



The Real-World HSPA+ User Experience

drive test results and network implications

February 17, 2010

A quick introduction to Signals Research Group, LLC.

- Signals Research Group, LLC offers thought-leading field research and proprietary consulting services on the wireless telecommunications industry.
- Our flagship research product, a research newsletter entitled “Signals Ahead,” includes more than 70 corporate subscribers on five continents across the entire wireless ecosystem.



Presentation Outline

- HSPA+ Market and Technology Update
- Present methodology and results for the HSPA+ drive test from Melbourne, Australia in May 2009 (results published in July 2009)
- HSPA+ in an LTE and Mobile WiMAX World

HSPA+ Market and Technology Update

- HSPA+ Market and Technology Update
 - Operator Interest – what and why
 - Infrastructure Suppliers Roadmap
 - Chipset Suppliers Roadmap
- Present methodology and results for the HSPA+ drive test from Melbourne, Australia in May 2009 (results published in July 2009).
- HSPA+ in an LTE and Mobile WiMAX World

Operator Interest and the Key HSPA+ Features

	HSPA+ Features						
	CPC, etc	Enhanced FACH	64-QAM	MIMO	64-QAM + MIMO	DC-HSPA	CS over HSPA/VoIP
Operator 1	Very Interested	Very Interested	Interested	Mildly Interested	Mildly Interested	Mildly Interested	Mildly Interested
Operator 2	Very Interested	Very Interested	Mildly Interested	Mildly Interested	Mildly Interested	Very Interested	Mildly Interested
Operator 3	Very Interested	Very Interested	Commercial	Mildly Interested	Mildly Interested	Very Interested	Mildly Interested
Operator 4	Very Interested	Interested	Very Interested	Mildly Interested	Mildly Interested	Interested	Very Interested

Source: SRG analysis

- Operator installed base is 235 million subscribers and is spread across three continents
- Operators are primarily interested in 64 QAM, followed by DC-HSPA and then MIMO-related enhancements
- “HSPA+ Lite” features also have a strong following
- Operators generally cautious about using HSPA+ for voice services
- Additional research across a much broader base of operators supports the above findings

Understanding Operator Interest – Part I

- 64QAM (21Mbps) is relatively easy to deploy in most networks
 - Software upgrade in various touch points throughout the network
 - Does require a backhaul network upgrade – by no means a trivial task
 - Allows operators to promote a better end user experience – less interest in the capacity benefits at the moment
- MIMO (28Mbps) is promising from a performance perspective, but requires a much greater impact on the cell site
 - Additional radio chain and potentially antennas
 - Impacts site leasing agreements; could be prohibited on some sites
 - Some concerns about MIMO's impact on legacy handsets
 - More likely to happen with LTE, which presupposes the use of MIMO

Understanding Operator Interest – Part II

- DC-HSPA (42Mbps and beyond) is promising from both a technical and economics perspective
 - Software upgrade (assumes two radio carriers are present)
 - 2x data rate throughput cell, plus trunking gain, which increases capacity
- HSPA+ Lite features, such as Enhanced_FACH, are a critical part of improving the user experience with handsets/smartphones.
 - Benefits of ultra-high data rates in a small handheld device are questionable
 - Improves battery life
 - Reduces “latency” associated with the first connection to the Internet
 - Reduces the amount of signaling traffic required to “wake up” and receive messages

Leading Infrastructure Supplier Roadmaps

	HSPA+ Features								Cat 9/10
	CPC, etc.	Enhanced FACH	CS Voice over HSPA	64-QAM	MIMO	64-QAM + MIMO	DC-HSPA	16 QAM (UL)	
Alcatel-Lucent	2010	Commercial (2009)	2010	Commercial (2009)	2010	2010+	2010	2010	Commercial (2009)
Ericsson	Q1/10	Yes	-	Dec-08	mid-09	Dec-09	mid-2010	mid-2009	Commercial (Q4/08)
Nokia Siemens Networks	2H/09	2H/09	2H/09	2H/09	2H/09	2010	2010	2H/09	Q1/09

