Facilities-based First-Mile Strategies

An Adaptive Approach to Customer Access

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EXECUTIVE SUMMARY

BACKGROUND

First-mile access facilities are those physical wires, cables, radio frequencies and transmission equipment or other interfaces that provide a customer with physical connectivity to a service provider’s network. Once connected, the customer gains access to whatever services have been made available to the customer by that service provider.

There are a variety of players in the access network market, including conventional telephone companies, cable companies, cellular providers and wireless service providers. Each of these companies, historically, has operated with business models that largely derive revenue from applications that ride upon these networks, instead of directly from the network services themselves. That is, networks were originally conceived, developed and deployed to support a single application, which served as the revenue engine that drove the economic performance of a viable business model. In the case of telephone networks, the application was voice communications. Cable networks relied upon video entertainment packages. And cellular networks relied upon the demand for mobile communication. Wi-Fi (WLAN) and fledgling WiMAX (WAN) networks provided best-effort Internet connectivity.

Sometime thereafter, either as a proactive initiative or as a competitive response, each network provider expanded its network capabilities to facilitate support for other purposes, in addition to its primary application. Moving from a business model based on dedicated use to one supporting multipurpose use meant that the consumer instantly had additional options for each application. Intermodal competition was born, and the race was on between service providers to build double-, triple- and quadruple-play service packages that included the services conventionally offered on a dedicated-network by competitors. Internet Protocol (IP) transformed the customer access facility from a single-purposed connection to a communications portal used to access all manner of applications.

Soon, intermodal competition itself was disrupted by application service providers with no network at all. These companies began to offer services in competition with the access service provider’s primary application. Companies
such as Vonage and Skype offered voice and video telephony services in
competition with landline and cellular telephone companies, while NetFlix, Hulu
and others offered video entertainment services in competition with cable
companies. These so-called over-the-top (OTT) providers rely upon the
facilities-based access provider to deliver their service to the customer.

Without the revenue from its primary application, the facilities-based first-mile
access provider cannot sustain its network. More disconcerting is the fact that,
as the first-mile provider improves network performance and subscriber speed
to stave off competition, the viability of competing OTT application services
becomes even more sustainable. To the extent the provider is not charging for
this increased network performance, while at the same time suffering a steady
erosion of application revenue, continued economic viability becomes a
significant concern that demands immediate attention. Consequently, a new
business model that allows the first-mile access provider to recover the cost of
its network, while still supporting the offerings of OTT providers is in order.

A NEW APPROACH

Within the new vision of “first-mile access facility as multipurpose portal,” it is
important to quickly and dynamically provide the means whereby the
customer’s immediate needs can be accommodated. Whether those needs are
for mobility, massive bandwidth, multimedia support, multidevice support or a
simple voice conversation, the first-mile access network must provide the
means to satisfy those needs. Government plays a role, as well, and must
ensure that critical components of this equation, such as rules requiring
interconnection between providers, are preserved and do not fall victim to
technological slight-of-hand by dominant providers as we move to the all-IP
networks that will enable these advancements.

NEXT-GENERATION CUSTOMERS

Next-generation users are looking for multiple methods of access that satisfy
their needs of the moment and would prefer if those methods could be
provided by a single company in a multimedia format.

Multimedia support is fast becoming a requirement. For example, consider how
infuriated iPhone and Android smartphone users were when they found out
they couldn’t talk and surf the Internet at the same time on a CDMA cellular
network. “If a client calls to ask me directions to a restaurant for a lunch meeting, I can’t just pull it up on my smartphone while speaking to him; that’s a major concern!” Those events will increase in frequency as users come to rely on these new-found features and require a sophisticated level of control for first-mile access networks that is aware of how users initiate and conduct multiple, related sessions using one or more devices.

Bundling services, such as entertainment packages, Internet access and fixed-line and mobile telephone, has been a successful marketing strategy while subscribers became acclimated to a communications industry with multimodal competition. However, as the Internet becomes the hosting platform for all types of OTT services, applications and content, next-gen users have begun to express increasing interest in pricing models that allow them to pay “by the drink.”

It is also well understood that video-on-demand, video conferencing and other unicast video applications, will drive consumption of bandwidth on all networks for the foreseeable future and that content providers such as Netflix, Hulu, YouTube and others are largely responsible for this growth. These OTT providers are beginning to measure the speed with which first-mile access providers are delivering their content, as a guide to subscribers who are seeking networks with superior performance. For example, just as the cable company does not risk the quality of its primary application by allowing its video content to vie for access bandwidth with the subscriber’s Internet traffic, so too, the next-gen subscriber may not want her Netflix or Hulu feed to vie for bandwidth.

Today, there is no mechanism available to the subscriber that would allow for such preferential expression. This condition should serve as an engraved invitation for first-mile access providers to introduce such a service.

