Dynamic Per-Subscriber Link Optimization

The Solution to Real-World Multi-Service BWA Network Deployments

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Broadband Wireless Network Requirements

- **Rapid Deployment**
  - No wires
  - Reduced truck rolls
  - ILEC bypass

- **Ease of Installation**
  - User installed subscriber unit
  - Automatic tuning of wireless parameters

- **Network Scalability**
  - Scalable coverage
  - Scalable capacity
  - Scalable network provisioning

- **Service Scalability**
  - User rate and service flexibility up to 20 Mbps per channel
  - MultiService: Data, Voice & Video

- **Low Cost**
  - Complete solution per subscriber

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Optimizing Network Performance

- Leveraging a multi-tier optimization of
  - Capacity
  - Coverage
  - Cost
  - QoS

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Hostile Broadband Wireless Links

- Wireless Channels
  - vary by subscriber location
  - vary enormously over time
 - are subject to high error rates

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Optimizing the Link

- Dynamic Per-Subscriber Link Optimization (OptimaLink™)
  - Automatic optimization of each user link for simultaneous management of Multipath, Interference, and Signal Strength.

- Intelligent network and connectivity management

- Leverages the MAC-PHY synergy

- Maximizes capacity, coverage, and QoS, and minimizes cost.

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Real-World Robustness

- Multipath Management
  - Inter-Symbol Interference
  - Fading
  - Intra-Symbol Distortion
- Interference Management
  - External
  - Intra-Network
- Attenuation

Real-World Network Deployment
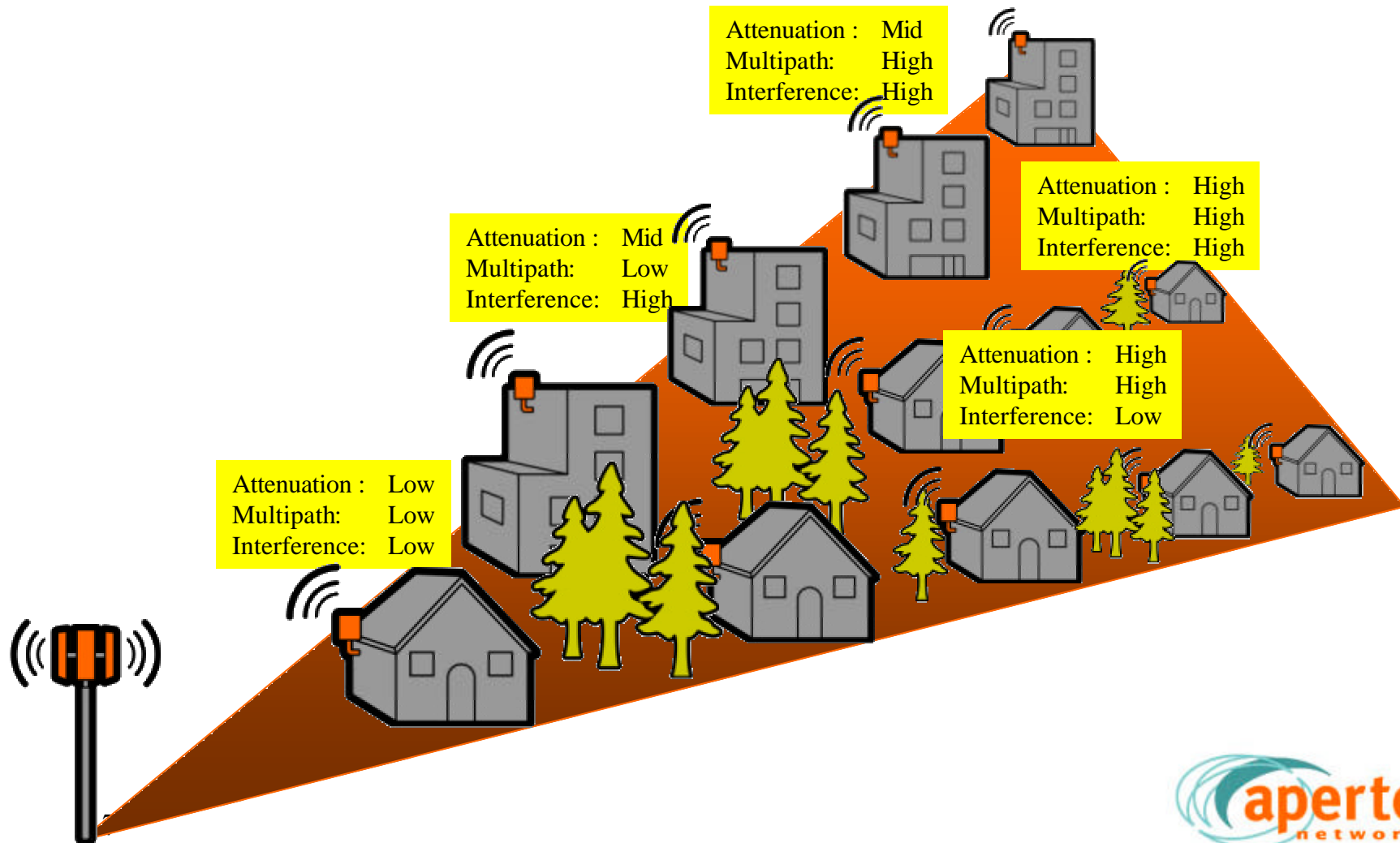
Real-World Deployment Problems