Source: Vendor input and SRG analysis

- Input from all vendors was not available at the time the research was done, but dates are still representative of when the industry will be ready
- Dates subject to change due to customer interest and the availability of chipsets
- Category 9/10 (e.g., 14.4Mbps capabilities) are shown for informational purposes, but are not considered to be HSPA+ features

Leading Chipset Supplier Roadmaps

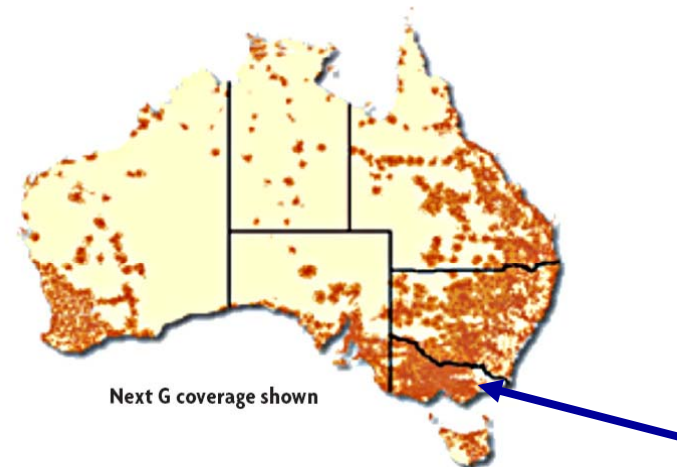
	HSPA+ Features								Cat 9/10
	CPC, etc	Enhanced FACH	CS Voice over HSPA	64-QAM	MIMO	64-QAM + MIMO	DC-HSPA	16 QAM (UL)	
Comneon (s/w)	2H/09	Yes	2H/09	2H/09	2H/09	2H/10	2H/10	Yes	commercial
Icera	Q4/09	Q1/10	Q4/10	H2/09	Q3/10	-	H2/10	Q3/10	Q3/09
Infineon	2H/09	Yes	Yes	Q1/10	Q4/10	Q4/10	Q4/10	Q1/10	Q1/10
Nokia (modem)	Yes	Yes	Yes	under eval	under eval	under eval	Yes	under eval	commercial (Cat 9)
Qualcomm	2H/09	Yes	2H/09	2H/08	1H/09	1H/10	2H/09	Yes	2H/08
ST-Ericsson	Q2/09	2010	2010	Q2/09	2010	2010	2010	2010	Cat 9 under eval

Source: Vendor input and SRG analysis

- Input from all vendors was not available at the time the research was done, but dates are still representative of when the industry will be ready
- Commercial availability dates do not necessarily equate to device availability
- Dates vary across chipset suppliers due to their different strategies and target end markets (e.g., handset versus broadband connectivity modems)

HSPA+ Drive Test Background

- In May 2009 we conducted an independent performance benchmark test of HSPA+ (DL = 21Mbps; UL = 5.7Mbps)
- Independent tests, “funded” by our broad list of Signals Ahead clientele
- The tests leveraged Telstra’s Next G HSPA+ network in Melbourne, Australia
- Telstra provided access to an in-network server devices/SIM cards but otherwise did not participate in our benchmark tests
- Out of necessity, some vendors were aware of the tests, but they had no influence on the test/test methodology

