Fiber to the Node(FTTN) or VDSL – but not WiMAX

Playing the Devil's Advocate

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A Case for WiMAX

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Wireless in General

- WiMAX comes with inherent advantages of wireless operations:
  - Transport/make-ready cost
  - No transport medium to degrade or replace
  - Advanced channel and RF technology
  - Generally less expensive to connect to the target markets for both backhaul and access
  - Minimizes easement requirements
  - Weather driven service outages are usually much quicker to solve (replacing antennas as opposed to placing replacement poles)
  - Broadcast vs Relay advantages where there are adjacent targets of opportunity

WiMAX as a Technology

- The best wireless access platform performance available:
  - Uses TDD for maximizing frequency usage, which is a critical feature in the limited spectrum environment
  - Supports profiles for 3.5/5/7/10/20MHz channels for a variety of inter-cell coordination plans. Many models include GPS-synchronization for inter-cell transmission coordination to mitigate localized self-interference issues.
  - Demonstrates 2.8 bph ethernet throughput
  - Uses advanced signal optimization methodologies like OFDMA, MIMO and Feedback-based adaptive modulation to improve reliability in adverse environments
  - Flexible usage controls for subscriber servicing options at the CPE
  - QoS for Voice packet prioritization, and models based on specific protocol prioritization

WiMAX as a Business

- Residential service plans could range from 1Mbps to 10Mbps with asymetry where desired.
- Business class customers could be offered 20Mbps service plans, and the protocol-specific profiles could add additional bandwidth allocated for Voice traffic, as an example.
- A fixed-WiMAX 600-subscriber network, with a single service site and a wireless backhaul source, could expect to cost the provider < $215k for the CPE, cabinet, electronics and antennas.

WiMAX as an Operator

- With the powerful RF reliability technology now employed in this platform that dominates its WiFi predecessors, one of the greatest risks to the network is to over-subscribe the base station radios.
- At the end of the day, this is still a network node managing a wide variety of protocol loads. Careful tracking and load estimations are a must for mitigating peak-time network performance.
- The WiMAX advantage is being able to carefully control those protocol loads with specific usage profiles downloaded to the CPE.

WiMAX desiged networks just like the other technologies?

- The wireline and wireless design environment, while sharing some common considerations, have a few distinct differences:
  - Addressing the available frequency, bandwidth, power and subscriber load parameters (being service plans, count and range from POP).
  - Addressing the local frequency usage environment, and its associated coordination, registrations, permits and licenses.
  - Customer professional installation process.
- Beyond this, most of the design components are common with wireline.

WiMAX the only solution?

- In many cases where plant exists, short fiber builds may be easier to complete and produce more capacity than would be economical for a wireless approach.
- However, in places where the plant is over extended or non-existent, such as the rural ends of the plant, wireless deployments can be very economical and effective.
- Also, WiMAX deployments in dense rural neighborhoods may also be an attractive service option, as the range to subscribers is relatively close to the base station radios for optimum throughput performance.
- In short, building a new network in less dense areas from scratch is generally cheaper using wireless solutions.

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End User Services

- Approximately 3 television viewing points — 3 x 10 Mb/s (HDTV/ MPEG-4)
  - These can be live/or Video on Demand
- Internet Access — 3 x 10 Mb/s
  - Includes on-line Gaming and other Internet needs
- IP Telephone — 1Mb/s

TOTAL ~ 60Mb/s

Note: Should consider other applications for SOHO (video conferencing), Small Business (Security Camera monitoring), etc.

Service definition

- Three service categories :
  - Video based services
  - PC based services
  - Voice services
- Various combinations of theses elementary services can be offered
- Content security (Access control, content encryption, conditional access and digital right management) identified as key to deliver these services

Video Based services

- Broadcast TV and audio, up to three channels
- HDTV
- Pay per view/Video on demand
  - Search engine
  - Video control : pause, fast forward
- Electronic Program Guide
- Picture in Picture, Picture in Browser
- Interactive TV : browsing, mail, chat …
- Telemedicine and remote healthcare monitoring
- Distance Learning (Education)

Fiber To The Node (FTTN)

- Telcos are deploying FTTN and FTTP
  - Verizon spent $1 billion in 2005 to deploy FTTP to 3 million homes and businesses in 16 states
  - It plans to continue spending $1 to $2 billion per year on FTTP until 2010
- AT&T is spending $6 billion on FTTN (Fiber To The Neighborhood or Fiber To The Node) to be completed in 2008 (links Ch 3d, 3e)

Why Fiber?

