EVOLUTION OF THE BROADBAND NETWORK GATEWAY

INCREASE PROFIT AND LOYALTY BY DELIVERING RESIDENTIAL SUBSCRIBERS THE FREEDOM THEY CRAVE

APPLICATION NOTE

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ABSTRACT

Residential service providers today are at odds with the very subscribers they serve. Along with the liberating experience of Over The Top VoD Video on Demand (OTT VoD) services that cater to their unique needs, subscribers now want the freedom of a broadband service without boundaries — one in which they can consume any content or application, on any device, anytime, anywhere. Challenged by the negative impact of OTT VoD traffic on network bandwidth and the perceived threat to their PayTV services, service providers are responding with rigid caps on bandwidth utilization.

There is a better way. Rather than discourage the use of the very service they provide, service providers can embrace subscriber demands for freedom and enhance their services to thrive on higher bandwidth consumption. However, realizing these goals requires change. Centralized Broadband Remote Access Server (BRAS) architectures lack the scale, performance and service flexibility to thrive in this new VoD-dominated era. Service providers require a new approach to planning and building residential networks, an approach that embraces more performance, distributed subscriber management and enhanced feature capabilities to deliver higher quality, more personalized subscriber services.

Targeted to service providers as well as product marketing, network architecture and network operations executives, this document provides an overview of changing subscriber needs, the new service opportunities now open to service providers and the transformation challenges they face. We explain how all of these challenges and opportunities are best addressed with a distributed residential services architecture based on the Alcatel-Lucent 7750 Service Router (SR).

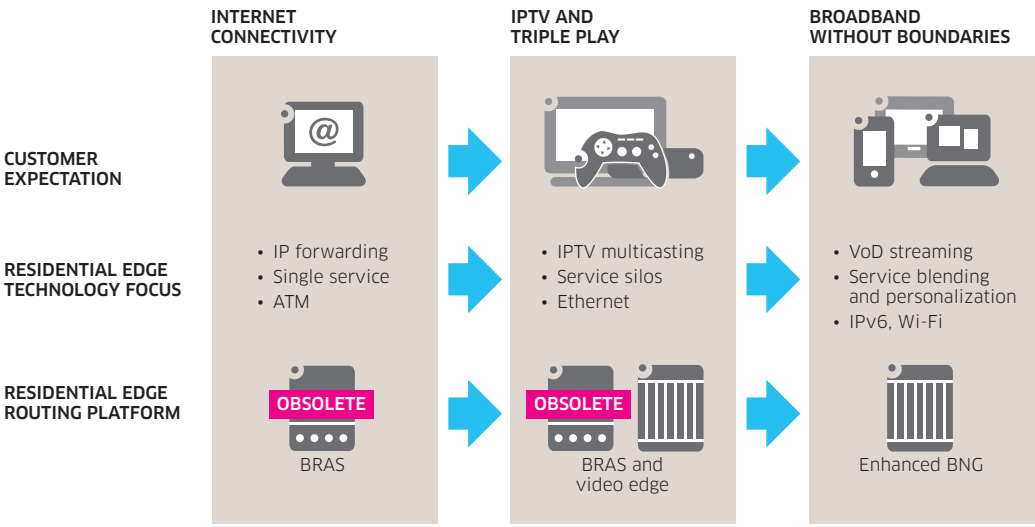
MARKET TRENDS AND CHALLENGES

What subscribers want

Residential broadband networks are once again entering a period of major change — and opportunity — driven by subscriber needs and expectations (see Figure 1). The first-generation networks based on centralized BRAS routers were driven by subscriber demand for an always-on High Speed Internet (HSI) service. The second generation, powered by Ethernet-based Broadband Network Gateway (BNG) routers, was driven by subscriber demand for a linear TV service (content broadcast at specific times) delivered in conjunction with voice and HSI services.

Today's increasingly sophisticated and Internet-savvy subscribers are raising the bar yet again. They want to remove the boundaries and limitations imposed by today's broadband services and customer premises equipment to create a richer, personalized experience that leverages all that the Internet and the consumer electronics industry have to offer.

Figure 1. Customer expectations driving residential broadband evolution



More specifically, subscribers want:

- **Device freedom:** The ability to consume, control and share content and the HSI connection on any device — from PC to gaming console, to tablet to big-screen TV.
- **Schedule freedom:** The ability to consume content based on their schedule, whether live, time shifted or on demand.
- **Location freedom:** The ability to replicate the home experience outside the home at Wi-Fi hotspots in stadiums, coffee shops, shopping malls and airports.
- **Plan freedom:** The ability to attain optimal value through customized HSI plans that reflect each subscriber's unique application and content consumption needs.
- **Content freedom:** The flexibility to consume any content — whether cloud, premium, live or user generated — at a resolution level that meets their changing needs and the capabilities of the consuming device.
- **Interactive freedom:** The ability to transform content consumption into an interactive experience, with sidebar content and suggestions, social media integration, and interacting ads and content. The ability to consume networked applications such as online gaming without the quality issues that diminish such online experiences today.

Subscribers also want the freedom to blend attributes of different residential services — such as the high quality of linear TV , the flexibility of VoD and the interactivity of the web — into a single, personalized service experience that fulfills their unique digital lifestyle needs. For example, a subscriber may want to watch an on-demand video that is not part of the premium linear TV lineup but has high video quality, fed directly to the big-screen TV, while using a tablet device to interact with other viewers through social networks and reviewing suggestions for related web and video content.

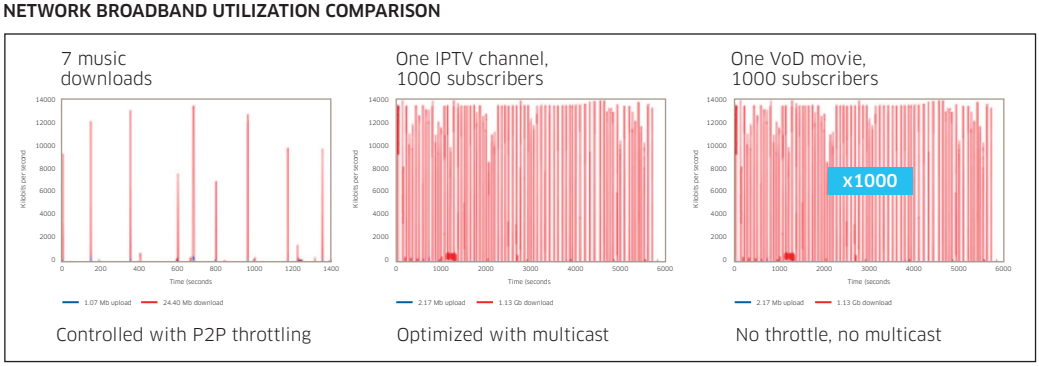
Subscriber freedom today: OTT VoD

OTT VoD providers were the first to identify and capitalize on this demand for freedom. Innovators such as Netflix® and YouTube launched flexible VoD services that have become household names and, in conjunction with VoD offerings from later entrants, are expected to consume over 58 percent of Internet bandwidth by 2015. Google™ and Apple® are taking these first-generation services to the next level by adding their cloud infrastructure, consumer devices and operating systems into the mix to provide a richer experience within the confines of their brand and ecosystem.