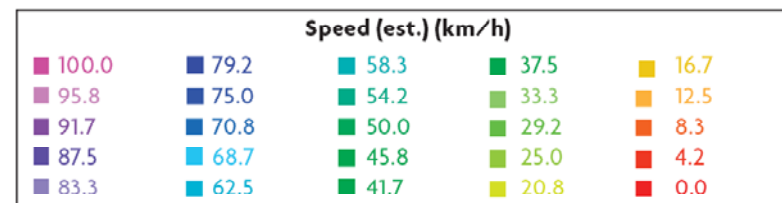
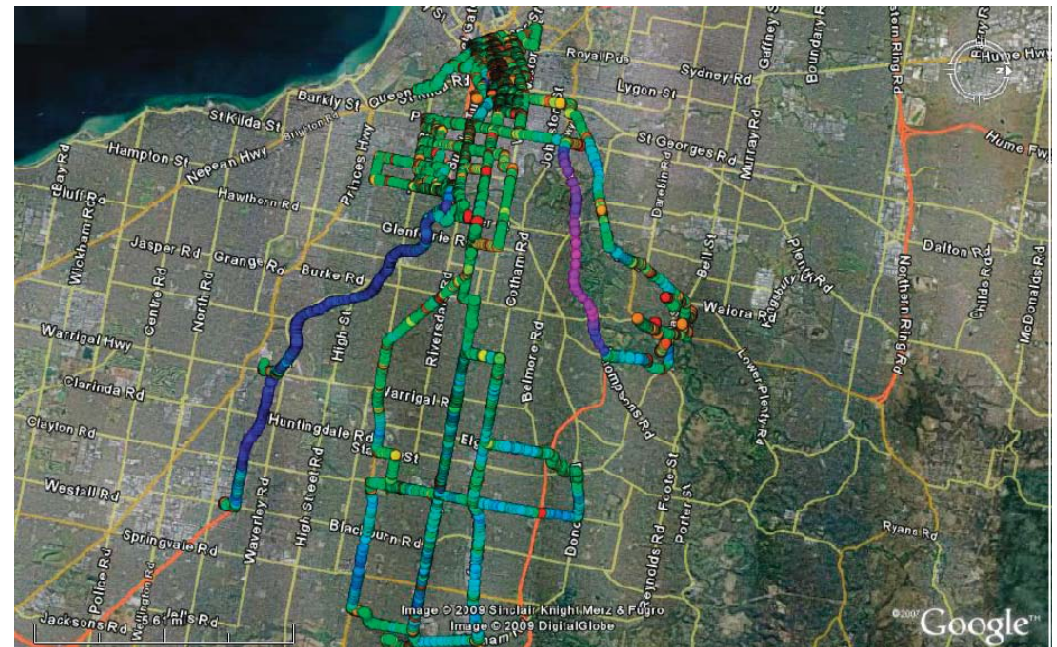


Source: Telstra Website

HSPA+ Drive Test Methodology (cont'd)

- During our tests we transferred ~41GB of data
 - \$214,164.10 in international roaming charges (if we had used our own SIM cards)
- We drove 400km while conducting tests
 - 90% of all capture data occurred in vehicular mode
- Testing occurred from as early as 0400 until as late as 1900

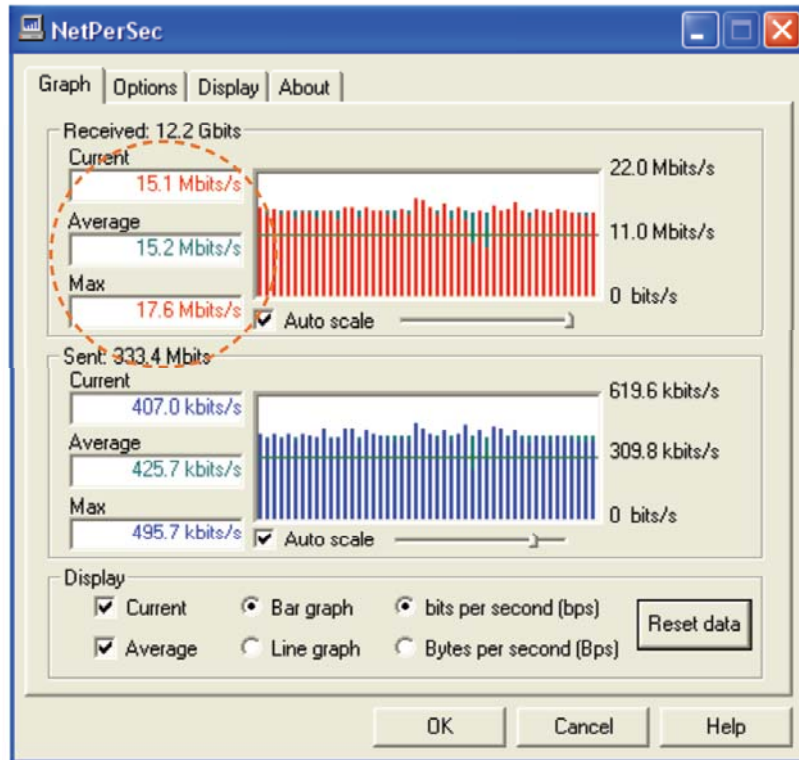
Oh The Places We Did Go!
Geo plot of all test routes with speed (km/h)