- Lifetime costs
  - No electronics (with backup power)
- Transparent to:
  - legacy or future bit rates and format
  - as more advanced formats become available the fiber need not be replaced (Ethernet)
- Low attenuation translates to:
  - Lower-power transmitters and less sensitive receiver
  - Convenient design rules for their installation
- Passive nature
  - The electronics is only at the ends
  - Provisioning are accomplished quickly

WiMAX Challenges

- Where's the bandwidth? Every user? Guaranteed?
- What about signal degradation during storms (rain/snow/wind)?
- How big are the antennas? No really?
- How do you cope with interference? Unlicensed spectrum right? Is the spectrum going to be there in 20 years? Is it secure?
- What happens if I have no "line of sight?" What if it changes (buildings, trees)?
- How many towers do you need? Where will they be built?
- How does WiMAX OA&M work?
- How does WiMAX QoS work?
- Can't I do that with my 3G Cell Phone?

A Case Study: Star Lake, NY

What are problems common to FTTx and WiMAX?

- Range. In both cases range:
  - Degrades the transmission strength
  - Develops timing latencies
  - Minimize processor margins for retrying packets
- Capacity degrades when the WiMAX service area is over-extended in much the same way of extending the fiber run beyond recommended specifications of the wave-length.
- This can be compounded for WiMAX gear if there are foliage and terrain issues, as well.

What are balancing issues?