THE MULTIMODAL FIRST-MILE ACCESS PROVIDER

As with most instances of unfulfilled demand, an entrepreneurial opportunity exists to satisfy it. One way to seize the opportunity lies in the creation of a new business model for a multimodal first-mile access provider.

A multimodal access provider is a first-mile provider who may or may not offer any underlying application, such as voice communication, video entertainment or a gaming platform, but provides a multimodal portal through which these
applications can be accessed, in a performance-enhanced environment. The term “multimodal” is used to describe an intuitive first-mile access network with the means to switch a communication session between end user devices and delivery networks without losing session continuity, network performance or content/session security.

Rather than holding a customer captive, solely to choose applications made available by the first-mile access provider, this new approach would allow customers to enjoy the freedom and flexibility to pick and choose applications, entertainment packages, etc. from any content, service or application provider. The access provider in such a model could monetize its service by, for example, charging the subscriber for the access portal (by mode and by device) and for data of a specific traffic-class, transported at the requested levels of performance.

4G networks already support the classification and intercarrier handoff of services using traffic classifications such as conversational class, streaming class, interactive class and background class. Classification of traffic alone, however, does not guarantee performance so multimodal access networks must implement quality of service (QoS) policies and service level agreement (SLA) structures to use service classes (and user priority) to drive network performance, based upon subscriber preference.

QoS policies and administration can be controlled via IMS, which provides the necessary control layer to implement this strategy. More importantly, IMS supports roaming to a visited first-mile access network which, in the future, will allow the home network provider to integrate roaming features, complete with automated intercarrier settlements, into its product portfolio.

To the extent the subscriber is in control of the choices made, the network provider would manage its network resources in conformance with the wishes of the customer. In this model, an IMS Policy and Charging Control (PCC) function would track the customer’s data usage per traffic class as well as the number of concurrent connections used in each connection mode during the month. Charges would be applied dynamically (real-time) to the customer’s account, using the PCC.
Benefits of the New Approach

The next-generation customer will instantly value two things about this new approach: First, that the data usage component of the pricing algorithm is based on the sum total of usage across all devices, regardless of mode. And second, that the pricing algorithm allows for any number of devices to be registered to the network and used as little or as much as wanted, since the charges for device connections are based on concurrent pathways to the network.

For commercial customers, each session for each device can carry its own service class and security policy so that, for the first time, virtual private networking for each application can be supported; complete with authorized and authenticated user devices and performance guarantees.

For a very long time, first-mile access providers have used a business model whereby the cost of networking was recovered through the sale of applications that transited those networks. With the aforementioned erosion of that model, first-mile providers need to evolve pricing models to a more direct recovery structure, and this suggested approach accomplishes that goal.

By introducing the new approach as a way to allow customers more flexibility in their choice of applications, content and services, first-mile providers will have responded to evolving customer demands in a way that showcases the value of their network. Further, by providing a way in which customers can influence network behavior based upon their own priorities, using IMS, multimedia applications can continue to evolve in sophistication, taking advantage of this new-found capability. Finally, by supporting multimodal access, first-mile providers set the stage for mobility, convergence and end-to-end service quality support, first within their own network and, in the future, on an intercarrier basis.

The multimodal first-mile access provider successfully shifts the principal revenue engine from application to network, and does so in a way that is valued by customers. The result of this shift is a more direct correlation between revenue and cost, a reduced risk to revenue from unforeseen threats posed by alternative application or content providers and yet, an undiminished opportunity to compete for additional revenue with hosted applications, content and services.
**Deployment Models**

The deployment models available to support the multimodal first-mile access provider approach are numerous, because there are many ways in which to build revenue-producing multipurpose access networks. These ways all can be combined to reduce the provider’s average cost of first-mile access by more than 12 percent, compared to the legacy strategies of wireline carriers.

Greenfield deployments lend themselves to such strategies and a facilities-based provider is in a very good position to selectively pursue these opportunities. By seeking out real estate developments, office parks, academic campuses and other concentrations of customer demand, a facilities-based provider can build a communications ecosystem that provides multimodal, multimedia support for the served area, while allowing users maximum flexibility in the selection of applications to which they subscribe.

In urban and suburban deployments, the multimodal first-mile access provider has the ability to build its wireline network with the unbundled copper plant of the PSTN, using enabling technologies that radically improve the achievable data speeds offered to customers.

In a campus environment, the first-mile access provider enjoys a similar opportunity to that afforded by the greenfield deployment. Working with a single administrative authority, similar physical deployments to those in the greenfield model can be achieved, with the added benefit of using any existing infrastructure to augment raw capacity.