Source: Signals Research Group, LLC

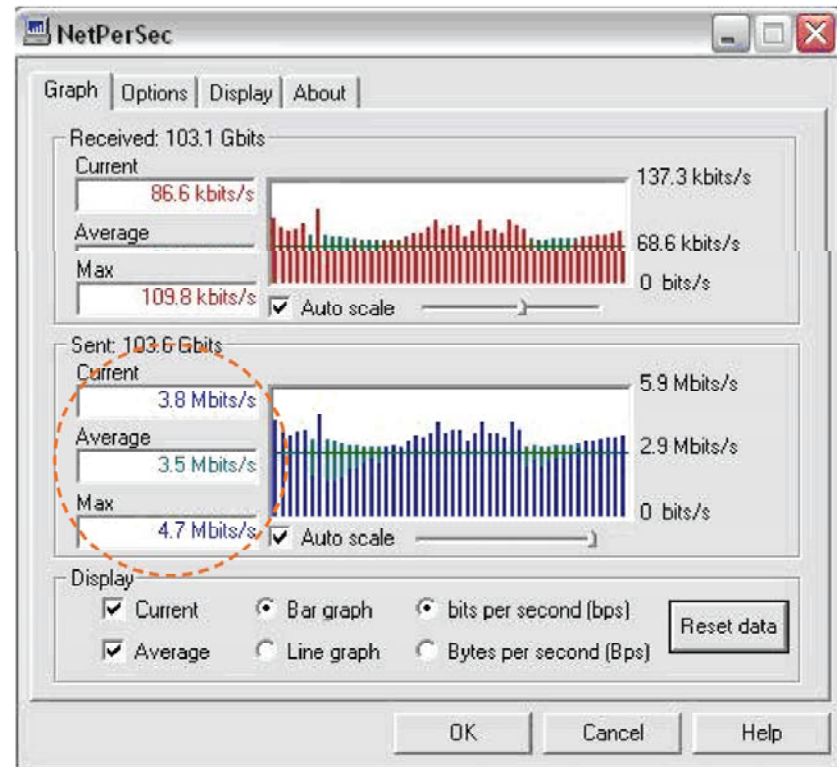
Headline Results (from our Hotel Room)

Observed Application Layer Data Rates from the Westin Hotel Room (05/08, 0400hrs)



Source: Signals Research Group, LLC

Observed Application Layer Uplink Data Rates from the Westin Hotel Room SWIR 888 USB dongle (05/05, 0900hrs)