- Varying Multipath
  - Variable Delay-Spread, Fading, Intra-Symbol Distortion
- Varying Interference
  - Variable external and self-interference from Cell Center to the edge
- Varying Signal Strength
  - Variable path-loss average and spread
- Combination of LoS, OLoS, & NLoS
- Combination of Best-Effort, CIR, & CBR
  - Low-End Data-Only to QoS-enabled MultiService platforms

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Dynamic Per-Subscriber Link Optimization

- OptimaLink™
  - Multiple PHY-Layer Adaptive Parameter
    - Adaptive Modulation
    - Adaptive FEC
    - Adaptive Multiple Receive-Antenna Diversity
    - Adaptive Multiple Transmit-Antenna Diversity
    - Adaptive Power Control
    - ...
  - Multiple MAC-Layer Adaptive Parameters
    - Adaptive ARQ
    - Adaptive Packet Size
    - ....

Frequency

Space

Time

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n e t w o r k s
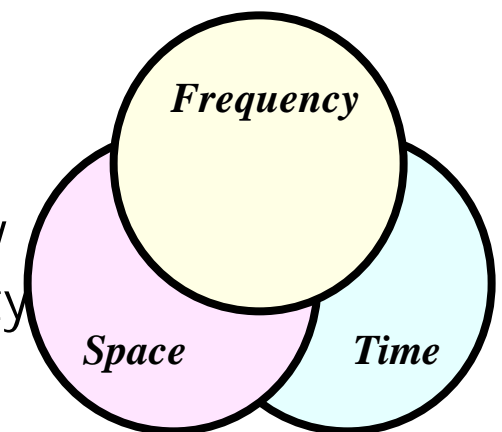
Real-World QoS for Access

- IP: New World Order
- Broadband Access: Fast Connectivity w. Multiple Services
- QoS: One Multi-Service Platform
- Wireless: Availability & Scalability

The Challenge:

Throughput, Jitter & Delay Management
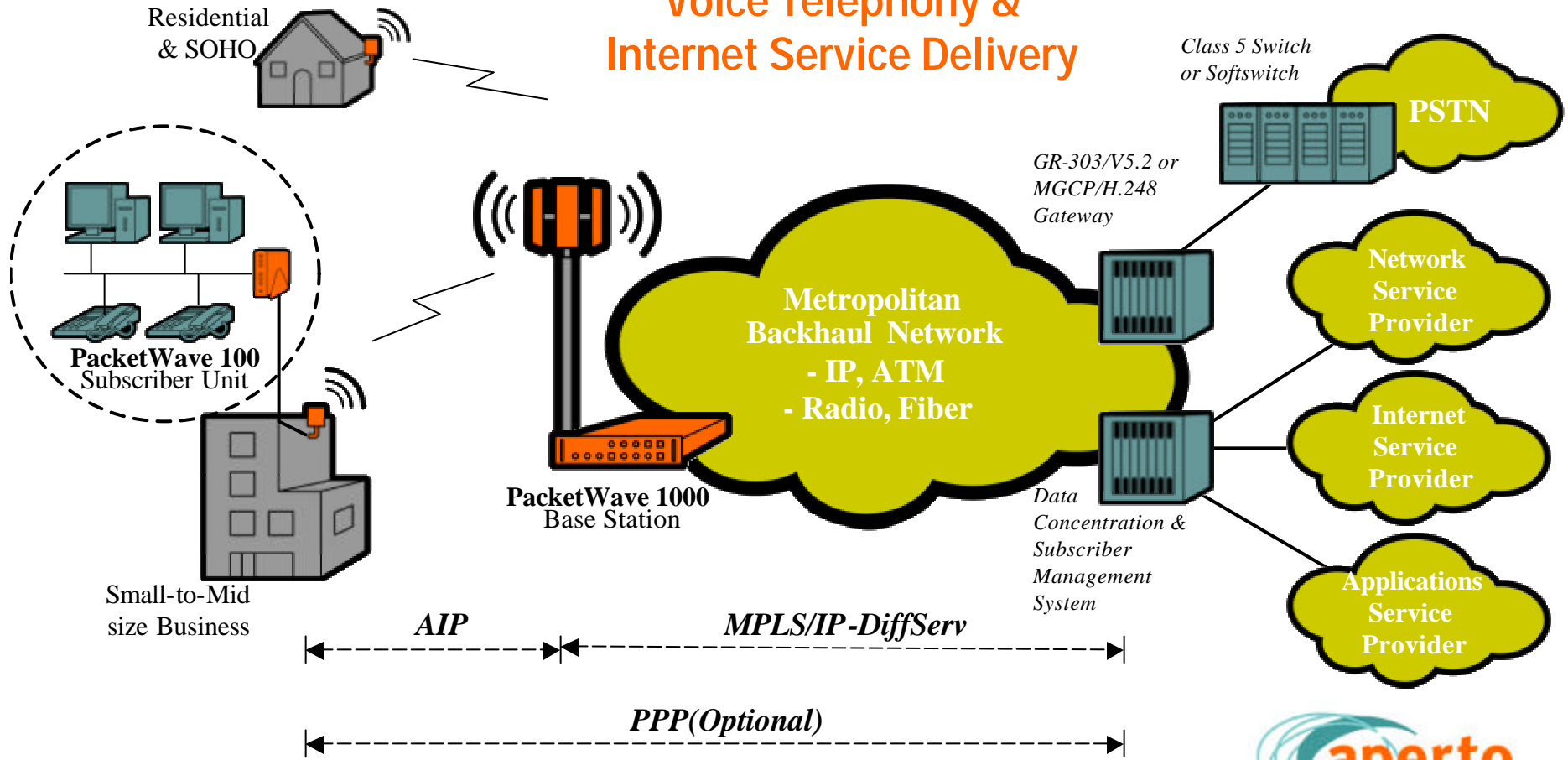over hostile broadband wireless channels

The QoS Need for Dynamic Link Optimization

- Wireless channel variations range is very Large
  - 100-1000X: 20-30 dB variations
  - Multipath
  - Interference
- Channel variations make traditional QoS Guarantees meaningless.
- Wireless channel variations are inherently uncontrollable

The Solution: Dynamic Per-Subscriber Link Optimization

IP-based End-to-End QoS

ServiceQ™
Voice Telephony &
Internet Service Delivery

Residential & SOHO

Class 5 Switch or Softswitch

PSTN

GR-303/V5.2 or MGCP/H.248 Gateway

PacketWave 100 Subscriber Unit

Metropolitan Backhaul Network
- IP, ATM
- Radio, Fiber

Network Service Provider

PacketWave 1000 Base Station

Data Concentration & Subscriber Management System

Internet Service Provider

Small-to-Mid size Business

Applications Service Provider

AIP   *MPLS/IP-DiffServ*

PPP(Optional)

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Multiple Access Protocol

- ## RapidBurst™
  - ### Advanced TDMA – Air Interface Protocol
    - burst mode upstream and downstream
    - on-demand allocation of time slots & packet size
    - multi-user protocol for OptimaLink & ServiceQ
  - ### Flexible duplexing – Adaptive TDD & FDD
    - depending on market & channel plans
    - TDD advantage in unstructured environments
      - adaptive bandwidth allocation between upstream & downstream depending on traffic requirements

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Benefits of Dynamic Per-Subscriber Optimization

- ## High Capacity
  - Maximizes link & network capacity
  - Maximizes carriers' spectrum utilization
  - High burst-rate
  - Up to 20Mbps burst rates over a 6 MHz channel
  - Advanced interference mitigation and management in multi-cell networks
  - High frequency-reuse

- ## High Coverage
  - Line-of-sight
  - Obstructed line-of-sight
  - Non line-of-sight

- ## High QoS
  - Intelligent bandwith and connectivity management with QoS
  - IP-Based multi-service

- ## Low Cost
  - Minimizes CPE complexity & cost
  - Minimizes Infrastructure cost

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Summary

- Dynamic Per-Subscriber Link Optimization (OptimaLink™) maximizes real-world BWA network performance

    – Is automatic optimization of each user link for simultaneous Multipath, Interference, and Signal Strength Management.

    – Provides intelligent network and connectivity management

    – Leverages the MAC-PHY synergy

    – Maximizes capacity, coverage, and QoS and minimizes cost.

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