-headline reads: "Stadiums and arenas are scrambling for wireless systems that can handle the mosh pit of Twitter, Facebook, Snapchat and Instagram users". The article is accompanied by a large photograph of a dense crowd of concertgoers at night, many holding up their phones. To the right of the article is a promotional banner for "AWAY HOME" with the text "Introducing WSJ Expat" and a button that says "EXPLORE NOW". At the bottom of the page, there is a blue banner with the Wall Street Journal logo, a promotion for "\$12 FOR 12 WEEKS" (with the hashtag #MAKETIME FOR THE JOURNAL), and a "SUBSCRIBE NOW" button. The Windows taskbar at the bottom of the screen shows various application icons and the system clock indicating 10:11 AM on 8/27/2015.

Project Fi Review: Google | Cablevision to Introduce | Concert Crowds Flounder

www.wsj.com/articles/demand-for-wireless-signals-pressures-concert-promoters-1417722615

DIJA 16485.74 1.23% Nasdaq 4766.75 1.47% U.S. 10 Yr -1/32 Yield 2.18% Crude Oil 40.22 4.20% Euro 1.1249 -0.59%

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MUSIC

Concert Crowds Flounder in Digital Dead Zones

Stadiums and arenas are scrambling for wireless systems that can handle the mosh pit of Twitter, Facebook, Snapchat and Instagram users