Source: Signals Research Group, LLC

**Peak DL = 17.6Mbps; Average DL = 15.2Mbps
Peak UL = 4.7Mbps; Average UL = 3.5Mbps**

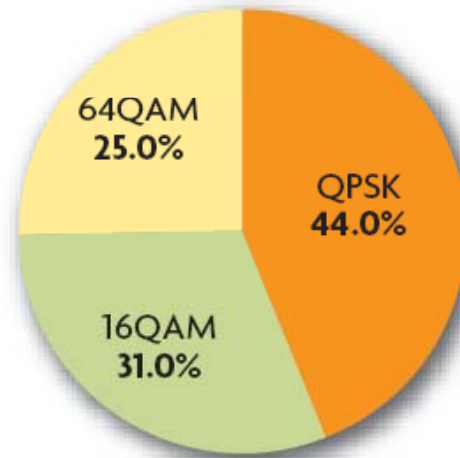
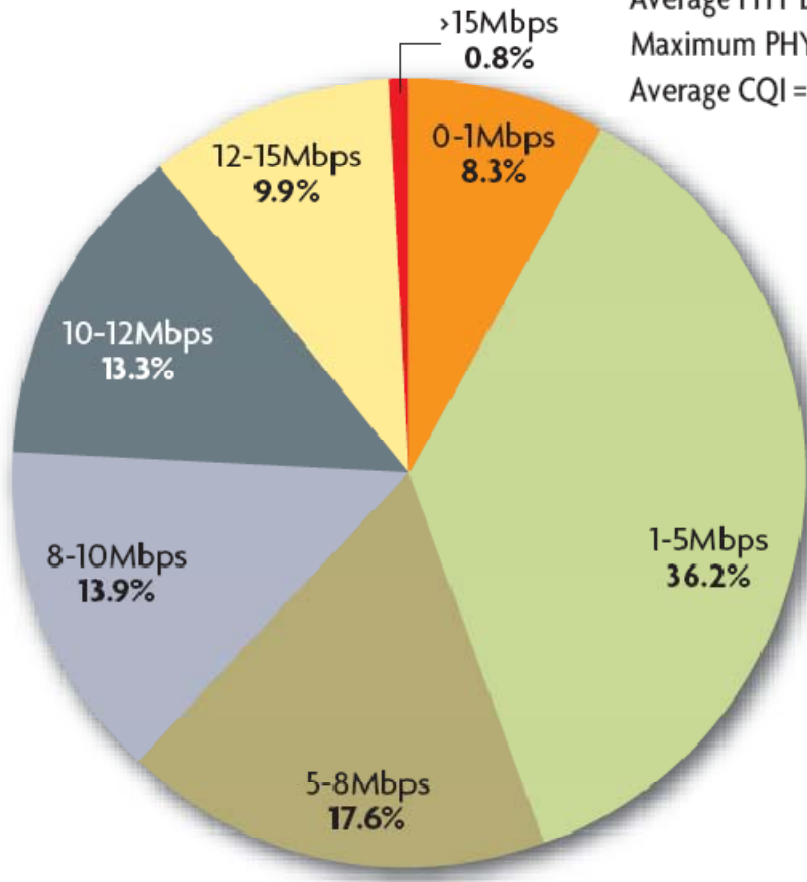
HSPA+ Drive Test – downtown Melbourne during Rush Hour

Melbourne CBD Cat 14 versus Cat 9 Drive test (Cat 14 only results)

Distribution of normalized throughput and modulation schemes (05/05, 1845hrs)

Average PHY Data Rate = 5.53Mbps
Maximum PHY Data Rate = 16.5Mbps
Average CQI = 22.6

Average Number of Assigned Codes = 11.8
Percentage >10 codes assigned = 81.8%
Capture Period = ~ 9.1 minutes

