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Novarum Wireless Broadband Review

First Half 2007 Summary

October 16, 2007

www.novarum.com

Agenda

- Novarum Wireless Broadband Review
  - Published first half 2007 reports
    - City reports and New Summary
- Key themes emerge from the NWBR data
  - Clients Matter: 802.11n rocks
  - Metro Wi-Fi Node Density Key: 40 is not enough
  - Cellular Data Services Still King of Hill
  - Self Improvement Guide
- Novarum's Best of Wireless
- What's Next?

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Novarum Wireless Broadband Review

- ✦ Benchmarks the wireless services
    - ✦ Does Metro Wi-Fi or cellular data or WiMAX really work?
    - ✦ How do they compare to each other and to wired services?
- ✦ Analyzes Metro Wi-Fi, Cellular and WiMAX
    - ✦ Testing from user perspective
    - ✦ Performance and coverage validation
- ✦ Business model insight
    - ✦ Rating the service delivered
- ✦ First independent validation of wireless broadband services
    - ✦ Service availability, performance, value, ease of use
    - ✦ Enables apples to apples comparison

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News

- Novarum published new wireless broadband rankings
  - Available for free on our website October 16
    - http://www.novarum.com/Rankings.htm
  - A small subset of the data we have been gathering
- Novarum published Q1 and Q2 2007 reports
  - New summary report for 2007 and new city reports
  - Now available as individual reports on our web site
    - http://www.novarum.com/publications.php
  - Also available as annual subscription
- Trends emerge from the testing
  - Cellular data services have better service availability
  - Metro Wi-Fi continues to deliver higher performance
  - Metro Wi-Fi clients make a huge difference
  - Metro Wi-Fi node density increasing

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Explaining the Charts

- The tables on slides 6, 7 and 8 are comparing cellular and Wi-Fi
  - all client types are included
  - some Metro Wi-Fi nets appear more than once
  - ... HP is the High Power Wi-Fi client
    - "Google MV HP" is high power client on Google network
  - ... 11n is the draft 802.11n client
    - "Rochelle RMU 11n" is the 11n client on the Rochelle network
- The tables on slide 9 are comparing Metro Wi-Fi networks only
  - We use only the standard Wi-Fi client for these
  - Same client has been used to test all networks to date

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Overall Ratings

✦ Wireless Broadband Overall Rating

Rank	Date	Network/Client	Avail	Ease	Perf	Value	Overall
1	2007Q2	MV Google HP	4.75	5.00	3.76	5.00	**4.48**
2	2006Q4	Toronto OneZone HP	4.00	4.00	4.63	5.00	**4.37**
3	2007Q2	MV Google Ruckus	4.75	5.00	3.26	5.00	**4.30**
4	2007Q2	MV Google 11n ext	4.50	5.00	3.44	5.00	**4.28**
5	2007Q2	Philadelphia Feather 11n	4.35	5.00	3.65	3.00	**4.00**
6	2006Q4	St. Cloud CyberSpot	5.00	4.00	2.53	5.00	**3.98**
6	2006Q4	Toronto OneZone	3.50	4.00	4.00	5.00	**3.98**
8	2007Q2	Philadelphia Feather HP	4.13	5.00	3.74	3.00	**3.95**
9	2007Q2	Rochelle RMU HP	4.00	4.00	4.63	2.00	**3.92**
10	2007Q2	MV Verizon	5.00	5.00	3.35	1.00	**3.82**

✦ Metro Wi-Fi has nine of the top ten spots.