For service providers, this represents both a challenge and an opportunity (see Figure 2 and Figure 3). A challenge because a single unicast VoD session consumes the same network bandwidth as a linear-TV flow delivered to thousands of subscribers through multicast. A challenge because VoD streaming protocols and applications are relentless; they adjust to changing network conditions, consuming new network capacity as soon as it is made available.

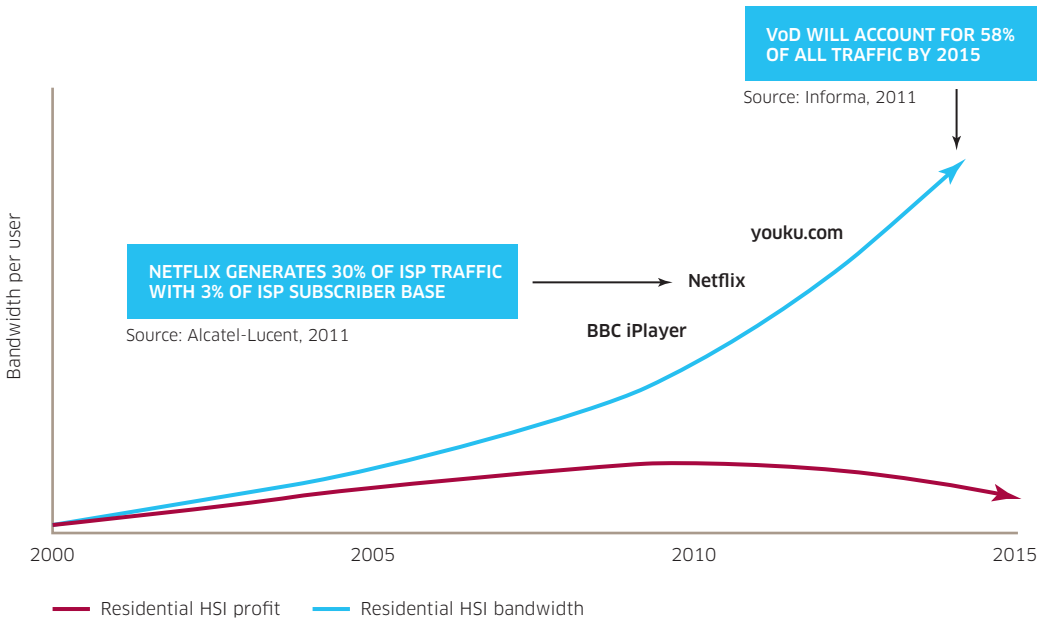
The impact on service providers has been rapid, global and significant. In the United States alone, approximately one third of ISP network capacity at peak times is now being consumed by Netflix users who represent a small fraction of the total ISP subscriber base. OTT VoD providers across the globe are creating similar challenges for service providers in Canada (Netflix), the United Kingdom (BBC iPlayer) and China (Youku.com), to name only a few.

Figure 2. The impact of VoD on IP network bandwidth



Data: Caffeinated Bitstream, 2009

Figure 3. The financial impact of OTT VoD on service providers

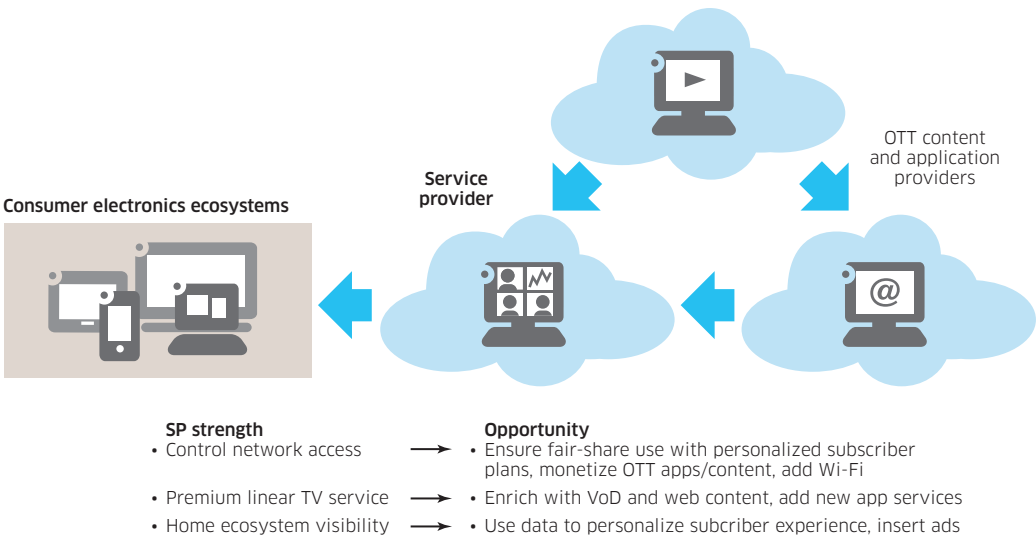


Service providers have responded to the OTT VoD bandwidth challenge — and the shift away from their own linear TV services — by introducing rigid bandwidth caps and down-speed techniques that limit bandwidth consumption on their HSI services. While this approach does provide short-term relief, it pits the service provider against their customer — the subscriber — and damages this all-important relationship. It also repositions the OTT vendor who fulfills subscriber demands for freedom at the top of the value chain and popularity polls. There is a better way.

Winning the battle for the subscriber

Rather than discourage the use of the very service they provide, service providers should embrace the concept of subscriber freedom and leverage their core strengths to thrive on increasing network usage (see Figure 4).

Figure 4. Wining the battle for the subscriber



Because they control access to the subscriber, service providers are in a unique position to free subscribers from OTT VoD service quality issues by providing a consistently high quality of experience (QoE) that will always be outside of the OTT vendors' scope of control to deliver. They can monetize the OTT flows that travel through their network, provide subscribers with optimal application-aware plans to free them from rigid usage caps or offer Wi-Fi access to provide the freedom of a home experience off-the-wire. They can work with OTT vendors to provide optimized application services that free subscribers from best-effort quality limitations of OTT gaming, person-to-person (p2p) video conferencing and other applications.

Service providers can also leverage their strong relationships with content providers. They can enrich current linear TV services with VoD and web content to deliver the blended broadband service experience their customers crave.

Finally, service providers can use their unique ability to gather performance and service usage data to personalize services and insert personalized ads.