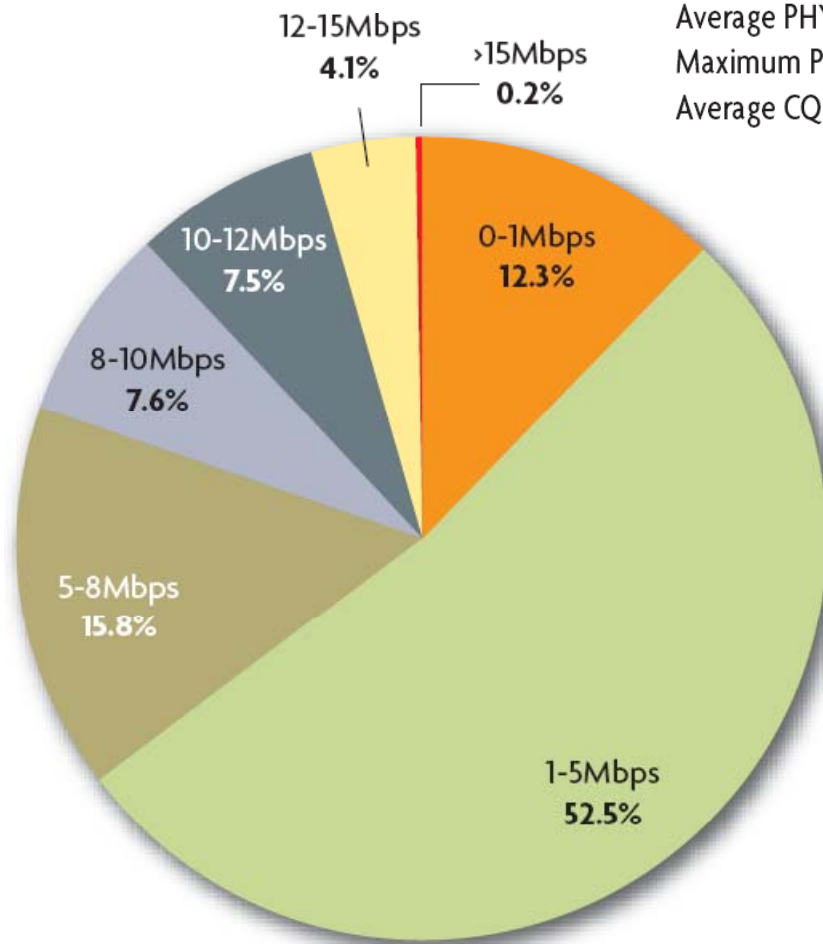


Source: Signals Research Group, LLC

HSPA+ Pedestrian Test – downtown Melbourne mid afternoon

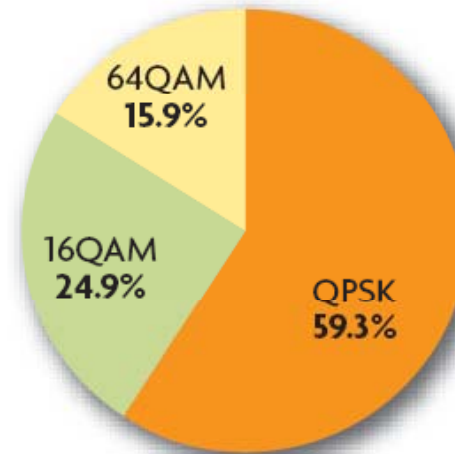
Melbourne CBD Cat 14 Pedestrian Mode

Distribution of normalized throughput and modulation schemes
(05/05, 1500hrs)



Average PHY Data Rate = 3.82Mbps
Maximum PHY Data Rate = 15.4Mbps
Average CQI = 20.5

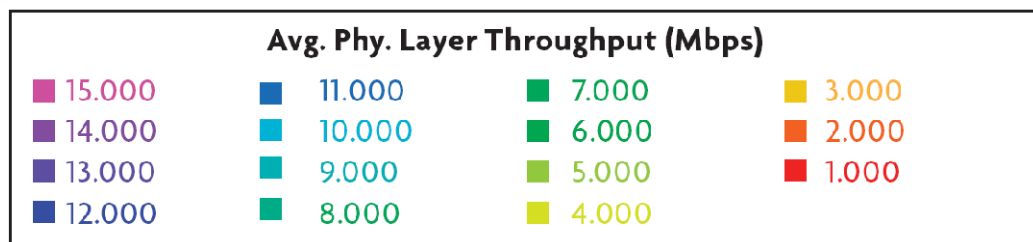
Average Number of Assigned Codes = 10.4
Percentage >10 codes assigned = 62.8%
Capture Period = ~ 23.7 minutes



Source: Signals Research Group, LLC

HSPA+ Pedestrian Test – downtown Melbourne mid afternoon

Melbourne CBD Cat 14 Pedestrian Mode
Geo plot of average throughput (05/05, 1500hrs)