THE WALL STREET JOURNAL. Read ambitiously

AWAY HOME

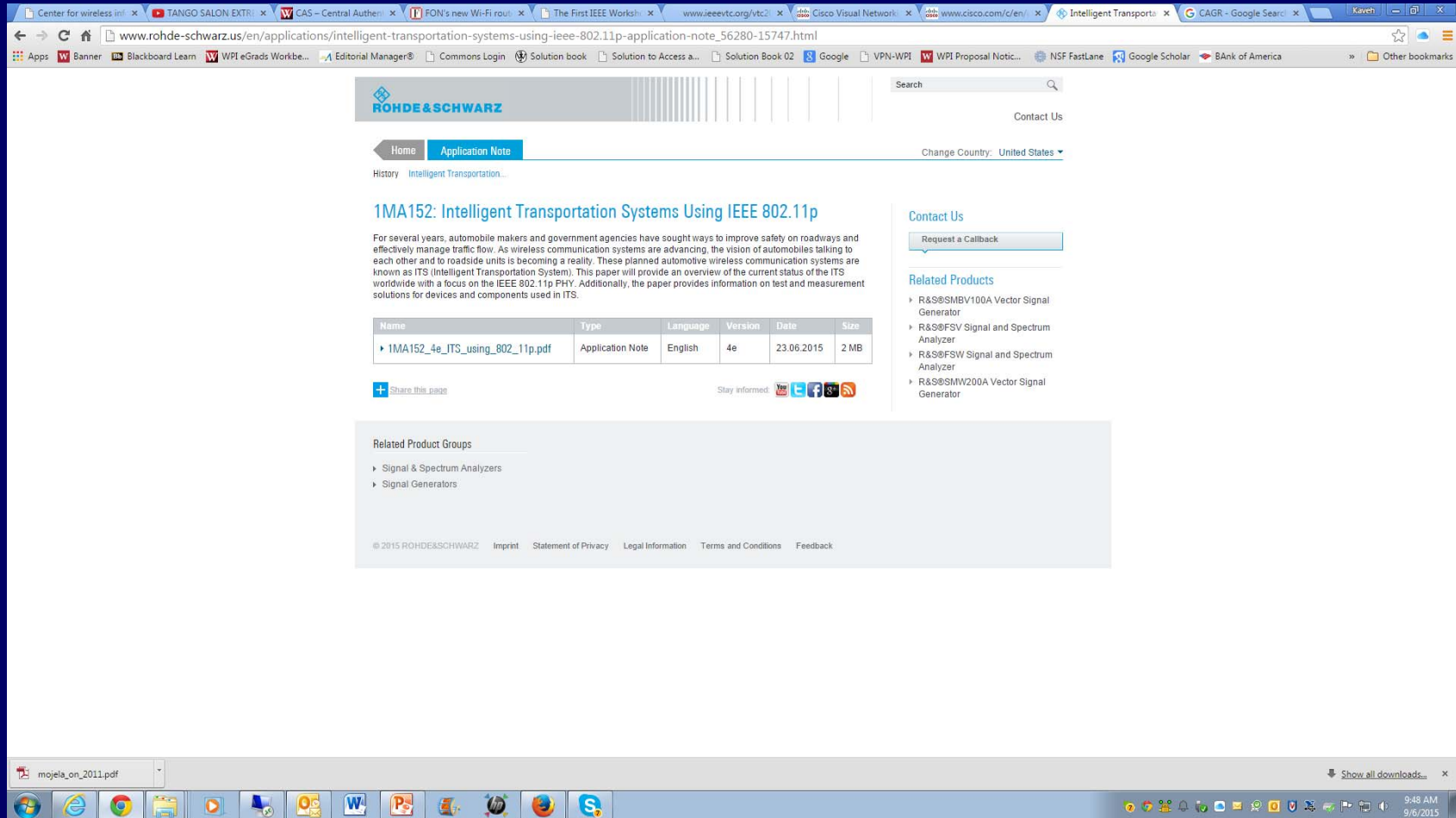
Introducing WSJ Expat

EXPLORE NOW

THE WALL STREET JOURNAL. #MAKETIME FOR THE JOURNAL DIGITAL + PRINT SUBSCRIBE NOW

10:11 AM 8/27/2015

Wi-Fi in Transportation



Center for wireless inf... x TANGO SALON EXTR... x CAS - Central Auth... x FON's new Wi-Fi rou... x The First IEEE Worksh... x www.ieeevtc.org/vtc... x Cisco Visual Networ... x www.cisco.com/c/en... x Intelligent Transport... x CAGR - Google Search... x Kaveh

www.rohde-schwarz.us/en/applications/intelligent-transportation-systems-using-ieee-802.11p-application-note_56280-15747.html

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Search

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Home Application Note

Change Country: United States

History Intelligent Transportation...

1MA152: Intelligent Transportation Systems Using IEEE 802.11p

For several years, automobile makers and government agencies have sought ways to improve safety on roadways and effectively manage traffic flow. As wireless communication systems are advancing, the vision of automobiles talking to each other and to roadside units is becoming a reality. These planned automotive wireless communication systems are known as ITS (Intelligent Transportation System). This paper will provide an overview of the current status of the ITS worldwide with a focus on the IEEE 802.11p PHY. Additionally, the paper provides information on test and measurement solutions for devices and components used in ITS.

Name	Type	Language	Version	Date	Size
1MA152_4e_ITS_using_802_11p.pdf	Application Note	English	4e	23.06.2015	2 MB

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- R&S®SMW200A Vector Signal Generator

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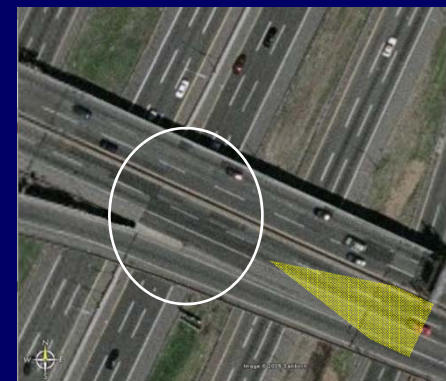
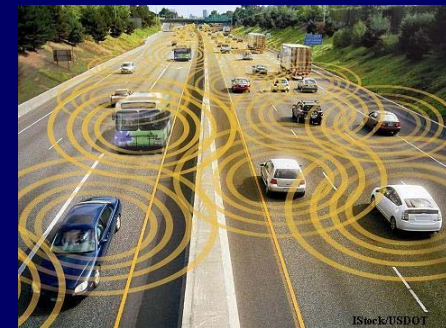
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Wi-Fi in Transportation

- Cars need to communicate for smart transportation to support
 - Communications-enabled road and vehicle safety
 - Real-time traffic monitoring
 - Intersection management technologies
 - Future telematics applications
 - Intelligent transportation services
- IEEE 802.11p is addressing these issues
- Cars carry several thousands of sensors, how can we integrate them into the IoT



Some Challenges for Evolution of Wi-Fi

- How to control the inference in massive deployments?
- How to handle coverage holes?
 - How Wi-Fi relay works in interference environment?
- How to handle crowded areas?
 - Balloons, Drone or Pigeons?
- How to handle sharing home deployments
 - How does private and public Wi-Fi at home work?
 - Who owns the home router (cable company or owner of the property)?
 - What is a good business model for massive home Wi-Fi deployment?
- How to manage secure sharing at Global scale?
- How to handle handoff for mobile voice?
- How to increase Wi-Fi localization accuracy?



Was Wi-Fi a Revolutionary Technology ?

- The WLAN industry was not initiated by Giant Telecomm companies
 - Because it was data-oriented
- The WLAN industry was not initiated by Giant Computer companies
 - Because it was not reliable and had bandwidth limitations
- The WLAN industry was integrated un both Giants after completion
 - To telecom industry when smart phones were introduced, which transformed that voice centric industry to a data centric industry
 - To computer giants, because it allowed flexibility to access connection and avoiding the wiring problem at micro-level
 - Not only that, Wi-Fi toke away localization business from cell tower localization as well as GPS industry
- WLAN industry has impacted all aspects of life unexpectedly, from that point of view, it was a revolutionary technology!

“An unexpected success against the odds, which changed the paradigm!”