

Novarum Wireless Broadband Review

Cutting Through the Wireless Noise

Wireless Broadband Review Methodology

- ★ Test and review broadband wireless data services
 - ★ Cingular, Verizon, Sprint 2.5G and 3G
 - ★ Metro Wi-Fi and publicly available Wi-Fi
 - ★ WiMAX as available
- ★ On going survey
 - ★ Test different geographic areas, 10 cities per quarter
 - ★ Repeat testing over time from same locations
- ★ Verify coverage
 - ★ Continuously as drive throughout the city
 - ★ Wi-Fi temperature, number of Metro Wi-Fi APs, other APs
- ★ Measure Performance
 - ★ From 20 locations within the city, test all services
 - ★ IxChariot running on PC laptop to measure
 - ★ Upload throughput, download throughput, round trip delay
- ★ 9 cities tested to date
 - ★ Approaching 1000 individual performance measurements
 - ★ A million Wi-Fi coverage samples

Q3 2006 Metro Wi-Fi Review

- ✦ Metro Wi-Fi has competitive availability in Q3 cities
 - ✦ Average 60% service availability within coverage area
 - ✦ Metro Wi-Fi is more available than true 3G
 - ✦ Cellular services address this by falling back to 2G
 - ✦ Incomplete service availability is an issue for Wi-Fi services
- ✦ Metro Wi-Fi delivers twice throughput of 3G
 - ✦ 869 kbps average download throughput on nets tested in Q3
 - ✦ 256 kbps upload throughput
 - ✦ Each metro Wi-Fi network has a unique “personality”
 - ✦ Business model dictates coverage and performance
- ✦ Metro Wi-Fi is immature service compared to 3G
 - ✦ Node density, service availability, ease of use
- ✦ The best Metro Wi-Fi nets can deliver residential broadband
 - ✦ Subscribers will need CPE device

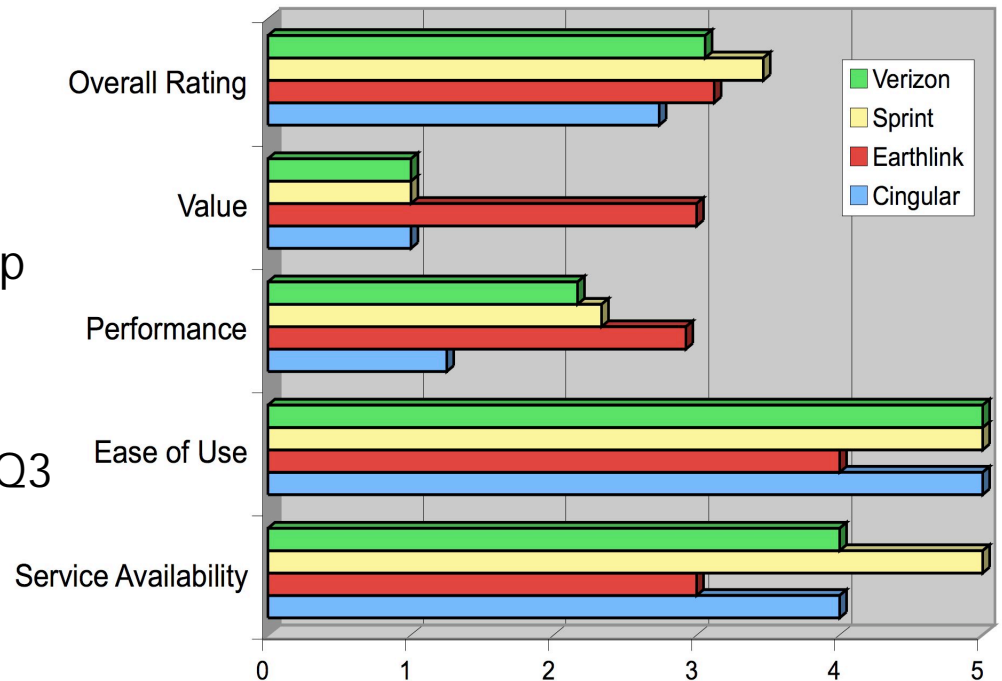
Q3 2006 Metro Cellular Review

- ✦ 3G broadband data is not ubiquitous
 - ✦ Average 34% service availability for 3G service in Q3 cities
 - ✦ Average 78% combined 2/3G availability within tested area
 - ✦ Metro Wi-Fi is *more* available than true 3G
- ✦ Metro Cellular services fall back to 2G to provide complete service
 - ✦ But performance suffers
 - ✦ EDGE and 1xRTT are OK for smart phones but not laptop users
- ✦ A cellular data service was the best service in each of the Q3 cities
- ✦ Metro 3G delivers 300 to 400 kbps download throughput
 - ✦ With 100 kbps uploads and high delay
- ✦ HSDPA is best cellular data service, but has limited availability
- ✦ Cellular data services are easy to use
- ✦ Cellular data services are highly priced