Source: Signals Research Group, LLC

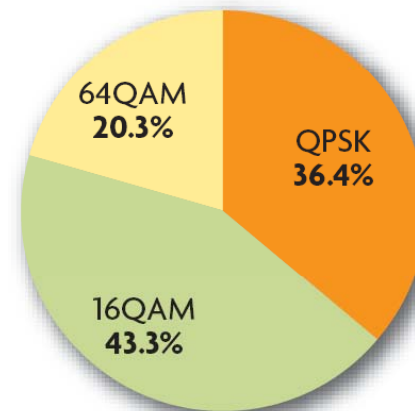
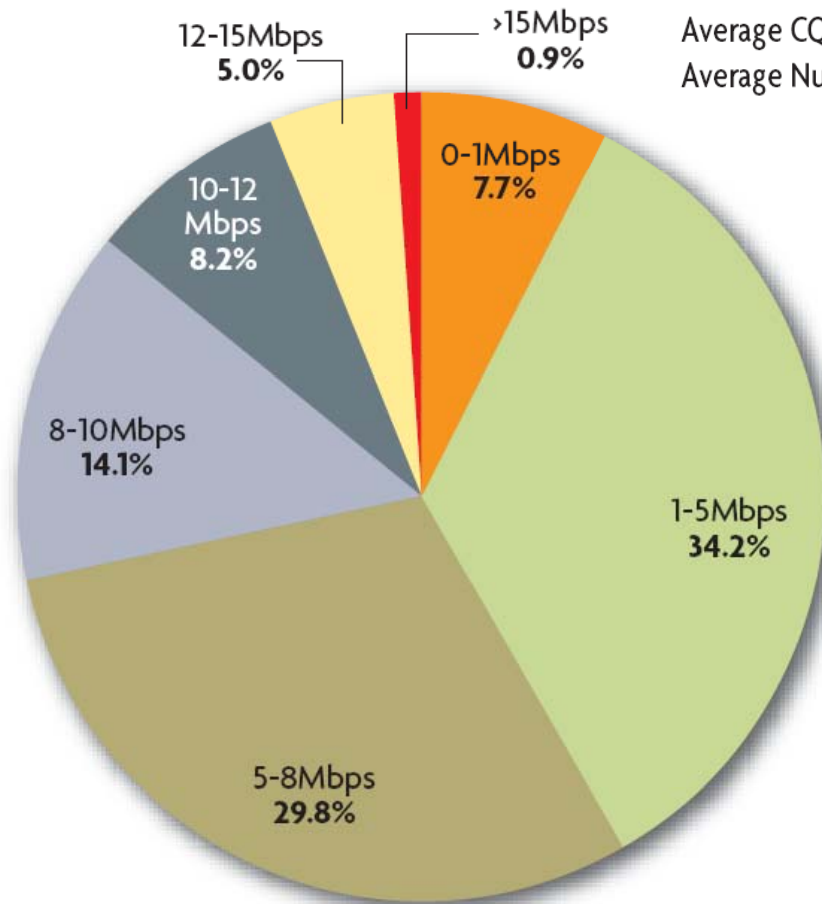
HSPA+ Drive Test – Box Hill #8

Box Hill #8 Cat 14 Drive Test

Distribution of normalized throughput and modulation schemes
(06/08, 0800hrs)

Average PHY Data Rate = 5.09Mbps
Maximum PHY Data Rate = 16.5Mbps
Average CQI = 22.6
Average Number of Assigned Codes = 11.3

Percentage >10 codes assigned = 58.5%
Capture Period = ~ 17.7 minutes
Average Vehicular Speed = 34.6km/h