A multimodal first-mile access provider can use a combination of all of these deployment strategies to serve high-density areas within a given market. The cost of common platforms, such as the IMS platform, certain 4G wireless assets and any application platforms can be amortized over the total subscribership of all served markets, since IMS technology allows their functionality to be shared, under common control.

Additionally, each served deployment can be logically connected, patchwork-style, to form a large home network area within which subscribers can move while preserving the functionality of applications, security policy, data usage allowances and other features. Finally, as facilities-based providers become more sophisticated, supporting IMS and QoS-enabled interconnection,
subscribers will be able to operate from visited networks with the scope of features available in their home network.

**Conclusion**

Throughout this series of white papers we have attempted to show the ways in which emerging technology is changing the landscape for communication service providers and their customers. These changes require certain policies and agreements to be implemented in order for the Federal Communications Commission’s vision of national broadband ubiquity to be achieved, and for the ensuing benefits to be realized.

- First, the FCC’s rules for intercarrier interconnection must be updated to recognize IP Interconnection if we are to evolve past the rudimentary technology implemented by yesterday’s networks. Unfortunately, though bound by law, incumbent parties will never be compelled to negotiate such interconnection agreements with would-be competitors in the absence of such an update to the granularity of existing rules.

- Second, facilities-based service providers must recognize how customers are evolving in their use of networks and how multimedia applications from OTT providers are changing (eroding) the economics of the facilities-based service provider business model. They should recognize and seriously consider the opportunity for reinvention afforded through the use of an IMS-controlled, multimodal access approach.

- Third, all stakeholders should recognize that access networks should be opportunistic, using whatever transport medium or combination of media that is available, or least expensive to deploy. This includes the copper wires that comprise the PSTN that, using today’s technology, can be transformed into a formidable broadband delivery platform.

- Finally, the FCC should be encouraged to speed the process of evaluating and acting upon gating issues such as freeing RF spectrum for broadband use in a well-defined and purposeful manner. Instability in the white spaces area, for example, has delayed deployments for more than two years, at a time when broadband access is thought of as a badly needed economic catalyst. Another example is in the allowance
of companies to retire copper loops when their successful use as a critical broadband delivery platform is so well documented.

Taken as a whole, this series provides a compelling opportunity for facilities-based service providers to embrace a new business model with the promise of expansive growth and subscriber adoption for many years to come. As with all technology-based opportunities, evolution begets complexity. Though the need for a more sophisticated operational acumen is inevitable, competitive communication providers have always proven equal to the challenge. There is ample basis upon which to conclude they will sustain their record of success in undertaking this endeavor.
INTRODUCTION

First-mile access facilities are those physical wires, cables, radio frequencies and transmission equipment or other interfaces that provide a customer with physical connectivity to a service provider’s network. Once connected, the customer gains access to whatever services have been made available to the customer by that service provider.

THE PLAYERS

TELEPHONE NETWORKS

First-mile access facilities have evolved, both in composition and use, since the old days of “telephone lines.” Back then, it was nothing to expect the local telephone company to install a 50-pair, 100-pair or even a 600-pair copper cable from the central office to a building that housed one or several businesses. Each copper pair (line) would be used to provide a dedicated telephone connection from the telephone company central office to a customer PBX or “Key” system and, in some cases (CENTREX), even to a single telephone.

As Time Division Multiplexing (TDM) became available, signaling techniques such as Integrated Services Digital Network (ISDN) made it possible to separate the physical facility from its dedicated, assigned use in favor of a more flexible assignment framework. For example, rather than having a copper pair dedicated to a single telephone number (line or telephone), the combined TDM/ISDN technologies made it possible to combine two copper pairs and build a facility that could serve any amount of telephone numbers with up to 23 “talk paths” for use at any one time. Still this technology was, for the most part, dedicated to voice communication.

The increased need for data communications created a period when commercial customers (and carriers) began building and operating two distinct networks – one to handle voice communication and another to support ever-increasing data communication demands. The cost of this duplication was enormous but necessary and, importantly, spawned research to discover ways in which voice and data services could be integrated on a single physical facility in a commercially viable way.

In many areas of the country, especially in urban locales, the copper facilities that supported that bygone era of telephone lines also represent the most
economical first-mile access facilities for the most advanced broadband services demanded by customers today. Using technologies such as VDSL2 and copper bonding techniques, symmetrical bandwidth of 100Mb can be provided to customers over voice-grade copper pairs.

In other service areas, an opportunity exists for greenfield deployments of state-of-the-art optical fiber access facilities using either active or passive technologies. These facilities can accommodate the projected growth of broadband demand for decades to come, to the extent the initial deployment costs can be financed.

**Cable Networks**

In consumer markets, cable television companies built alternative networks to support video content delivery. These networks provided shared, high bandwidth in the “downstream” direction (toward the customer) but, originally, provided very little support for information flowing in the upstream direction. Principally dedicated to the task of “broadcasting” video content to consumers, the cable network had little need to support traffic in the opposite direction apart from occasional signaling from set-top boxes.