✦ Enhanced Metro Wi-Fi clients dominate

　✦ Only 2 standard Wi-Fi clients in top 10 - St. Cloud and Toronto

✦ Verizon in Mountain View was excellent cellular data service

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Performance Ratings

✦ Wireless Broadband Performance

Rank	Date	Network/Client	Perf	Speed
1	2006Q4	Toronto OneZone HP	4.63	2980
1	2007Q2	Rochelle RMU HP	4.63	1644
3	2007Q2	Rochelle RMU 11n	4.50	1511
4	2006Q4	Toronto OneZone	4.00	2216
5	2007Q2	MV Google HP	3.76	813
6	2007Q2	Philadelphia Feather HP	3.74	938
7	2007Q1	Portland MetroFi HP	3.67	648
8	2007Q2	Philadelphia Feather 11n	3.65	802
9	2007Q2	Philadelphia Feather	3.59	787
10	2007Q2	MV Google 11n	3.44	713
11	2006Q4	Tempe Cingular	3.35	441
11	2007Q2	MV Verizon	3.35	674

✦ No cellular data services in the top ten

✦ High power and 802.11n Wi-Fi clients excel

✦ Speed metric is kbps

  ✦ = ((download throughput *2) + upload throughput)/3

✦ Perf shows ability to deliver good performance throughout coverage area

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Service Availability

★ **Wireless Broadband Service Availability**

 ★ Cellular data services dominate

 ★ 15 cellular services are 100%

  ★ only 1 Metro Wi-Fi

 ★ Cellular data average = 87%

 ★ Metro Wi-Fi average = 71%

Rank	Date	Network/Client	Avail
1	2007Q2	MV Verizon	100%
1	2006Q4	Tempe Verizon	100%
1	2006Q4	Tempe Sprint	100%
1	2006Q4	Madison Sprint	100%
1	2006Q4	Philadelphia Cingular	100%
1	2007Q2	MV Sprint	100%
1	2007Q2	MV Cingular	100%
1	2007Q2	Portland Cingular	100%
1	2006Q4	Philadelphia Verizon	100%
1	2006Q4	St. Cloud CyberSpot	100%
1	2006Q3	SCSC Cingular	100%
1	2006Q3	Palo Alto Verizon	100%
1	2006Q3	Anaheim Sprint	100%
1	2006Q4	Madison Verizon	100%
1	2006Q3	Galt Verizon	100%
1	2006Q4	Madison Cingular	100%
17	2007Q2	MV Google HP	95%
18	2007Q2	MV Google Ruckus	95%
19	2006Q3	Anaheim Verizon	95%
20	2006Q4	St. Cloud Verizon	95%

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Comparing Metro Wi-Fi

✦ **Metro Wi-Fi Overall Ratings**

| Rank	Date	Network/Client	Avail	Ease	Perf	Value	Overall
1	2006Q4	Toronto OneZone	3.50	4.00	4.00	5.00	**3.98**
1	2006Q4	St. Cloud CyberSpot	5.00	4.00	2.53	5.00	**3.98**
3	2007Q2	Philadelphia Feather	3.70	5.00	3.59	3.00	**3.75**
4	2007Q2	MV Google	3.38	5.00	2.96	5.00	**3.72**
5	2006Q3	Anaheim Feather	3.61	4.00	2.92	3.00	**3.34**

  ✦ Standard Wi-Fi clients only for these comparisons

✦ **Metro Wi-Fi Performance Ratings**

Rank	Date	Network/Client	Perf	Speed
1	2006Q4	Toronto OneZone	**4.00**	2216
2	2007Q2	Philadelphia Feather	**3.59**	787
3	2006Q3	Galt Softcom	**3.25**	903
4	2007Q2	Rochelle RMU	**3.20**	943
5	2007Q1	Longmont Kite	**3.08**	504

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Clients Matter in Metro Wi-Fi

- ✦ Enhanced Wi-Fi clients make Metro Wi-Fi networks better
  - ✦ Clients are the weak link in the chain
- ✦ Power Rules
  - ✦ High power is 10x standard client
  - ✦ 38% increase in availability
  - ✦ 36% increase in performance
  - ✦ Similar to home CPE or public safety
- ✦ 802.11n to the rescue
  - ✦ 802.11n clients surprise improvement
  - ✦ 20% increase in availability
  - ✦ 26% increase in performance
  - ✦ Already in mobile form factor
  - ✦ And still low power!