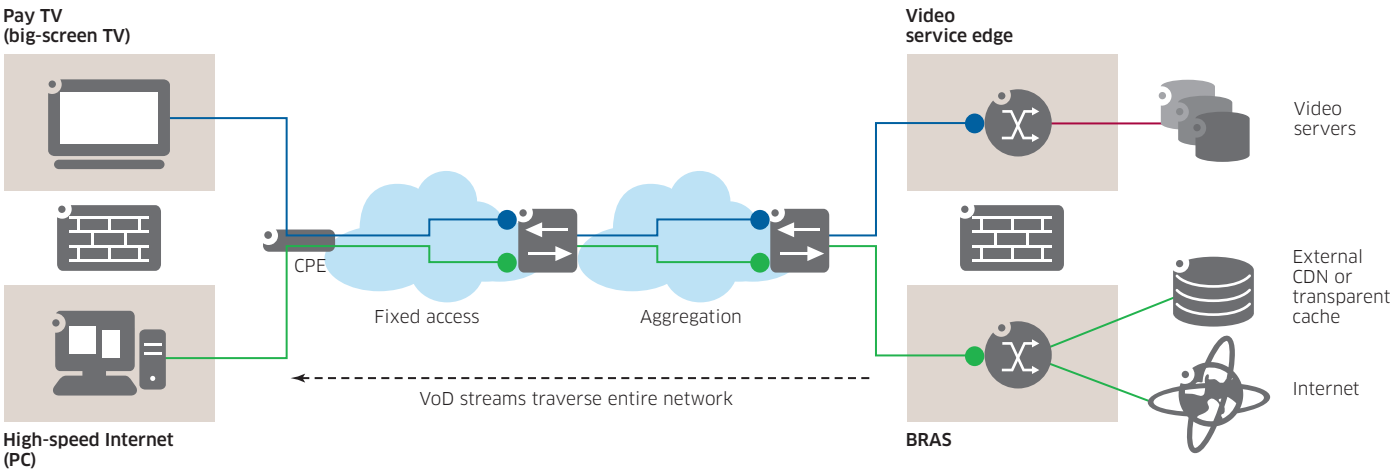
At stake in this battle for the subscriber is hundreds of billions of dollars in revenue from content alone, and the service provider's position in the value chain —whether as a provider of commodity Internet access or as a conduit for value-added services. With all the limitations of today's legacy BRAS-based architectures still in place, many service providers are ill equipped to win their share of the revenue pie.

EVOLVING THE RESIDENTIAL SERVICES NETWORK

Limitations of centralized BRAS architectures

Figure 5 shows some of the key limitations of today's legacy broadband architectures.

Figure 5. Traditional centralized BRAS architectures



Overlay model limitations

Residential services today are delivered on separate IP service platforms; HSI service is delivered through the BRAS router while video service is delivered through a separate video edge router. Each service connects to a different device at the home (TV or PC), often provisioned with a different IP address. This "wall" between services and lack of unified subscriber treatment makes it difficult to deliver the blended, personalized experience that subscribers want and is at odds with the demand for convergence within the home.

An overlay architecture is also very expensive to deploy and maintain. Multiple IP service platforms quickly deplete capital budgets, and the service overlays they spawn result in complex provisioning and capacity planning in the access and aggregation networks.

Centralized architecture limitations

The HSI service that contains all the unicast video flows from Internet-based OTT providers is delivered to subscribers from centralized BRAS routers deep within the service provider's network. Each time a subscriber starts a VoD session, a new video stream is created between the servers/caches that contain the content and the subscriber. The resulting traffic crosses the service provider's entire network, from the peering point or transparent cache behind the BRAS router all the way to the subscriber's residence.

As more and more users shift to VoD content consumption, transport costs for video skyrocket, and the resulting network and server congestion lowers performance and service availability. With video taking center stage as the killer app for residential use, central content injection and a central BRAS no longer make sense.

BRAS legacy obsolescence issues

BRAS routers may have impressive subscriber density for yesterday's Internet traffic mix but, with Internet video in the picture, they lack the performance and capacity to keep up. Actual subscriber density quickly drops as more and more users stream video, and the economies of scale of a centralized BRAS architecture quickly crumble.

IPv6 migration is also an area of concern for service providers because so many legacy BRAS routers lack the performance and scale of a carrier-grade network address translation (NAT) capability to enable flexible IPv4-to-IPv6 migration. And because a BRAS is a single-service delivery platform (HSI), it lacks the capability to delivery new features or services beyond basic HSI or reap the operational and cost benefits of service convergence.

Requirements for the next-generation BNG

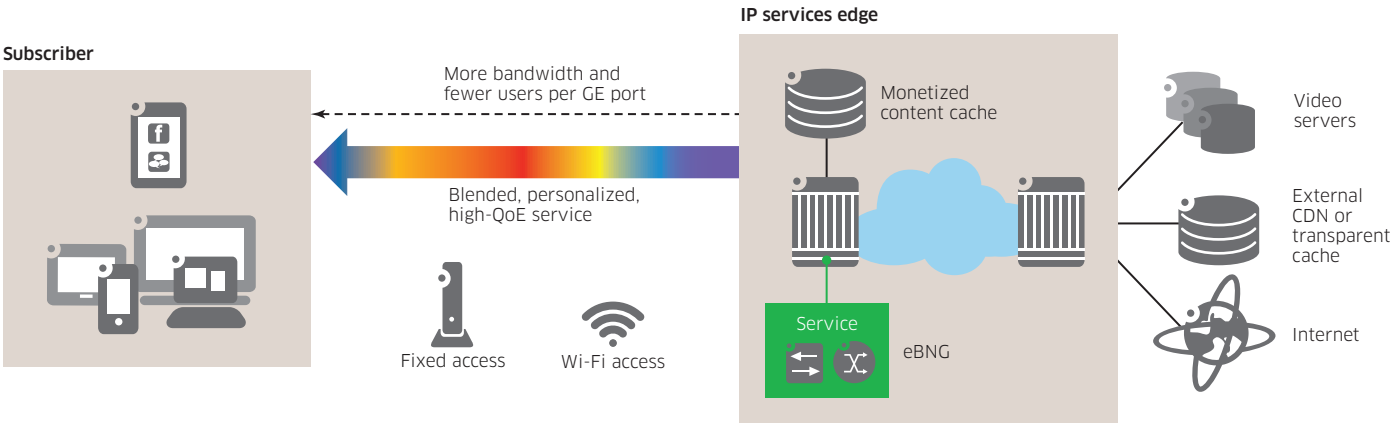
A new, distributed architecture optimized for video growth and service convergence is required to capitalize on the delivery of subscriber freedom(see Figure 6). This architecture is based on a BNG platform with the attributes that follow.

Massive scale and performance

The BNG must sustain high throughput and be capable of 100G+ speeds — with services — to support the rapid growth and monetization of video. This massive scale also enables convergence: the ability to deliver all residential services from a common delivery platform in the IP edge. Convergence enables a unified view of each subscriber with consistent treatment of all the subscriber's traffic across all services used. This enhances a service provider's ability to deliver a blended, high-quality service experience that is personalized for each subscriber and eases the task of capacity planning across the different services.

Convergence also simplifies provisioning by removing the need for multiple service overlays in the access and aggregation networks and the need for multiple IP addresses per subscriber.

Figure 6. Distributed architecture based on a high-performance, enhanced BNG



Distributed service intelligence

The BNG must contain IP over Ethernet/Dynamic Host Configuration Protocol (IPoE/DHCP) subscriber management capabilities for multiservice support while remaining backwards compatible with legacy Point-to-Point Protocol over Ethernet (PPPoE). Service intelligence to help simplify provisioning and authentication and to ensure high availability is a baseline requirement. Multiple queues per subscriber with flexible allocation are required to ensure quality of service (QoS) for multiple services and applications.

In a distributed architecture, subscriber management, content caches and high-touch processing capabilities move to the edge of the network, closer to the customer. By distributing service intelligence to the edge, service providers can provision more bandwidth and fewer subscribers per Gigabit Ethernet (GigE) port to accommodate the growth of video and other high-bandwidth services. VoD flows are limited to high-bandwidth access networks and no longer traverse the entire IP network. This has the dual benefit of enabling long-term scale and lowering cost per bit for video transport. Because VoD content delivered by the service provider has a much shorter distance to travel compared to content from the OTT VoD cloud, service providers can also offer significantly higher service quality and performance than OTT offerings.

