Rural Wireless Connectivity: Design Concepts for Ubiquitous Coverage in Low Density Population Areas

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Rural Coverage Challenges

• Technical Challenges
  ▪ Limited coverage radius of a traditional cell-site leads to large number of cell sites
  ▪ Thin population density, in true rural Greenfields, leads to severe underutilization of BTS resources
  ▪ Limited resources of power supply to cover the large number of cell sites
Rural Coverage Challenges

• Economic Challenges
  - Large CAPEX and OPEX commitment to cover a small population over a large area
  - Low income levels
  - ROI levels do not equate with the current business models
Convergence?

Broadcasting
- TV
- DTV data
- Mobile TV
- Radio
- HDRadio data

Telecommunications
- Telephony
  - Voice
- Data
- Mobile Video
- Broadband Wireless Access

Digital Wireless Connectivity
“Anytime, Anywhere, Anyway” NAB 2005
Dielectric Communications

- **Broadcast Equipment**
  - DTV
  - FM
  - Mobile Media
  - Mobile Broadcast

- **Wireless Equipment**
  - Cellular
  - Broadband Wireless Access (BWA)
  - Public Safety
  - Wimax, LTE, 4G, etc.

- **Products**
  - Antennas
  - Filters, combiners, etc.
  - Transmission Line
  - PA’s, LNA’s, etc.

US Domestic & Global Deployments
Cellular Broadcast System Concept

- Coverage Efficient – 6X to 13X greater coverage; uniform power distribution over a wide coverage area.
- Power Efficient – low loss tower-top electronics; antenna radiates most of the power delivered to it
- Cost Efficient – 50% lower capex; 50-80% lower opex
- Scalable Capacity
Cellular Broadcast System Concept

Force Coefficient Factor 43% Less
vasTerra™ Wireless System

- Broadcast Technology
- Improved System Design
- 10x Coverage = Economical Deployment
- Public Safety Interoperability (700 MHz)
- Rural Mobile Telephony
- Rural Wireless Broadband Access
- Smart Grid Monitoring
How can the coverage be increased 10-20 times?

**Raise the antenna.** Similar to terrestrial broadcast, high-mounted antennas provide line of sight coverage to a large territory.

![Antenna Diagram](image)
Coverage Benefits of New Antenna System

The vasTerra system can achieve 10X coverage, at an average, as compared to the traditional system.

- **Dielectric vasTerra Cell-site**
  - Coverage is created by a phased-array antenna with a gain 30dB, vertical beam width ~1 deg, and height 100 m

- **Standard Cell-site**
  - Coverage is created by an antenna with a gain 16-18dB, vertical beam width 6-8 deg, and height 50 m

**Figure 1: Coverage of standard cell**

- Antenna height: 50 m
- Vertical beamwidth: 16 degrees
- Antenna gain: 15 dBi (32x)
- Frequency: 900 MHz
- Coverage limit: ~6 km
- Coverage area: ~113 km²

**Figure 2: Coverage of vasTerra cell**

- Antenna height: 100 m
- Vertical beamwidth: 1 degrees
- Antenna gain: 30 dBi (1000x)
- Frequency: 900 MHz
- Coverage limit: ~30 km
- Coverage area: ~1284 km²

Approximate values depend on terrain and clutter.
“Robin Hood Principle”

Redistribution of radiated power

- Increase signal strength more than 50 times for remote users
- Reduce the signal strength by 10 times for nearby users
- Near zone radiation is lower diminishing RF exposure concerns

Field strength vs. distance from antenna

- Standard antenna
- Cellular broadcast technology

Distance from antenna: 3 miles to 25 miles
Elevation Pattern – Standard 15 dBi Antenna vs. vasTerra™

Degrees Below Horizontal

dB

vasTerra

Standard 15 dBi Antenna
vasTerra™ Beta Site Test Results

SEC Beta Site Test Results

- Received Signal Strength dBm
- Miles from Antenna

Comparison between vasTerra and Standard Technology:
- vasTerra shows a 16 dB Quality Improvement
- vasTerra extends coverage by approximately 20 miles or 9X area

Good indoor coverage is indicated by a green line.
Coverage Benefit of vasTerra System

- The high mounted antenna provides a line-of-sight radio coverage over a 30-40km range.
- High antenna gain, low cable losses, and low NF LNA amplify downlink and uplink signals.
- Link budget improved by 18 to 30dB in comparison to traditional cell-site and coverage by a factor of 6X-13X.
- Intelligent beam forming techniques shape and focus the radiated energy so that it is uniformly distributed over the coverage region.
Beta Site – Gray Maine Drive Test Results

Single Sector Results

**Standard Antenna at 165’**

**SEC Antenna at 345’**

SEC Provides 3 Times the Distance in Coverage of a Standard Antenna System
Cell Coverage Enhancement

10 Sites - Standard Macrocell Network

10 Sites - vasTerra Network
Benefit for Rural Coverage

- Reduces number of tower sites
- Provides improved coverage to large undeveloped and agricultural areas (reduces gaps in coverage)
- Supports future development without additional tower buildouts

Coverage of Many Villages in Rural Area
Wireless Broadband Application
Rural U.S. Opportunities

- **Cellular**
  - Opportunities in Maine, the mid-west and other rural pockets of the country

- **Wireless Broadband**
  - Reduces number of sites
  - Speeds deployment
  - Reduces capital requirements
  - Reduces operational costs
  - Increase customer base
  - Improves performance

**Economical Solution for Rural U.S. Coverage**
vasTerra Solution Saves Money

**CAPEX Savings**

- A nominal 10X expansion of the coverage area relative to a traditional cell-site translates into 10X reduction in the number of sites required
  - Significant less number of base stations
  - Reduction in cables and RF equipment requirement
  - Exponential reduction in construction and deployment costs

- Considerable simplification and cost reduction in the backhaul network
OPEX Savings

- Reduction in network maintenance and repair costs by due to decreased number of required BTSs in the network
- Reduction in rental and lease expenses for land, towers, BTS premises and rented transmission lines
- Reduction in capital expenditure and extended useful life of equipment
- Energy utilization efficiency
Key Performance Differentiators

- Opens previously economically unviable territory for expansion
- Improves utility of the service by enabling continuous coverage (homes, fields and roads in between population centers)
- Faster deployments give competitive advantage in customer acquisition and revenue capture
- Increased tower capacity gives opportunity for increased revenues and improved profits