The dawn of the Internet changed things, however. The cable industry began to recognize that its network infrastructure could be realigned in order to allocate a portion of the available bandwidth to an Internet access service, whereby customers would pay a monthly subscription fee in order to gain access to the wide array of applications, information and services available on the Internet.

Cable operators readily embraced this new source of revenue and began developing technology that allowed them to allocate the bandwidth of unused television channels to support an isolated IP network. Importantly, this technology could assign channel bandwidth for use, on a shared basis, in either the downstream or upstream direction. Later advancements allowed for combining or “bonding” unused channels to increase the bandwidth available in either direction on the shared IP access network.

**Mobile Wireless Networks**

Cellular companies have evolved as well. From the early days of exclusive analog voice support, cellular technology advanced to support modest data rates. As the demand for mobile Internet access grew, cellular technology kept
pace by implementing technological advancements in data traffic support such as EV-DO, UMTS, EDGE and now LTE\textsuperscript{advanced}, a 4G technology that promises data rates of up to 1Gb in fixed deployments and 100Mb in mobile applications. Today’s 4G networks transport far more data traffic than voice, and using LTE\textsuperscript{advanced} technology, can support that demand in a native IP format.

The rate of evolution of cellular technologies to support this exploding demand has had to accelerate in order to accommodate the emerging dominance of mobile applications. Research efforts span the areas of intelligent control, as well as the spectral efficiency (number of bits per Hertz\textsuperscript{1}), of the radio access network. Of all network types, mobile cellular networks are the most “resource constrained,” being limited to the licensed spectrum available to the service provider in any given area. However, the attraction of mobility has elevated cellular access to its clear position of dominance in the consumer market and with the emergence of app stores, stands to lead innovation in all manner of communication services.

**Wi-Fi and WiMAX Fixed/Mobile Wireless Networks**

One of the most exciting areas of first-mile access comprises Wi-Fi and WiMAX technologies. While Wi-Fi provides the most pervasive unlicensed fixed wireless WLAN deployments of any wireless access technology, WiMAX, by way of IEEE 802.16m, promises wide-area mobile data speeds of 100Mb and fixed deployment speeds in excess of 1Gb, principally using licensed spectrum. If WiMAX is accepted as a facilitating technology for operationalizing unlicensed television white spaces spectrum, it will pose a formidable challenge to cellular networks for WAN mobile broadband access.

**Television White Spaces (Honorable Mention)**

It is still too early to identify ways in which the FCC’s repacking and reallocation of television spectrum\textsuperscript{2} for licensed and/or unlicensed use will improve first-mile access facility deployments, though it is anticipated that WiMAX (IEEE 802.16m)

\textsuperscript{1} A Hertz (Hz) is a unit of measure that denotes the number of 360\textdegree cycles that can be completed in one second by a sine wave of that frequency.

may prove an adaptable technology to quickly operationalize this badly needed spectrum. It has been almost three years since the FCC’s landmark decision to free television white spaces for unlicensed use. However, little has been done to put this spectrum to use so a “push” provided by using existing technology standards in order to shorten deployment periods would be a welcome development.

**From Dedicated Use to Customer Portal**

Each of the access methods listed above has a common evolutionary history. That is, they were originally conceived, developed and deployed to support a single application which served as the revenue engine that drove the economic performance of a viable business model. In the case of telephone networks, the application was voice communications; cable networks relied upon video entertainment packages; and cellular networks relied upon the demand for mobile communication. Wi-Fi (WLAN) and fledgling WiMAX (WAN) networks provided best-effort Internet connectivity.

Sometime thereafter, either as a proactive initiative or as a competitive response, each network provider expanded its network capabilities to facilitate support for other purposes, in addition to its primary application. Moving from a business model based on dedicated use to one supporting multipurpose use meant that the consumer instantly had additional options for each application. Intermodal competition was born, and the race was on between service providers to build double-, triple- and quadruple-play service packages that included the services conventionally offered on a dedicated-network basis by competitors. IP transformed the customer access facility from a single-purposed connection to a communications portal used to access all manner of applications.

By far, the most prolific secondary use of this portal was to give customers access to the Internet. Soon, intermodal competition itself was disrupted by application service providers with no network at all. These companies began to offer services in competition with the access service provider’s primary application. Companies such as Vonage and Skype offered voice and video

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telephony services in competition with landline and cellular telephone companies while NetFlix, Hulu and others offered video entertainment services in competition with cable companies.

These so-called OTT providers rely upon the facilities-based access provider to deliver their service to the customer. Figure 1 depicts the delivery model for OTT services vs. those offered by the first-mile access network (or broadband) service provider.