Service providers looking for a future-safe approach to delivering truly differentiated residential services need to consider the benefits of introducing enhanced capabilities such as high-touch processing to the common platform. High-touch processing enables extension of IPv4-based services, OTT monetization and new types of service bundles and service personalization for residential subscribers. The ability to distribute application monitoring and policy enforcement capabilities — right to the edge of the network — ensures the highest quality of service for residential customers. Along with the universal gateway capability described in the next section, this enhanced ability to truly monetize subscriber freedom is the value of the enhanced BNG (eBNG).

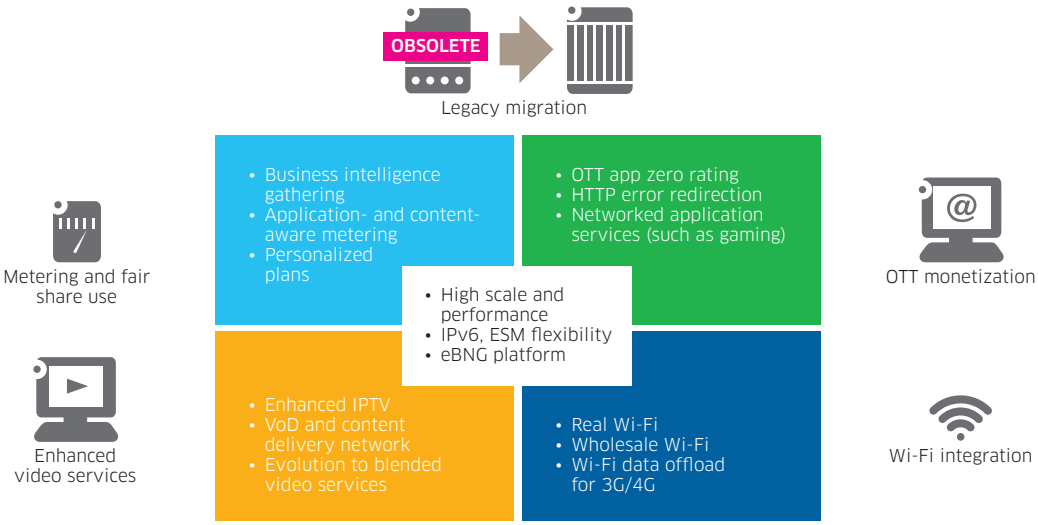
Universal gateway

An enhanced BNG has the ability to bring other services and access methods to the common platform. Service providers can integrate community Wi-Fi access to provide exciting new service bundles that enrich the residential subscriber experience. They can converge residential, business and mobile IP services on a single IP services edge platform to reduce total cost of ownership (TCO) and provide universal access to any content/application from any device, anywhere.

Service transformation: roadmap for success

With OTT VoD providers disrupting service provider business models and BRAS routers lacking the performance and scale to support cost-effective video delivery and flexible IPv6 migration, the time to begin broadband network transformation is now. Once they've deployed a high performance BNG at the IP edge of their residential network and moved towards a more distributed architecture for subscriber management, service providers can truly start to capitalize on new revenue opportunities in the video-dominated era of residential services (see Figure 7).

Figure 7. Flexible service transformation and new revenue opportunities



Service providers can start by monetizing OTT applications, enforcing fair-share access through personalized plans, offering Wi-Fi access or even enhancing existing video and application services: the starting point will vary with each service provider. For example, a service provider with existing linear TV services forming the bulk of their revenue may choose to begin with enriching their video services through an on-net content delivery network (CDN), while a service provider with no content experience may start by optimizing their HSI service with application-based metering to create personalized plans.

Because each service transformation journey is likely to take many twists and turns as subscriber needs, legislative constraints and even a service provider's financial position change, it is of paramount importance that service providers invest in a platform with the flexibility to accommodate change.

To assist providers in their service transformation journey, Alcatel-Lucent has integrated all the industry-leading capabilities of a high-performance BNG described in the previous sections and all the value-added enhancements required to generate new service revenue in the Alcatel-Lucent 7750 SR. Customers have the flexibility of installing a new 7750 SR chassis configured with this new functionality or upgrading deployed 7750 SRs and Alcatel-Lucent 7450 Ethernet Service Switches (ESSs). (The 7450 ESSs currently perform access aggregation or IPTV multicast delivery). The remainder of this paper discusses the new service capabilities — and the enhanced feature set that enables them — of the 7750 SR as outlined in Figure 7.

ALCATEL-LUCENT 7750 SR: PURPOSE-BUILT IP SERVICES PLATFORM

The first step in the residential service transformation outlined in the previous section is to replace the centralized BRAS architecture with a high-performance BNG to enable IPv6 migration, VoD (unicast traffic) scale and new service enablement. The Alcatel-Lucent 7750 SR addresses legacy platform issues by providing the features, performance and scale lacking in BRAS routers.

Industry-leading BNG capability

Alcatel-Lucent has a long track record as a key force shaping the direction of residential broadband networks. The BNG capability of the 7750 SR draws from this experience and expertise to lead the BNG market in flexibility, scale and robustness:

- A robust subscriber management implementation that converges legacy PPPoE access with IPoE to enable video and other new service capabilities
- Multivendor support for RADIUS authentication, with built-in DHCP-RADIUS proxy functions to leverage existing authentication infrastructure
- Flexible IP address management by DHCP relay or integrated DHCP servers
- PPPoE-based retail and wholesale support with Layer 2 Tunneling Protocol location area code support
- Support for time- and volume-based accounting with RADIUS- or Diameter-based credit control to support pre-paid and other new services
- Automated provisioning of logical access interfaces through a managed Services Access Point concept to minimize operational costs and reduce time-to-market
- 8 ingress and 8 egress queues per subscriber (using high-speed Media Dependent Adapter[HS-MDA]) to support multiple services or service personalization (through QoS per application)
- Flexible use of network infrastructure: can act as a BNG or an Ethernet Aggregation Node (EAN) simultaneously or extend subscriber management functionality across an access network through pseudo-wires
- Highest levels of BNG redundancy in the market to ensure a high-quality, always-on service experience (through Subscriber Router Redundancy Protocol, multi-chassis link aggregation, and pseudo-wires and VPLS link redundancy).

Industry-leading performance

Based on current subscriber trends, Tier 1 and Tier 2 central offices (COs) will require dozens of new 100GigE ports to handle unicast video growth over the next few years. To meet this demand, Alcatel-Lucent recently delivered their third-generation network processor (NP) for the Alcatel-Lucent 7750 SR, the FP3.

Supporting packet throughput of 400Gb/s, the FP3 provides the performance and high-bandwidth port density to accommodate this video surge. All features are supported at line rate so that network operators can create, monitor and control new feature-rich services without impacting performance. Feature continuity with previous FP generations enables FP3-enabled equipment to remain backwards-compatible while benefiting from the latest performance enhancements.

Enabled by FP technology, the 7750 SR has the bandwidth and feature processing scale to support service convergence and service blending, the benefits of which were described in the section Market Trends and Challenges. Hundreds of thousands of subscribers can be supported per chassis simultaneously to access multiple residential (VoD, HSI and IPTV) or business (Ethernet VPN, IP VPN and business Internet) services.