Q3 Anaheim Analysis Summary

- ★ Sprint is best service overall
 - ★ 100% service availability with good performance
 - ★ 420 kbps down, 78 kbps up
 - ★ 286 msec delay
- ★ EarthLink best performance
 - ★ 811 kbps down, 380 kbps up
 - ★ 146 msec delay
 - ★ 72% Service Availability
 - ★ Best Metro Wi-Fi service in Q3
 - ★ Portable and fixed service
 - ★ Smooth mobility
 - ★ Secure and open

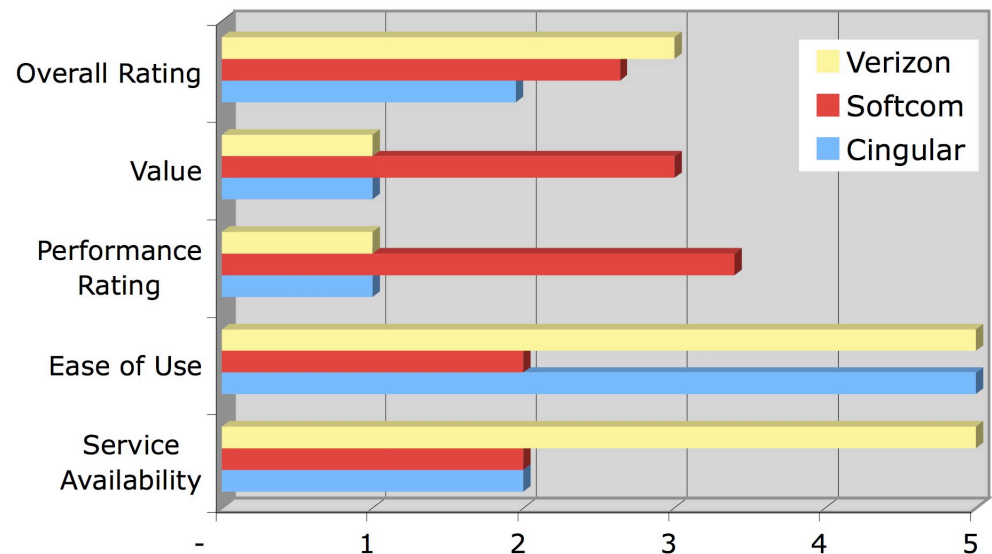
Anaheim Service Summary



Q3 Galt Analysis Summary

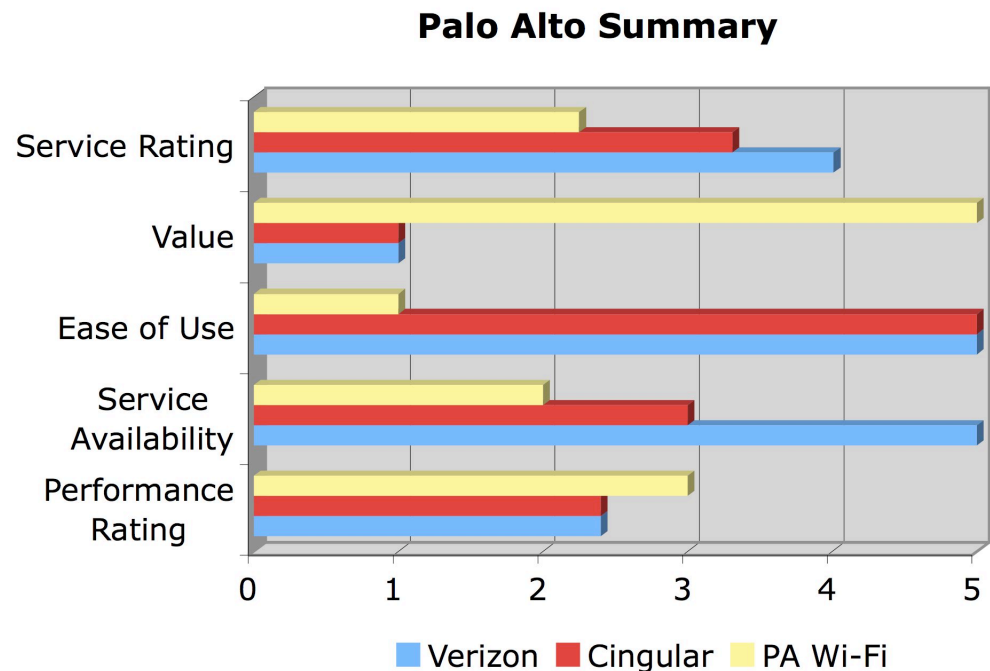
- ★ Verizon was best overall service
 - ★ 100% service availability
 - ★ But no 3G availability
 - ★ Low performance
- ★ Softcom Wi-Fi Service
 - ★ Best performance of Q3 Wi-Fi
 - ★ 1095 kbps down, 519 kbps up
 - ★ Highly variable
 - ★ 115 msec delay very low
 - ★ Modest Service Availability
 - ★ Some coverage related
 - ★ Some service related
 - ★ Primarily residential broadband
 - ★ Portable service is immature
 - ★ Would perform better with CPE
- ★ No 3G service available in Galt
 - ★ 20 miles from Sacramento
 - ★ Along a major highway