![Figure 1. – Configuration of first-mile access facility depicting OTT service delivery.](image)

Often, the OTT service is of lower quality than the comparable service offered by the conventional (first-mile) provider. However, the lower price of these services (often free) has been sufficient to shift massive amounts of traffic away from the conventional provider to these OTT services.

Without the revenue from its primary application, the facilities-based first-mile access provider cannot sustain its network. More disconcerting is the fact that, as the first-mile provider improves network performance and subscriber speed to stave off competition, the viability of competing OTT application services becomes even more sustainable. To the extent the provider is not charging for this increased network performance and at the same time suffers a steady erosion of application revenue, continued economic viability becomes a significant concern that demands immediate attention. Consequently, a new business model that allows the first-mile access provider to recover the cost of its network, while still supporting the offerings of OTT providers, is in order.
A New Approach

The technology used to provide customers with first-mile access to service provider networks will continue to evolve. Within the new vision of “first-mile access facility as multi-purpose portal,” the specific technology used to provide the access is of minimal importance. What is important is that it provides the means whereby the customer’s immediate needs can be accommodated. Whether those needs are for mobility, massive bandwidth, multimedia support, multidevice support or a simple voice conversation, the first-mile access network must provide the means to satisfy those needs.

Next-Generation Customers

New generations of users would tell us that “gone are the days” when facilities-based first-mile access providers should be thought of as having a primary application. In fact, many would tell us that distinctions such as “cable company,” “cellular company” and “telecom company” are all fast becoming passé. These next-generation users are looking for multiple methods of access to satisfy their needs of the moment and would prefer if those methods could be provided by a single company in a multimedia format.

Multimedia support is fast becoming a requirement. For example, consider how infuriated iPhone and Android smartphone users were when they found out they couldn’t talk and surf the net at the same time on a CDMA cellular network. “If a client calls to ask me directions to a restaurant for a lunch meeting, I can’t just pull it up on my smartphone while speaking to him; that’s a major concern!” Those events will increase in frequency as users come to rely on these new-found features and will require a sophisticated level of control for first-mile access networks that is aware of how users initiate and conduct multiple, related sessions using one or more devices.

The Multimodal First-Mile Access Provider

As with most instances of unfulfilled demand, an entrepreneurial opportunity exists to satisfy it. One way to seize the opportunity lies in the creation of a new business model for a multimodal first-mile access provider.

A multimodal access provider is a first-mile provider that may or may not offer any underlying application, such as voice communication, video entertainment or a gaming platform, but provides a multimodal portal through which these
applications can be accessed, in a performance-enhanced environment. The term “multimodal” is used to describe an intuitive first-mile access network with the means to switch a communication session between end user devices and delivery networks without losing session continuity, network performance or content/session security⁴. In other words, assume for example, that a user watching HD IPTV in her living room over a wireline, fiber or cable connection would like to transfer the “picture-in-picture” feature to her authorized and authenticated, 4G-connected iPad so as not to disturb the family viewing experience while she channel-surfs for alternative programming that is of greater interest. Once she finds it, she directs the application to stream the content to the IPTV with a bandwidth reservation sufficient for HD performance.

**Will Performance Bundles Replace Service Bundles?**

Bundling services such as entertainment packages, Internet access and fixed-line and mobile telephone has been a successful marketing strategy while subscribers became acclimated to a communications industry with multimodal competition. However, as the Internet becomes the hosting platform for all types of OTT services, applications and content, next-gen users have begun to express increasing interest in pricing models that allow them to pay “by the drink.”

For example, because 1G and 2G networks were incapable of supporting high data rates, cellular carriers offered unlimited data plans. With the expansive increase in subscriber data rates made possible with the deployment of 3G and 4G networks, however, we see the introduction and enforcement of data caps on those plans. Interestingly, we also see the introduction of plans with lower data caps for a lower monthly price and plenty of subscribers willing to make the downward change. This could be interpreted as further evidence of the willingness of certain subscribers to pay for services on an “as used” basis.

If that is true it may also hold that certain subscribers are interested in reserving a higher level of network performance than the Internet’s “best effort” service for certain applications. For example, just as the cable company does not risk the quality of its primary application by allowing its video content to vie for

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access bandwidth with the subscriber’s Internet traffic, so too, the subscriber, as in the example above, may not want her Netflix or Hulu feed to vie for bandwidth. Going back to the cellular analogy, a subscriber may, indeed prefer the improved performance of a 4G network connection, but may not be interested at all in an increased data cap (higher consumption).