Distributed service intelligence

Distributed service intelligence on the 7750 SR is enabled by the Multi-Service Integrated Service Adapter (MS-ISA); (see Figure 8). The MS-ISA provides the embedded high-touch processing required to differentiate services, optimize network operations and enable long-term scale:

- Specialized service capability can be embedded anywhere it is needed in the 7750 SR network so that new services can be turned on quickly and efficiently.
- High-touch video software enables revenue-generating enhancements to video services, including fast channel change, enhanced video quality, monetization through ad insertion and VoD services. Long-term scale for VoD growth is enabled through support for integrated caching. These enhancements are discussed in more detail in the Enhanced Video Services section.
- Specialized DPI software allows service providers to lower operational costs and maximize service revenue through application-level intelligence for capacity planning, intelligent metering for managing subscriber bandwidth, carrier-grade NAT for flexible IPv6 migration capabilities and integrated security to protect both the network and subscribers.
- A high level of programmability ensures new high-touch feature development to enable new services as opportunities materialize.

Figure 8. Distributed service intelligence with the MS-ISA

Integrated Services Adapter

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VIDEO/CONTENT

- Industry's fastest channel change
- Retransmit on error for high QoE
- PerfectStream video conditioning
- Video-quality monitoring
- Content caching/delivery

APPLICATION ASSURANCE

- Application-to-subscriber monitoring and control
- Metering and fair-share usage
- Service personalization and consistency

eBNG EXTENSIONS

- Carrier-grade NAT
- Multiple tunneling and IPv6 migration capabilities

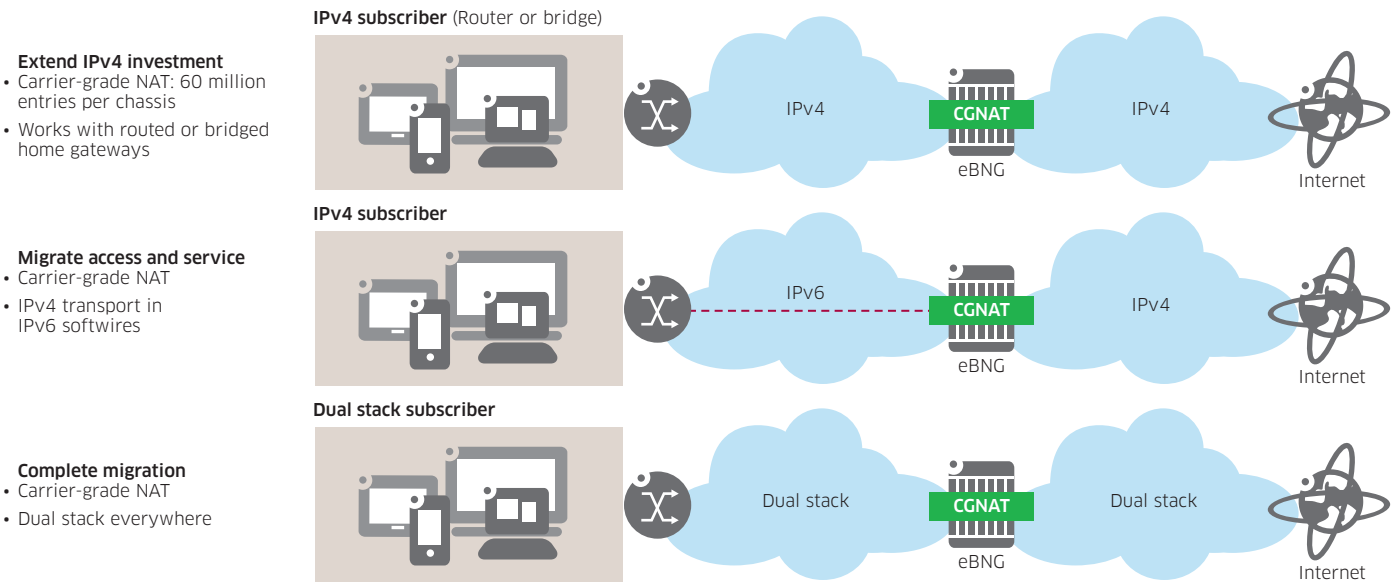
SECURITY SERVICES

- Distributed Denial of Service (DDoS) attack mitigation
- IPSec

Flexible IPv4 extension/IPv6 migration

The reality of IPv4 address exhaustion is hitting home as consumer electronics vendors churn out more and more IP-capable devices. The result is that service providers can no longer defer IPv6 migration strategies. With so much at stake as revenue-generating networks undergo IPv6 transition, one size definitely does not fit all. The 7750 SR provides service providers with the flexibility to extend IPv4 lifespan, migrate specific services or networks to IPv6, or dive right into a full-scale IPv4/IPv6 implementation (see Figure 9):

Figure 9. Flexible IPv6 migration



Extend use of IPv4 as long as possible

Adress overloading is avoided by embedding Carrier-Grade NAT (CG-NAT) capabilities in the network with the MS-ISA hardware. With over 60 million entries per chassis, the 7750 SR provides the most scalable integrated and carrier-grade NAT solution in the industry. Extensions such as Layer 2-aware NAT provide even more flexibility and operational savings by enabling IP-agnostic address translation.

Deploy dual stack in network only

The 7750 SR supports industry standards for softwires that tunnel subscriber IPv4 packets through the service provider's IPv6 network to an IPv4 Internet.

Adopt network-wide dual stack capability (Broadband Forum in WT-177 for IPoE and in WT-187 for PPPoE)

The 7750 SR supports wire-rate, dual-stack routing and large-scale, dual-stack subscriber management (256,000 subscribers per chassis) to support dual-stack transition.

METERING AND FAIR-SHARE USE

With a distributed architecture and a high performance BNG at the IP edge, service providers can start to capitalize on new revenue opportunities. One of the first areas of focus for most service providers will be metering and fair-share use.

As discussed in the section Market Trends and Challenges, consumers are dissatisfied with current attempts by service providers to limit OTT VoD consumption, and they feel HSI plans today are primarily designed solely to protect the service providers, not to benefit the subscriber. Current HSI plans are perceived as:

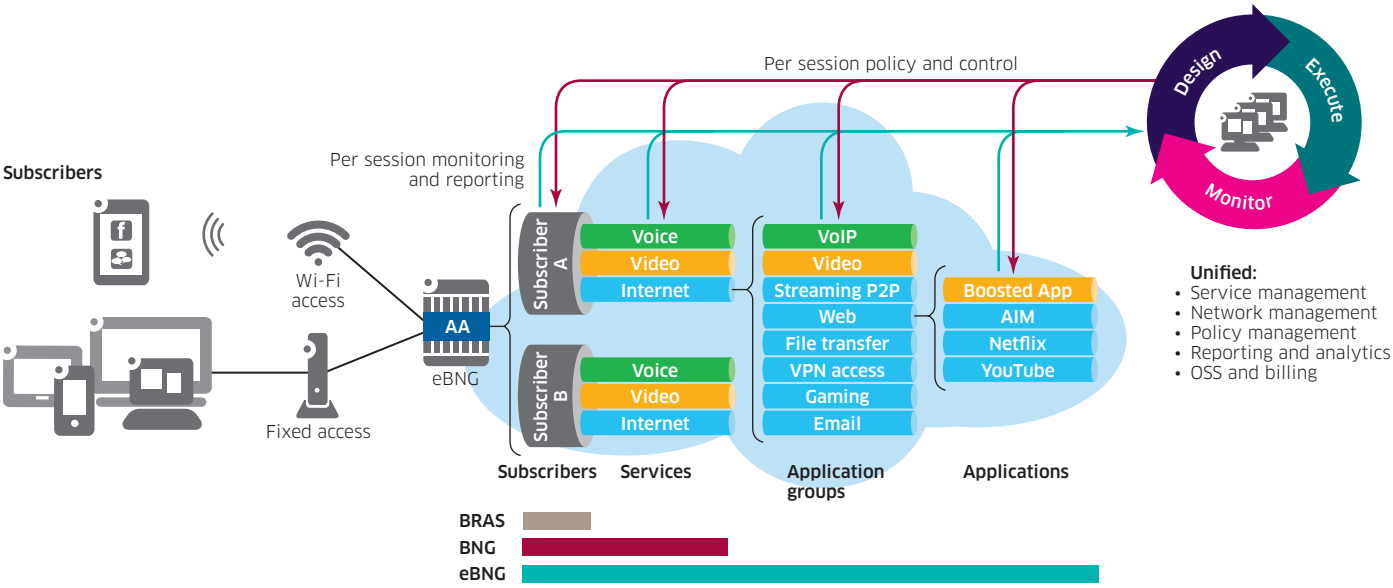
- Rigid: all or nothing, lacking personalization
- Confusing: subscriber guesses at data consumption rates, suffers bill shock
- Punitive: link down-speed, automatic fees
- Non-transparent

Service providers are faced with a dual challenge: dissatisfied customers and the inability to push their own applications with bandwidth caps in place. With the 7750 SR as their BNG, service providers attain a subscriber-friendly alternative to rigid use caps — personalized plans that let the subscriber make the trade-offs and get optimal value from their share of bandwidth.

Application assurance and subscriber-friendly plans

Personalized plans are enabled by the unique ability of the application assurance (AA) software on the MS-ISA module to fulfill each subscriber's application- and session-level needs. With AA, service providers can see into their network down to the application level and limit, boost and re-prioritize that traffic on a per-subscriber, per-session or per-application basis (see Figure 10).

Figure 10. Per subscriber/session/application monitoring and control



Before embarking on a personalized plan offering, service providers need to leverage AA and get detailed business intelligence on their subscribers and their subscribers' online habits. Service providers can get answers to the types of questions that follow.

Subscribers

Who are my top users?
What applications are they consuming?
How much bandwidth is required per application?
What is their usage profile per app?

Peering

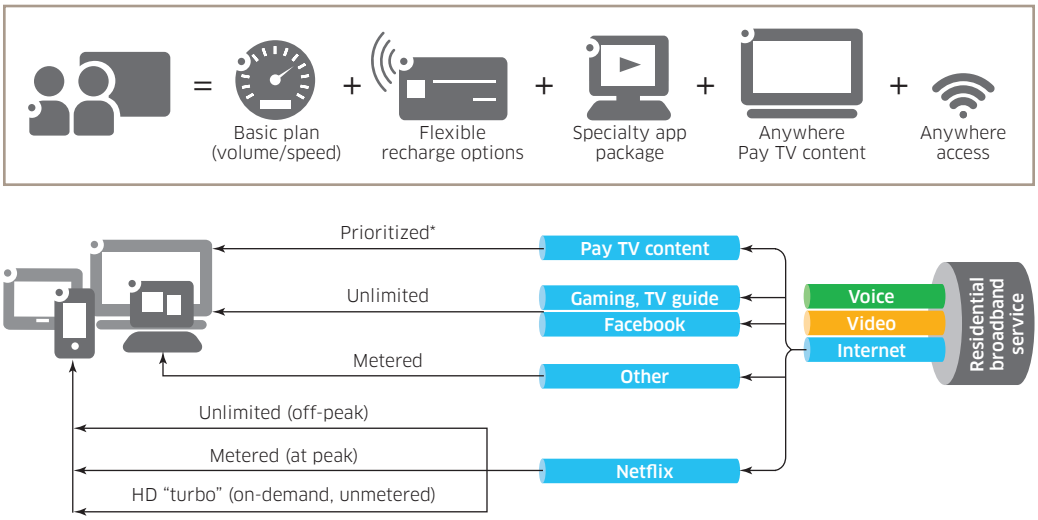
Which apps are flowing through my peering points?
How much bandwidth do they consume?
Who are the top users of peering bandwidth?

Network

How do applications flow in my network?
Which applications use the most bandwidth, when?
How do applications perform over time?
What percentage of traffic is OTT?

Armed with this information, service providers can begin offering personalized plans to ensure fair-share usage in a manner that satisfies each of their subscriber's unique needs. An example of a specialized plan is shown in Figure 11.

Figure 11. Fair-share use and subscriber freedom: personalized plans



Premium content is blended into the Internet service so that the subscriber can access it from any device in the home or through a community broadband link. The service provider offers this feature as an add-on to a basic metering plan. All content related traffic — including the content itself, the television guide and any related side-bar content — is identified by its application signature and is zero-rated (that is, not applied against the subscriber's cap).

Other selected applications, such as Facebook, are zero-rated for a nominal fee or provided as a promotional incentive. OTT video applications such as Netflix are identified by their application signature and are metered.

Add-on features, such as unlimited Netflix off-peak, volume Netflix packages on-peak or guaranteed high-quality boost for a period of time, are used to either minimize OTT traffic concurrency at peak times or to monetize the flows.

OTT MONETIZATION

In the previous section, the AA capability of the Alcatel-Lucent 7750 SR allowed popular OTT applications such as Facebook and Netflix to be monetized or used for promotional purposes through specialized metering, billing and QoS arrangements. This is only a first step in changing subscriber perception of the service provider as the provider of commodity bandwidth to a provider of value-added services.

Service providers can extend the concepts and 7750 SR tools used to achieve personalized plans to develop a whole range of new application services. Service providers can work with content providers, advertising providers, application providers and retailers to set up specialized monitoring and control of their applications and services in a way that adds value to subscribers. New revenue can be generated through revenue-sharing arrangements with OTT vendors.

Examples include increasing the QoE for specialty OTT online applications or monetizing HTTP error redirection. With specialty OTT applications, the BNG can be used to identify, zero-rate or apply special treatment to traffic flows as they traverse the IP network. Subscribers can enjoy the freedom of high-quality p2p video or gaming without the timing glitches that frustrate play today. In HTTP error redirection, AA can be used to identify and intercept erroneous page references in a URL issued by a subscriber. The reference is forwarded to an advertising partner — who provides an alternative suggestion for a fee — and is then forwarded to the subscriber.

LOCATION FREEDOM: WI-FI

Given their high level of portability, it is no surprise that 30 percent of tablet usage (for example, Apple® iPAD™) is now nomadic: it's done at shopping malls, stadiums, hotels, train stations and other congregation points. Customers with these portable computing devices are now looking to replicate the home experience — transparent access to all that their residential provider has to offer — outside the home.

For those with mobile subscriptions, the limited bandwidth of today's 3G data plans are far too punitive and restrictive to satisfy their needs, and there is no link to their residential services and content. While Wi-Fi hot-spots are popular alternatives, they come with many problems and limitations, including:

- **No simple access:** The customer needs to select access from a list of cryptic service set identifiers.
- **No QoS guarantees:** Performance is variable with video quality that is often unwatchable.
- **No strong security:** Lack of security opens up the device to security threats.
- **No service bundling:** Wi-Fi hotspots are an added expense for the customer and a missed opportunity for the service provider.
- **No unified billing:** This adds complexity for customer.
- **No "my service everywhere":** Wi-Fi is a not an extension of the residential experience.