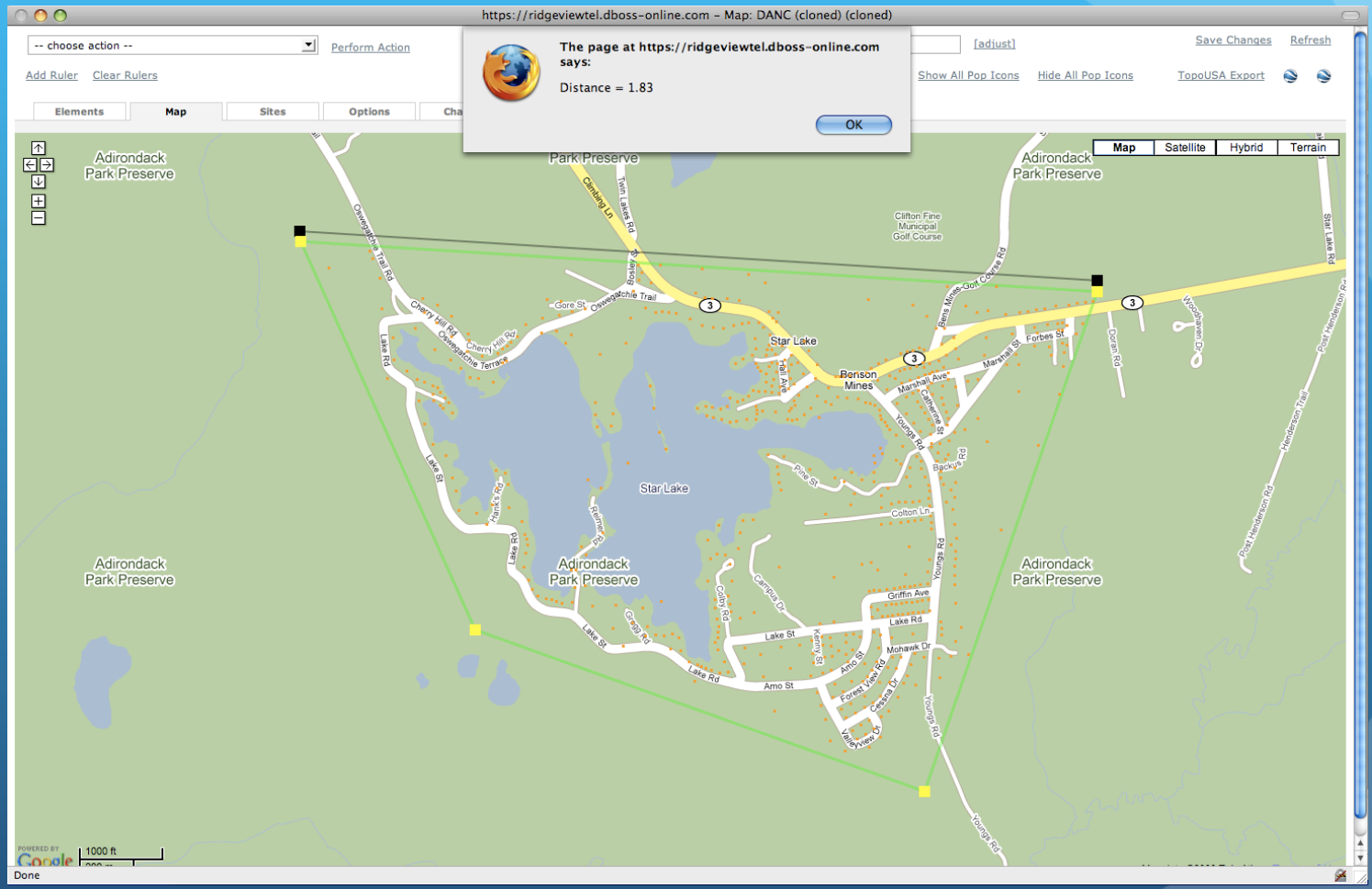
FTTX

- Install costs per mile
- Fiber Termination
- Physical reliability (backhoe fade, pole breaks)

WiMAX

- Available spectrum
- FCC frequency coordination
- Line of sight may require structures and permits