Wi-Fi Client Speed

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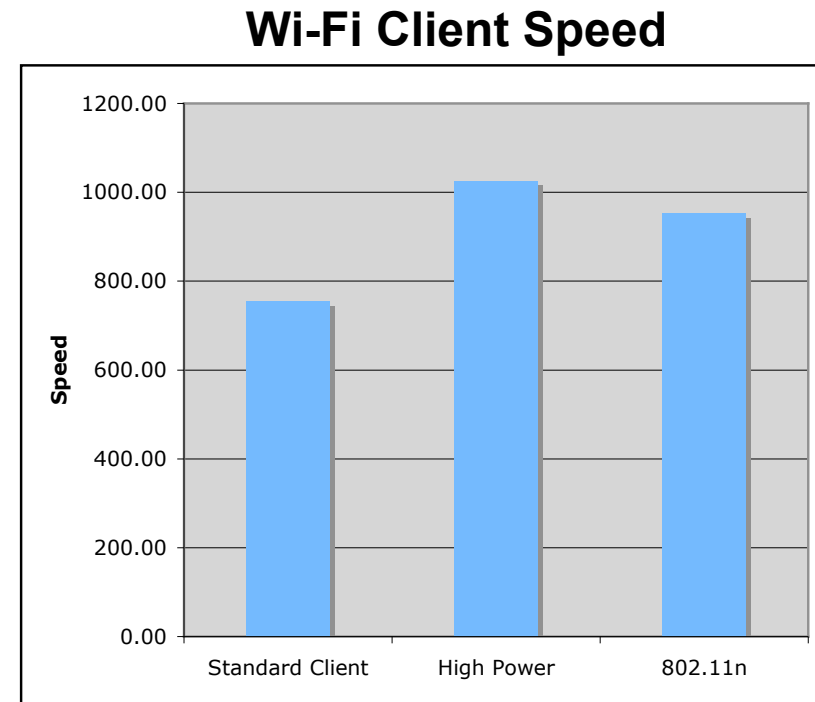
Metro Wi-Fi Node Density: 40 is Not Enough

- ✦ **Infrastructure Density a Key to Success**
  - ✦ More infrastructure access nodes mean clients are closer on average to the network.

- ✦ **40 is not Enough**
  - ✦ Last time we said "40 is the new 20"
    - ✦ now 40 access nodes per square mile insufficient
  - ✦ 60 nodes per square mile may match cellular for availability
  - ✦ 60 may match cable and DSL performance
    - ✦ 100+ exceeds cable and DSL performance

- ✦ **You get what you pay for**
  - ✦ Higher infrastructure density increases Metro Wi-Fi cost
  - ✦ Cellular historically increased density over time
  - ✦ Mobile WiMAX will likely go through same evolution

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The Good Get Better: Cellular Data Services Improve

- ✦ Gold standard in metro scale wireless data
  - ✦ Wide coverage with more than 87% service availability
  - ✦ 3G service with 2G as backup

- ✦ Good Get Better: Major carriers improve service
  - ✦ 25% increase in performance from 2006
    - ✦ All major carriers deploying next generation 3G
    - ✦ EVDO Rev A improvements noticeable to end user
  - ✦ Modest increase in 3G footprint

- ✦ Cellular Rich and the Cellular Poor
  - ✦ Wide diversity in service between big cities and small towns
    - ✦ 3G common in major metropolitan areas
    - ✦ Rural and suburban areas still in 2G service

- ✦ Cellular performance still only half of Metro Wi-Fi

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Guide to Self-Improvement: Investment Makes a Difference

- ✦ Two re-surveyed networks showed updated investment
  - ✦ EarthLink's Feather in Philadelphia PA
    - ✦ 50% increase in node density
    - ✦ Much better Service Availability
  - ✦ Google's Mountain View CA
    - ✦ Modest increase in node density, lots of tweaking
      - ✦ channel plan, new firmware etc.
    - ✦ Much better performance

- ✦ It is possible to deliver quality service through Metro Wi-Fi.
  - ✦ St. Cloud CyberSpot's 100% Availability
  - ✦ Toronto OneZone's Cable and DSL beating performance

- ✦ Question is: what is the appropriate level of investment

- ✦ Metro Wi-Fi ISPs still figuring it out...