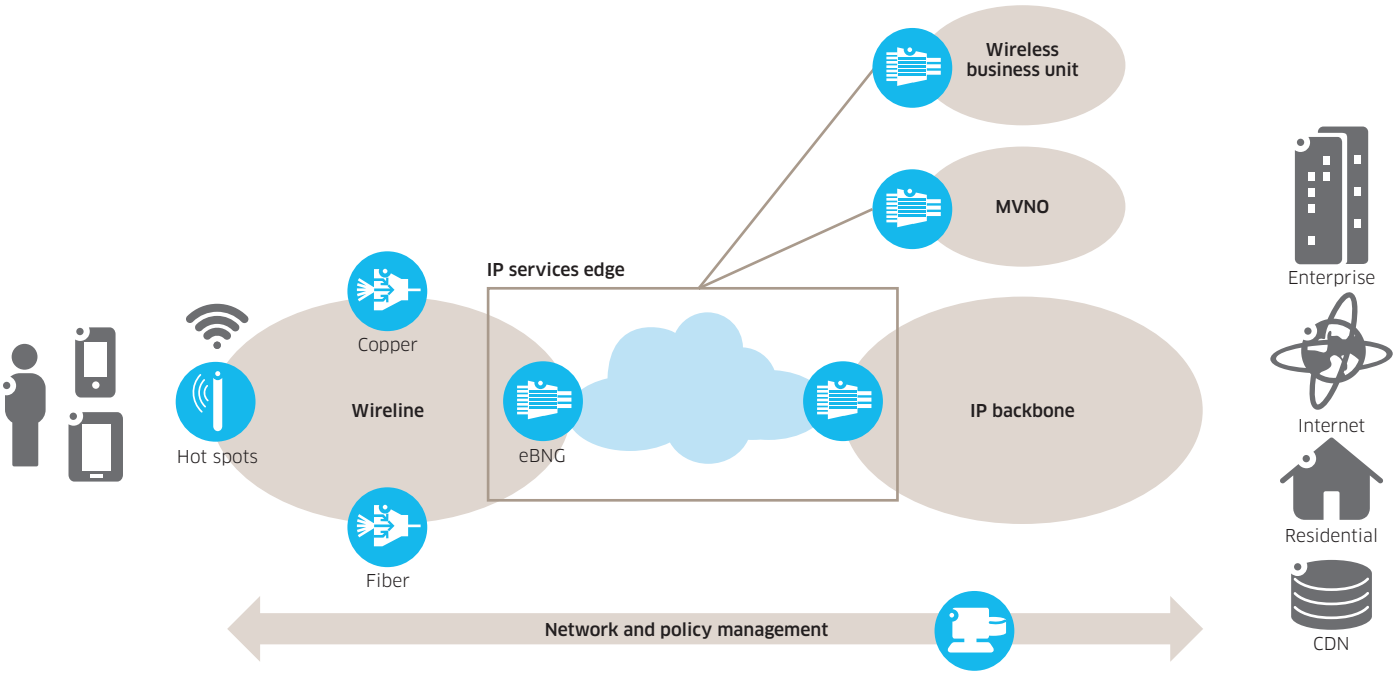
The WLAN capability on an Alcatel-Lucent 7750 SR allows residential broadband providers to bundle Wi-Fi access as a revenue-generating option to residential service plans. The WLAN gateway aggregates the Wi-Fi access points at Wi-Fi hotspots and transparently forwards their connection requests to all the residential and business services offered on the BNG.

Residential subscribers within range of their service provider's Wi-Fi hotspots can transparently connect to their service provider as if they were at home — simply, securely, with access to all their services and content and with a familiar QoE. Transparent Wi-Fi access allows residential broadband providers to offer subscribers freedom in the truest sense.

For service providers with both mobile and residential business units, the Wi-Fi access infrastructure and WLAN gateway on the 7750 SR can also be used to transparently hand off mobile data connections to the mobile data network. Mobile business units can realize significant reductions in radio network costs and operational complexity by transparently moving data connections off the radio network to the Wi-Fi aggregation network whenever a mobile handset is within range of a Wi-Fi hotspot. For the consumer, unlimited data access through Wi-Fi encourages usage off the radio network and breeds customer loyalty.

For service providers without a mobile business unit, excess capacity of the Wi-Fi aggregation network can also be sold wholesale to mobile virtual network operators and other mobile providers with a small radio footprint. The WLAN capabilities on the 7750 SR are summarized in Figure 12.

Figure 12. New retail and wholesale revenue opportunities with Wi-Fi



ENHANCED SERVICES

Enhanced IPTV

For many service providers, the first step in enhanced video services with enhanced BNG capabilities will start with IPTV. The Alcatel-Lucent 7750 SR supports multiple new features that allow service providers to monetize and increase the quality of the IPTV viewing experience:

- **PerfectStream video conditioning:** The BNG sends two copies of the IPTV stream and uses information from both to reconstruct a perfect stream with the highest possible quality in cases of data loss or corruption.
- **Industry's fastest channel change:** IPTV content is copied onto a running cache on the BNG and forwarded to the subscriber when the channel is changed. This ensures that the screen is not empty in the several seconds it may take to switch channels when using the latest video compression formats.
- **Retransmit on error for high QoE:** The information in the above cache is used to reconstruct the multicast stream in case of error. This process ensures high video stream integrity.
- **IGMP-based intelligence gathering:** Requests for video content are redirected and stored to augment business intelligence. This allows service providers to better monetize and tailor their services and advertising campaigns to subscribers.

- **IGMP redirect with QoS adjust:** Specific requests for video content can be redirected to provide higher levels of service and increased QoS for higher-end subscribers.
- **Multiscreen IPTV:** Providers can leverage the BNG to deliver their IPTV content through multicast to the big-screen TV (through the set-top box) and through unicast to any other device (through a home router). While this does not address unicast scale issues, it is an excellent transitional step for service providers looking to provide device freedom for their subscribers as they plan their CDN strategy.

Providers with IPTV services can leverage these 7750 SR features to continue generating revenue and enhancing their offerings while preparing for a blended video experience that brings in VoD and Internet content.