Rural example
Star Lake – Unserved area

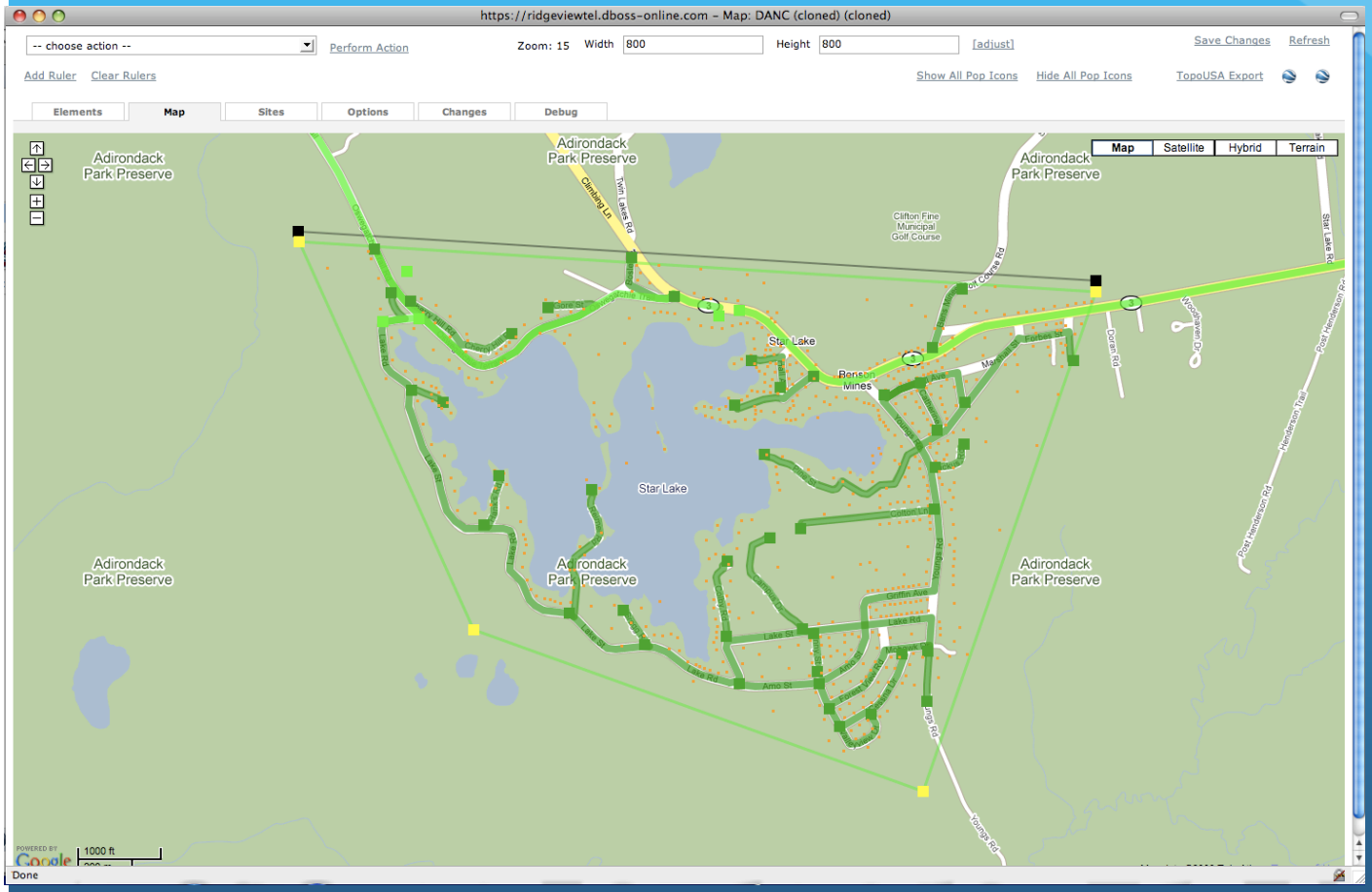


Star Lake as a WiMAX Market

-600 Target Subscribers
-$215K with one tower, 600 CPE, cabinets, P2P and WiMAX base station radios, and antennas

$358 per sub to distribute 1 – 3 Mbps services to this community

Star Lake with FTTX



-600 Target Subscribers
-$235K for the Fiber pulls. (not including costing for cabinets, splices, etc)

$392 per sub to distribute 1 – 3 Mbps services to this community

Why FTTX and not WiMAX?

- The Star Lake area was targeted for FTTX because the community desires the higher capacity services available through FTTX.
- Higher target saturation allows for shorter fiber pulls, and in turn less cost.

Can WiMAX and FTTx coexist?

- Using FTTx to local services that have greater than 50 ppm and anything less then 50ppm WiMAX deployments can be used to keep both platforms employed.
- FTTH/P is the ultimate business case over a 20-25 year time period
- FTTN is deployable today in the majority of developed cities in the world and provides good value for money
- WiMAX / WiFi makes complete economic sense for green-field situations
- WIMAX makes sense where this is little to no copper in the ground

Cost Breakdown for FTTx

- Cost of Fiber: <$1 per foot for 45 fiber bundle (usually close to 50 cents!) installed
- Cost of Distribution:
  - Approximately $100 per drop on the CO side
  - Approximately $350 per home with power backup
- This works out to .00045 cents per bit
- Equal WiMAX is at .00036 cents per bit

State of the Market

- The wired world is racing to FTTN/FTTH
  - Bandwidth required for today's user in the developed market is >40 Mbps
  - Costs are prohibitive for much of the emerging market with FTTH, FTTN being an option for good quality copper installations
- The wireless world is racing to personal broadband
  - Bandwidth's are limited to the shared wireless medium
  - Removes the need for the ULL and much lower cost than FTTN
  - 3G is suited to handsets but is additional cost for broadband

FTTN Issues

- Cost of equipment
- Termination Challenge
- Installation Methods

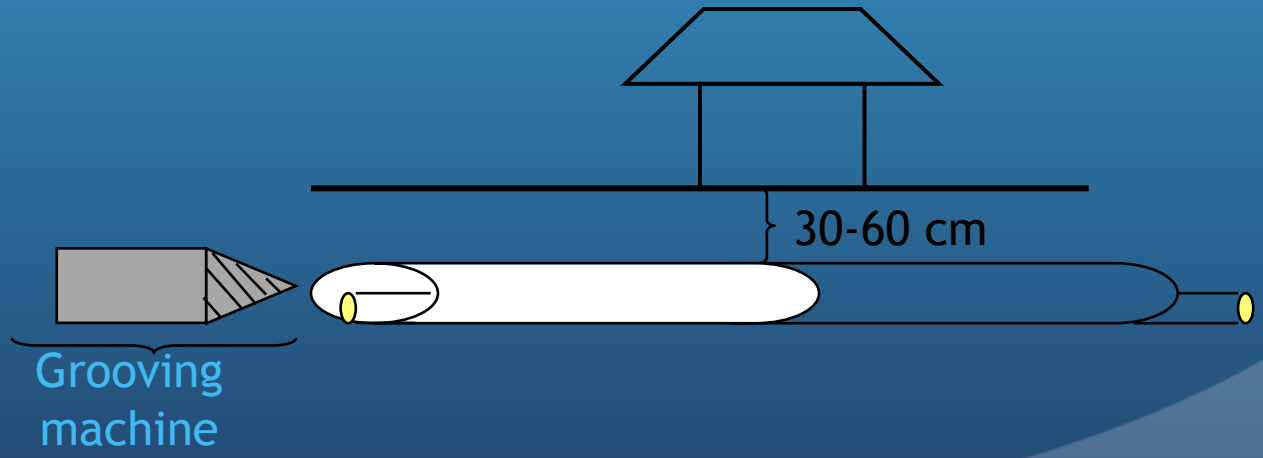
- All these issues are under exponential improvement as large service providers worldwide are driving demand, and demand affects supply and price.