As pointed out in an earlier white paper in this series⁵, it is well understood that video and specifically video-on-demand, video conferencing and other unicast video applications, will drive consumption in bandwidth on all networks for the foreseeable future and that content providers such as Netflix, Hulu, YouTube and others are largely responsible for this growth. These OTT providers are beginning to measure the speed with which first-mile access providers are delivering their content, as a guide to subscribers who are seeking networks with superior performance.

Figure 2 shows the results of Netflix testing for the period from October 1, 2010 to January 15, 2011. On its tech-blog website⁶ Netflix discloses to customers that its current HD feeds stream at a rate of 4.8Mbps. However, they do not expect subscriber’s access networks to be able to support that speed for a sustained period of time. Their answer is to use a rate-adaptive algorithm to reduce the video resolution and, therefore, the quality of the picture when the access network cannot provide the required bandwidth. Such an explanation would undoubtedly cause customers a high degree of frustration with their first-mile access provider, since the video content they prefer receives inferior network resources while the video content they care least about is given superior network resources.

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⁵ See COMPTEL/ETC Group, LLC white paper entitled: “IP Interconnection for Managed VoIP – Interconnecting Next Generation Network Service Providers.”
Today, there is no mechanism available to the subscriber that would allow for such preferential expression. This condition should serve as an engraved invitation for first-mile access providers to introduce such a service.

Furthermore, in this new environment of virtually unlimited content sources, the “entertainment package” bundling strategy itself begins to lose its attraction to subscribers. In other words, if the subscriber is only interested in video content available from such alternative sources as Netflix or Hulu, why should the customer submit to a “bundled” package from a cable provider that forces her to purchase an entertainment package as part of her basic service?

Rather than holding a customer captive, solely to choose applications made available by the first-mile access provider, this new approach would allow customers to enjoy the freedom and flexibility to pick and choose applications or entertainment packages from any content, service or application provider. The access provider in such a model could monetize its service by, for example, charging the subscriber for the access portal (by mode and by device) and for data of a specific traffic-class, transported at the requested levels of performance. To the extent the subscriber is in control of the choices made, the
network provider would manage its network resources in conformance with the wishes of the customer. Billing could easily be accomplished with an automated charging algorithm (by traffic class and mode of connection), such as that described in the chart of Figure 3. In this model, an IMS PCC function would track the customer’s data usage per traffic class, as well as the number of concurrent connections used in each connection mode during the month. Charges would be applied automatically.

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<td>$25.00</td>
<td>$20.00</td>
<td>$15.00</td>
</tr>
<tr>
<td>Wireless (Ex. 50Mb/50Mb)</td>
<td>$30.00</td>
<td>$25.00</td>
<td>$20.00</td>
<td>$15.00</td>
</tr>
</tbody>
</table>

Figure 3. – Possible pricing matrix for Multimodal First-mile Access Provider

Example: A customer maintains a single wired connection at his home and has family members with a number of wireless devices. During the month, the customer’s combined data usage (all devices) and concurrent connection requirements are automatically tracked by the PCC and yield the charges described in Figure 4.
4G networks already support the classification and intercarrier handoff of services using traffic classifications such as conversational class, streaming class, interactive class and background class. Classification of traffic alone, however, does not guarantee performance so multimodal access networks must implement QoS policies and service level agreement structures to use service classes (and user priority) to drive network performance, based upon subscriber preference.

As mentioned above, QoS policies and administration can be controlled via IMS\(^7\), which provides the necessary control layer to implement this strategy. More importantly, IMS supports roaming to a visited first-mile access network which, in the future, will allow the home network provider to integrate roaming features, complete with automated intercarrier settlements, into its product portfolio.

\(^7\) See COMPTEL/ETC Group, LLC white paper entitled: “IP Multimedia Subsystem (IMS) – The Carrier-grade Challenge to OTT Services”
Benefits of the New Approach

Customer Benefits

The next-generation customer will instantly value two things about this new approach: First, that the data usage component of the pricing algorithm is based on the sum total of usage across all devices, regardless of mode and; second, that the pricing algorithm allows for any number of devices to be registered to the network and used as little or as much as wanted, since the charges for device connections are based on concurrent pathways to the network. This charging algorithm means that connection of a telephone, computer, television, or any other device can be accommodated by simply registering the device at no extra cost.

For commercial customers, each session for each device can carry its own service class and security policy so that, for the first time, per-application virtual private networking can be supported; complete with authorized and authenticated user devices and performance guarantees.

Finally, the elasticity of this pricing policy, and the separation of underlying network functionality from applications, gives all customers the ability to direct network performance based upon customer preferences and to independently purchase applications from whatever source they so choose.

First-Mile Access Provider Benefits

For a very long time, first-mile access providers have used a business model whereby the cost of networking was recovered through the sale of applications that transited those networks. With the aforementioned erosion of that model, first-mile providers need to evolve pricing models to a more direct recovery structure, and this suggested approach accomplishes that goal.