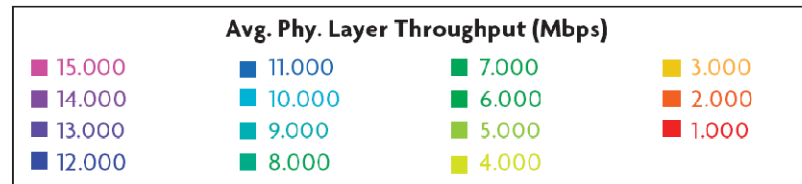
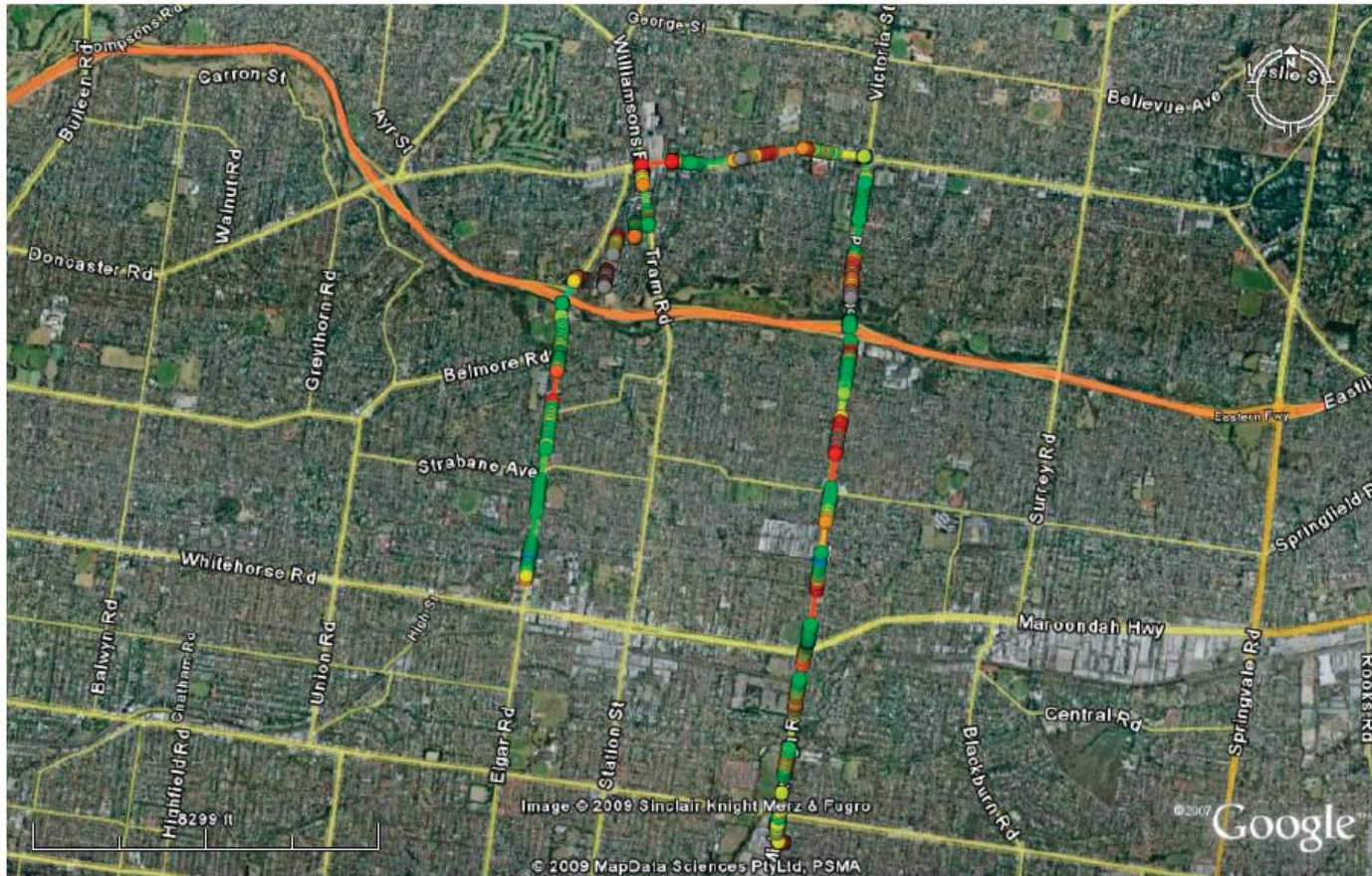


Source: Signals Research Group, LLC

HSPA+ Drive Test – Box Hill #8

Box Hill #8 Cat 14 Drive Test

Geo plot of average physical layer throughput (06/08, 0800hrs)



Source: Signals Research Group, LLC

HSPA+ in an LTE and Mobile WiMAX World

- Operators are basing their decision to deploy HSPA+ and/or LTE based on a number of factors
 - Competitive Landscape
 - Spectrum Availability
 - Maturity of mobile data offering
 - Time to Market requirements
- Operators with HSPA in the ground today are very likely to deploy HSPA+, it is merely a matter of timing
 - HSPA+ will become the de facto technology, just as HSPA is today
 - Operators jumping first to LTE have multi-RAN base stations
 - UMTS/HSPA will be around for a long time to come
- Mobile WiMAX performs quite well relative to HSPA+, but (as tested) utilizes substantially more spectrum
 - The issue isn't performance but the maturity and health of the ecosystem

The logo for Signals Research Group features a stylized orange signal icon above the word "SIGNALS" in a bold, black, sans-serif font. Below "SIGNALS", the words "Research Group" are written in a smaller, orange, sans-serif font.

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