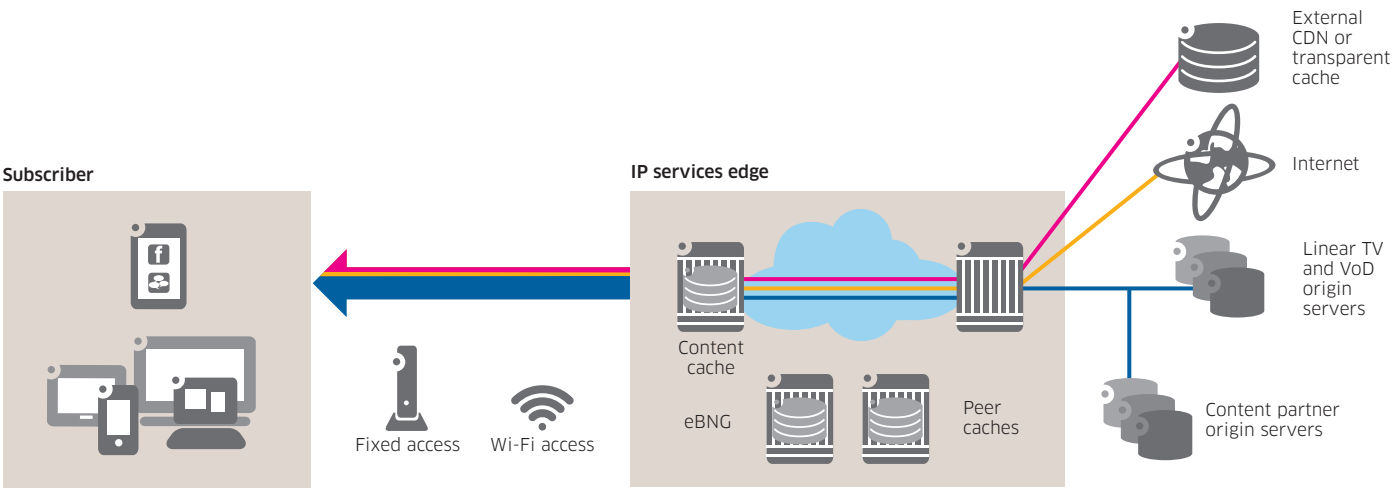
Evolving video services and CDNs

While linear TV will continue to grow in the foreseeable future, subscribers are flocking to an on-demand (VoD) consumption model in greater numbers. Because VoD content is delivered separately to each user, it cannot benefit from the efficiencies of multicasting, pushing the bandwidth requirements at centralized BRAS/video home office (VHO) sites to dozens of 100GigE ports by 2015. Service providers are faced with the dual challenge of how to accommodate the unicast bandwidth onslaught and how to deliver a unified service that blends in IPTV and OTT VoD experiences and content.

A distributed architecture (see Figure 13) with a high-performance BNG accomplishes this in two ways:

- It provides the massive scale and performance necessary to accommodate VoD bandwidth and enable IPTV/VoD convergence (see Alcatel-Lucent 7750 SR section).
- It allows Velocix CDN caching to be deployed at the edge of the network to optimize VoD delivery and eliminate QoS issues.

Figure 13. Video service fusion and optimized VoD delivery with distributed caching



The introduction of a CDN moves the video streaming origin point — and associated bandwidth load — from centralized video servers to distributed caches in BNGs located in Tier 1 and Tier 2 COs. The decision of what content to cache is based on dynamic demand, with stale content flushed as demand popularity declines over time. The

distributed caches with the BNG are cost-optimized for delivery of popular content while caches deeper in the network are cost-optimized to support a deep content library of less frequently watched content for a large audience.

Studies show that a distributed caching model based on a Velocix CDN results in a 70-90 percent bandwidth reduction between centralized video storage and distributed caches during peak times. And because the content travels a shorter distance to the subscriber, the QoE is far beyond anything an OTT provider can provide through their Internet-based streaming servers.

Even though a distributed architecture greatly reduces the burden on the streaming origin points, traffic at Tier-1 and Tier-2 COs is still expected to consume dozens of 100GigE ports as these routers are tasked with pushing the content to individual subscribers through the residential access network. 100GigE+ with features is far beyond the capacity of many BNG routers in the marketplace today but well within the range of an FP3-based Alcatel-Lucent 7750 SR.

The CDN delivery model can be used in a complementary role to the IPTV delivery infrastructure to support both live broadcast and on-demand content requirements while meeting user expectations for quality, availability and reliability. Service providers can enhance their linear IPTV service with broader content choices and evolve the traditional IPTV experience to an on-demand TV model as viewing habits evolve. Content can be acquired by extending private content peering arrangements with a broad range of content providers or through content federations.

CONCLUSION

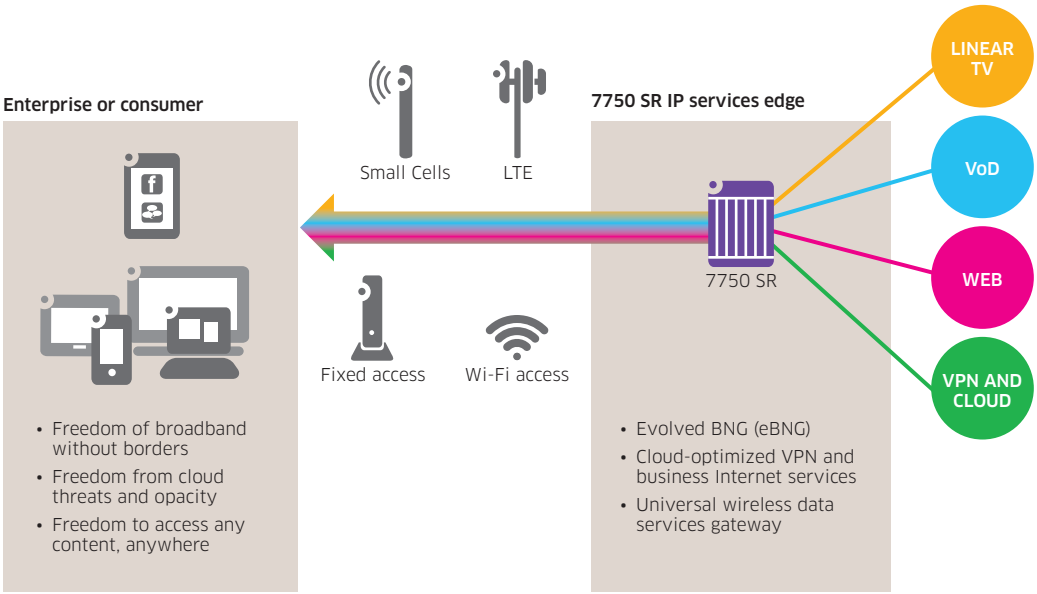
To best meet subscriber demands for a broadband experience without boundaries while achieving long-term network scale, service providers require a distributed residential network and a new high-performance BNG. The Alcatel-Lucent 7750 SR is uniquely qualified for this role by combining high-performance and industry-leading subscriber management with a range of enhanced capabilities that allow service providers to truly monetize subscriber freedom:

- **Industry-leading enhanced subscriber management:** Resolves BRAS obsolescence issues with the industry's most flexible, feature rich and robust subscriber management platform.
- **Massive scale and performance:** Delivers the sustained high throughput required to support VoD growth and a converged residential IP edge that enables service blending flexibility and lower network TCO.
- **Distributed service intelligence:** Enhanced BNG capabilities based on integrated high-touch processing enable long-term scale and lower cost per bit for video transport, a higher-quality and personalized experience for subscribers, and the ability to quickly leverage new service opportunities.
- **Universal gateway:** A truly unified Service Routing Operating System (SROS) enables the 7750 SR to bring in additional services and service access networks to a BNG platform. This opens up additional opportunities for service providers to monetize subscriber freedom through retail or wholesale Wi-Fi access or to reap the benefits of convergence through a unified IP services edge for residential, business and wireless services (see Figure 14).

Billions of dollars in revenue and the service providers' position in the services value

chain at stake. With today's centralized BRAS infrastructures requiring a major upgrade to resolve end-of-life issues and accommodate IPv6 migration, the time to migrate to the 7750 SR is now.

Figure 14. Extending freedom, service uniformity, simplified operations and platform re-use across residential, mobile and business customers.



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