Galt Summary



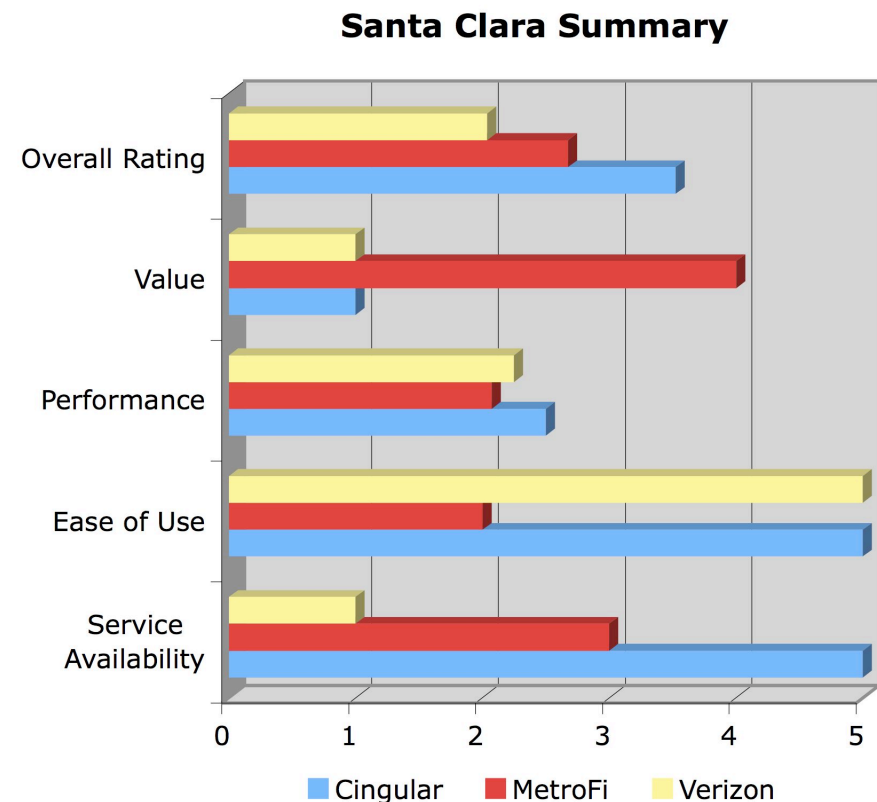
Q3 Palo Alto Analysis Summary

- ★ Verizon was best overall service
 - ★ 100% availability
 - ★ 491 kbps down, 91 kbps up
 - ★ 281 msec delay
- ★ Palo Alto Wi-Fi
 - ★ High Wi-Fi temperature in PA
 - ★ Not an organized service
 - ★ Open home APs
 - ★ Free Wi-Fi hot spots
 - ★ Wi-Fi "Lily Pad" network
 - ★ 52% Service Availability
 - ★ Good performance
 - ★ Have to scan for open APs
- ★ Cingular
 - ★ Good performance
 - ★ Limited service availability



Q3 Santa Clara Analysis Summary

- ★ Cingular was best overall service
 - ★ 100% availability
 - ★ 465 kbps down, 195 kbps up
 - ★ 268 msec delay
 - ★ Best cellular service in Q3
- ★ MetroFi
 - ★ Performance similar to cellular data services
 - ★ 527 kbps down, 124 kbps up
 - ★ 273 msec delay
 - ★ Very high for Metro Wi-Fi
 - ★ 55% Service Availability
- ★ Verizon
- ★ Very poor service availability
- ★ Tested in Santa Clara, Sunnyvale and Cupertino



Wireless Broadband Review Products from Novarum

- ✦ Annual subscription to Novarum Wireless Broadband Review
 - ✦ Access to all reports, analysis and detailed data
 - ✦ Four consecutive quarters
 - ✦ Consulting time each quarter to interpret data and customize reports
- ✦ Individual city Analysis of Wireless Broadband Services
- ✦ Service level validation for metro wireless networks
 - ✦ For cities or service providers
 - ✦ Confirm that network meets RFP requirements
 - ✦ Independent performance verification
 - ✦ Novarum certified
 - ✦ Test from user perspective - does network deliver desired service?
 - ✦ Same methodology and rigor as Novarum Wireless Broadband Review
- ✦ Custom testing and performance evaluation
 - ✦ Private testing and analysis of networks
 - ✦ Validate network before launch, test competing networks
 - ✦ Test new client devices or new applications