By introducing the new approach as a way to allow customers more flexibility in their choice of applications, content and services, first-mile providers will have responded to evolving customer demands in a way that showcases the value of their network. Further, by providing a way in which customers can influence network behavior based upon their own priorities, using IMS, multimedia applications can continue to evolve in sophistication, taking advantage of this new-found capability. Finally, by supporting multimodal access, first-mile providers set the stage for mobility, convergence and end-to-end service quality
support, first within their own network and, in the future, on an intercarrier basis.

The multimodal first-mile access provider successfully shifts the principal revenue engine from application to network, and does so in a way that is valued by customers. The result of this shift is a more direct correlation between revenue and cost, a reduced risk to revenue from unforeseen threats posed by alternative application or content providers and yet, an undiminished opportunity to compete for additional revenue with hosted applications, content and services.
**Deployment Models**

The deployment models available to support the multimodal first-mile access provider approach are numerous because there are many ways in which to build revenue-producing multipurpose access networks. In this section, we discuss several possible strategies, all of which can be combined to reduce the provider’s average cost of first-mile access by more than 12 percent, compared to the legacy strategies of wireline carriers.

**Greenfield Deployments**

Greenfield deployments lend themselves to such strategies and a facilities-based provider is in a very good position to selectively pursue these opportunities. By seeking out real estate developments, office parks, academic campuses and other concentrations of customer demand, a facilities-based provider can build a communications ecosystem that provides multimodal, multimedia support for the served area while allowing users maximum flexibility in the selection of applications to which they subscribe.

Though the downturn in the real estate market has slowed construction in a number of commercial and residential developments, projects already underway are looking for ways in which to differentiate their development from those of other developers. A state-of-the-art technology infrastructure is a formidable advantage for any development regardless of whether it is principally residential or commercial in nature.

Innovative first-mile service providers can work with select developers in order to deploy the multimodal access network described above in the subject development. By selecting developments for commercial and high-end residential (and mixed-use) tenants, the first-mile service provider can ensure a receptive market for its advanced multimedia access network. Figure 5 shows a configuration that allows for 4G wireless, Active Ethernet and GPON optical access modes. The 4G wireless deployment could be unlicensed spectrum in one of several frequency ranges, including television white spaces.
Many developers have long-since placed conduit and absorbed the cost of initial deployment within the development. A first-mile access provider, in these situations, can usually build optical fiber-to-the-home for less than $500/drop (shared PON). The cost of Gb Active Ethernet (dedicated optical fiber) deployment to commercial buildings can be done for between $3,000 and $10,000 per drop. Maintenance costs for such deployments are rarely more than 1 percent per year.

The cost of deployment for a 4G radio access network can depend, largely, on the cost of spectrum. To the extent the first-mile provider holds a spectrum license that cost can be mitigated. However, there are ranges of unlicensed spectrum also available that would work, unfettered, within the confined areas of most real estate developments.

Television white spaces are viewed by the FCC as a resource tailor-made for this application. The FCC conditionally appointed a company named Spectrum Bridge as a TV White Space Database Administrator in January 2011. Spectrum Bridge maintains an industry database and online application which maps unlicensed spectrum as well as licensed spectrum available for sale⁸. RF

manufacturers are now developing equipment solutions to take advantage of this spectrum, making it a valuable platform for wireless first-mile broadband access at speeds up to 100Mb in mobile configurations and 1Gb in fixed deployments. Of course, that bandwidth is shared across all users served by each RF access point but, in an environment where the 4G network augments a fixed GPON or Active Ethernet deployment, as suggested here, the resulting multi-modal access network is unmatched in both flexibility and capacity.

**Urban/Suburban Deployments**

In urban and suburban deployments, the multi-modal first-mile access provider has the ability to build its wireline network with the unbundled copper plant of the PSTN, using enabling technologies that radically improve the achievable data speeds offered to customers. VDSL2 allows providers to offer sustainable broadband speeds of 20Mb or more over distances of 2 km or less using two copper loops. This is sufficient to provide low-cost broadband access to small/medium businesses (SMBs).

Copper loops as unbundled network elements in urban and suburban settings are normally TELRIC-priced at between $8.50 and $13 per month. Therefore, by selecting urban and suburban central offices with very high concentrations of SMBs in close proximity, a first-mile access provider can capture a significant market share of highly profitable customers. Adding a 4G wireless overlay using television white spaces spectrum in select areas, all under IMS control, an access provider can offer true multi-modal functionality as well as augmented bandwidth (See Figure 6).
For larger commercial customers, Active Ethernet over copper pairs can yield bi-directional speeds of 100Mb or more. Again, with the deployment of IMS and a 4G wireless overlay multi-modal functionality makes for an attractive access architecture.