Termination Challenge

- Termination is attaching connectors to the end of the fiber strands
- Fiber cannot be used until it is terminated
- Termination is the largest labor cost for fiber
  - Install extra strands, but don't terminate them till you need them

Pavement Install of Fiber

- Machines can cut grooves in the pavement
  - Lay in small fiber bundles
  - Install plastic ducts 30-60 cm underground
  - Remote control
  - Ex) 2 km under the Hudson River
- Lineman can splice fibers on utility pole



Duct Installation of Fiber

Step 1

High pressure pipe cleaning

TV Inspection

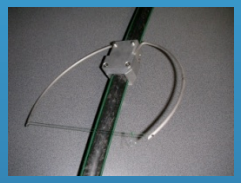
Recording of the pipe geometry

Step 2

Spring steel clips are fixed on a one inch HDPE duct

Clips are contracted

Duct is introduced into the pipe



Step 3

Duct is tended between two manholes

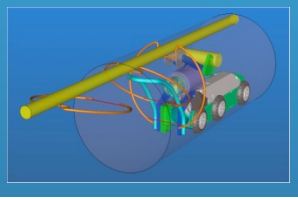
Step 4

With a small computer-driven robot, under TV control

Duct is positioned on the voute pipe

Clips are expanded

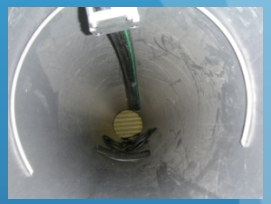
Duct is tightly fixed to the sewer wall

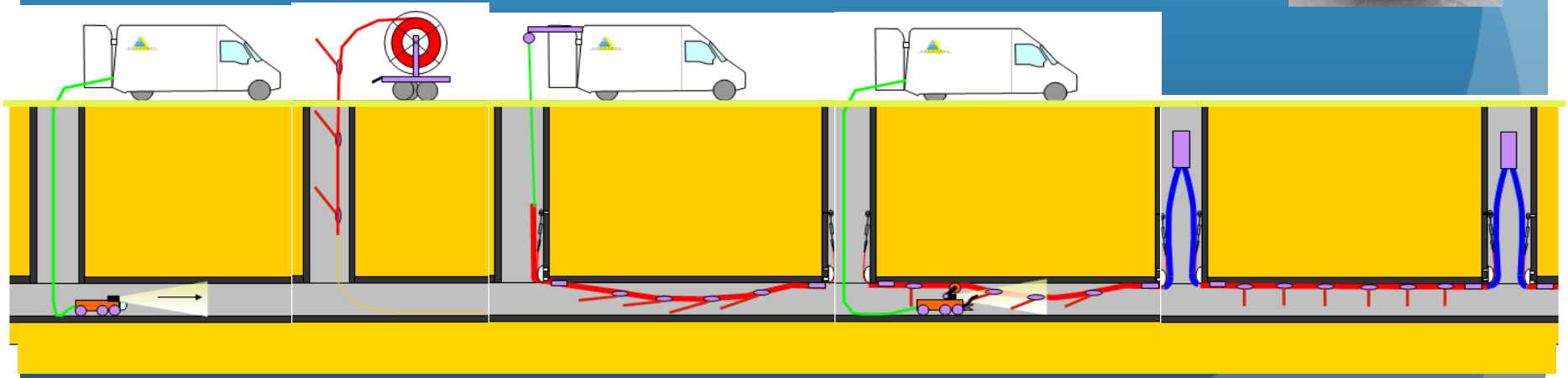


Step 5

Fiber cables are pulled

Manholes are equiped with splice boxes





Access Technologies to Consider

Access Technology	Usual/Average Mb/sec per Subscriber	Number of Splits (PON Only)
BPON (622 Mb/s)	19.4	32
EPON (1 Gb/s)	31.3	32
GPON (1.2 Gb/s)	37.5	32
GPON (2.4 Gb/s)	75	32
GPON (2.4 Gb/s)	37.5	64
ADSL2+ (24 Mb/s)	24	
ADSL2+ (12 Mb/s)	12	
VDSL2 (50 Mb/s)	50	
VDSL2 (12 MB/s)	12	
Fast Ethernet	100	
Gigabit Ethernet	1000	
Wireless 802.11b (6-7 miles)	11	
Wireless 802.11g & a (3-5 miles)	54	