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Novarum's Best of Wireless

- ✦ Best Overall Cellular Data Service
  - ✦ Verizon in Mountain View, CA
- ✦ Best Overall Metro Wi-Fi Service
  - ✦ OneZone in Toronto, ON
- ✦ Best Wireless Broadband Performance
  - ✦ OneZone in Toronto, ON
- ✦ Best Metro Wi-Fi Service Availability (Standard Client)
  - ✦ CyberSpot in St. Cloud FL - 100%
- ✦ Best Metro Wi-Fi Service Availability (Enhanced Client)
  - ✦ GoogleFi Mountain View CA - 95%
- ✦ Most Improved Metro Wi-Fi
  - ✦ EarthLink's Feather in Philadelphia PA

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What's Next for the NWBR?

- ✦ How Good is WiMAX?
    - ✦ First independent testing of fixed WiMAX
    - ✦ How does fixed WiMAX compare to "fixed Metro Wi-Fi"?
- ✦ Can the iPhone replicate 3G with Wi-Fi?
    - ✦ iPhone tested in metro Wi-Fi networks and hot spots
    - ✦ iPhone data coverage = home Wi-Fi+Metro Wi-Fi+hot spots+enterprise+2G
    - ✦ Other "Smartphone" data coverage = 3G +2G
- ✦ More cities
    - ✦ More retesting in cities as they deploy and invest
    - ✦ More cellular

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Thank you.

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Who are we?

✦ **Phil Belanger**
- ✦ Networking, wireless, protocols, software
- ✦ Marketing, business development, alliances
- ✦ IEEE 802.11 MAC protocol co-author, Wi-Fi Alliance Chairman and Founder
- ✦ VP Marketing - BelAir Networks, Vivato, Wayport, Aironet
- ✦ VP Business Development - Wayport, Aironet
- ✦ VP Wireless Systems - Aironet, Xircom

✦ **Ken Biba**
- ✦ Networking, wireless, security, software, protocols
- ✦ Entrepreneur and Internet pioneer
- ✦ CEO, Chairman and founder - Vivato, wide scale Wi-Fi
- ✦ COO - Xircom, mobile networking
- ✦ Founder, COO and President - Agilis, portable network computing
- ✦ Founder, EVP Marketing and Development - Sytek, cable modems and LANs

✦ **Wayne Gartin**
- ✦ Networking, Semiconductors, Software
- ✦ Sales, business development
- ✦ VP Sales - Centillium, Agility, Bandwidth 9, Infineon
- ✦ Director of Channels - Lucent, Adaptec, and Intel.

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Advisors with an Edge

- ✦ Consultants and industry analysts
- ✦ We understand wireless business and technology
  - ✦ We helped create the wireless LAN industry
  - ✦ We've "seen the movie" before
- ✦ Unique skills
  - ✦ Technology, Marketing, Business and Communication
  - ✦ Translating complex technology into customer benefits
- ✦ Focused on Metro Wi-Fi, IEEE 802.11n, WiMAX
- ✦ Help navigate through confusion about wireless
  - ✦ Vendor hype, misinformation, politics, technology

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Services from Novarum

- ✦ For Equipment Vendors, Channel Partners, and Venture Capital Firms
  - ✦ Technical and business due diligence, competitive intelligence
  - ✦ Go to market strategies, competitive positioning
  - ✦ Value proposition, product messaging
  - ✦ Customer, channel and press education
- ✦ For Enterprises
  - ✦ Strategic Analysis
  - ✦ Technology evaluation and due diligence
- ✦ For Service Providers
  - ✦ Strategic Analysis - Market, competition, technology, business models
  - ✦ Network validation and testing
  - ✦ Press education
- ✦ For Government
  - ✦ Business model validation and business plan development
  - ✦ Wireless technology education, technical due diligence
  - ✦ Network validation and testing

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