Finally, for the largest customers, optical fiber access to select buildings using a dark fiber provider can provide massive bandwidth. Again, when supplemented with 4G wireless functionality using unlicensed spectrum and placed under IMS control, maximum flexibility to support multidwelling units or multitenant office buildings with multimodal capability can be achieved.

**Academic Campus Deployments**

In a campus environment, the first-mile access provider enjoys a similar opportunity to that afforded by the greenfield deployment. Working with a single administrative authority, similar physical deployments to those in the greenfield model can be achieved, with the added benefit of using any existing infrastructure to augment raw capacity. Using existing buildings as platforms for 4G antenna structures and internal copper pairs with VDSL2 technology to serve multidwelling units, the first-mile provider can easily find that minimal
overbuild construction is necessary to implement a multimodal access network. While outside plant inventory records may be in need of updating, the use of existing copper comprises a significant advantage when paired with today’s superior technologies to transform this media into a formidable broadband delivery platform.

**THE “WHOLE” IS GREATER THAN THE SUM OF THE PARTS**

A multimodal first-mile access provider can use a combination of all of these deployment strategies to serve high-density areas within a given market. The cost of common platforms, such as the IMS platform, certain 4G wireless assets and any application platforms can be amortized over the total subscribership of all served markets, since IMS technology allows their functionality to be shared, under common control.

Additionally, each served deployment can be logically connected, patchwork style, to form a large home-network area within which subscribers can move while preserving the functionality of applications, security policy, data usage allowances and other features. Finally, as facilities-based providers become more sophisticated, supporting IMS and QoS-enabled interconnection, subscribers will be able to operate from visited networks with the scope of features available in their home network.
CONCLUSION

Throughout this series of white papers we have attempted to show the way in which emerging technology is changing the landscape for communication service providers and their customers. These changes require certain policies and agreements to be implemented in order for the FCC’s vision of national broadband ubiquity to be achieved, and for the ensuing benefits to be realized.

- First, the FCC’s rules for intercarrier interconnection must be updated to recognize IP Interconnection if we are to evolve past the rudimentary technology implemented by yesterday’s networks. Unfortunately, though bound by law, incumbent parties will never be compelled to negotiate such interconnection agreements with would-be competitors in the absence of such an update to the granularity of existing rules.

- Second, facilities-based service providers must recognize how customers are evolving in their use of networks and how multimedia applications from OTT providers are changing (eroding) the economics of the facilities-based service provider business model. They should recognize and seriously consider the opportunity for reinvention afforded through the use of an IMS-controlled, multimodal access approach.

- Third, all stakeholders should recognize that access networks should be opportunistic, using whatever transport medium or combination of media that is available, or least expensive to deploy. This includes the copper wires that comprise the PSTN that, using today’s technology, can be transformed into a formidable broadband delivery platform.

- Finally, the FCC should be encouraged to speed the process of evaluating and acting upon gating issues such as freeing RF Spectrum for broadband use in a well-defined and purposeful manner. Instability in the white spaces area, for example, has delayed deployments for more than two years, at a time when broadband access is thought of as a badly needed economic catalyst. Another example is in the allowance of companies to retire copper loops when their successful use as a critical broadband delivery platform is so well documented.

Taken as a whole, this series provides a compelling opportunity for facilities-based service providers to embrace a new business model with the promise of
expansive growth and subscriber adoption for many years to come. As with all technology-based opportunities, evolution begets complexity. Though the need for a more sophisticated operational acumen is inevitable, competitive communication providers have always proven equal to the challenge. There is ample basis upon which to conclude they will sustain their record of success in undertaking this endeavor.
ABOUT

ABOUT COMPTEL

Based in Washington, D.C., COMPTEL is the leading industry association representing competitive communications service providers and their supplier partners. COMPTEL members are entrepreneurial companies driving technological innovation and creating economic growth through competitive voice, video, and data offerings and the development and deployment of next-generation, IP-based networks and services.

COMPTEL advances its members’ interests through trade shows, networking, education, and policy advocacy before Congress, the Federal Communications Commission and the courts. COMPTEL works to ensure that competitive communications providers can continue to offer lower prices, better service, and greater innovation to consumers. For more information, please call (202) 296-6650 or visit www.comptel.org.

ABOUT ETC GROUP, LLC

ETC Group, LLC is a business management and engineering consulting company with significant experience in the management, operation and deployment of a wide range of business models using emerging technologies to support the successful operations of telecommunications and other broadband service providers.

Our team of professionals brings a wide and deep base of knowledge and best practices, derived through more than 200 years of combined, first-hand operating experience in both incumbent and competitive telecommunications companies as well as Internet and application service providers. If you would like to discuss ways in which ETC Group can help your organization, please call (724) 396-0432 or visit www.etcgroup.net.