OTT SERVICES AND INTELLIGENT NETWORK SELECTION

EXPERIENCE CONTINUITY differentiates OTT services with the right network policy

birdstep TECHNOLOGY

White Paper Contents

KEYWORDS:

Offload

OTT

analytics

mobile data

Wi-Fi

User Experience

Intelligent Network Selection

1 Executive Summary

SUMMARY OF THE SUMMARY OR THE FIVE EXPRESSIONS TO TAKE AWAY FROM THIS WHITE PAPER: USER BEHAVIOUR; POLICY; INTELLIGENT NETWORK SELECTION; OTT; EXPERIENCE CONTINUITY.

Understanding real user behaviour enables operators to establish network, device and content policies for Intelligent Network Selection. This will be a key differentiator among emerging OTT services, where Birdstep believes EXPERIENCE CONTINUITY will be vital.

Network operators have been moving "higher up the stack" into value added services for over a decade. Such upward mobility may not always be successful but is imperative in order to stay competitive. This White Paper addresses how Mobile Data Offloading, at first sight a technical feature of the service, is becoming a pivotal part of network policy and will therefore play a crucial role in that upward mobility story, but only so long as it is based on intelligent data analytics. We shall see that seamlessly switching both ways between cellular and Wi-Fi networks is a key enabler for user EXPERIENCE CONTINUITY, which in turn will deliver the holy grail of service differentiation.

This drive towards added value is leading to convergence of interests and strategies between the various parties in the content value chain, including network operators, content providers, broadcasters and pay TV operators. While Telcos are looking towards content-based services, content providers themselves are increasingly going direct to consumers Over The Top (OTT) of existing pay TV operators. The TV operators themselves are also reaching beyond their own broadcast networks to go OTT using the network operators' infrastructure. As OTT services use other operators' networks, they are largely "unmanaged networks" from the service provider's point of view and are therefore not very good at guaranteeing optimal EXPERIENCE CONTINUITY.

During this convergence of interests network operators must make their infrastructures more intelligent, while content stakeholders must differentiate beyond the content itself. This convergence is focused around a better user experience where offload and on-load can make all the difference. In the short term Wi-Fi offload will be particularly important.

Wi-Fi offload can obviously occur not just within an operator's own footprint of Hotspots and residential Wi-Fi but also within global Wi-Fi networks.

1 Executive Summary

A PARTNER'S VIEW:

"Boingo's global Wi-Fi network can be a boon to carriers who want to leverage unlicensed wireless to supplement their core networks. Birdstep's ability to overlay a complex policy control engine to that network adds an important component to help those carriers manage offload based on complex business rules. Both components are needed for successful Wi-Fi offload."

HOWARD BUZICK, VICE-PRESIDENT,
BUSINESS DEVELOPMENT, BOINGO WIRELESS, INC.

Network operators have been moving "higher up the stack" into value added services for over a decade. Such upward mobility may not always be successful but is imperative in order to stay competitive. This White Paper addresses how Mobile Data Offloading, at first sight a technical feature of the service, is becoming a pivotal part of network policy and will therefore play a crucial role in that upward mobility story, but only so long as it is based on intelligent data analytics. We shall see that seamlessly switching both ways between cellular and Wi-Fi networks is a key enabler for user EXPERIENCE CONTINUITY, which in turn will deliver the holy grail of service differentiation.

The objective of this White Paper is to make all these concepts accessible to a non-technical audience, while explaining the business rationale so that more technical readers will also find food for thought and maybe even a call to action.

1.1 INTRODUCTION AND HOW WE GOT HERE

Telecommunications networks took many decades to grow. National incumbents operated them within protected environments until recently. But it is now clear that operators large and small have an imperative to adapt, innovate and change because they must now compete for clients and subscribers who are all too often just a button-press away from the competition.

Telecom markets have become just like any other in being ruled by traditional economic cycles. Ever since the dawn of capitalism, new ideas come along, followed hopefully by capital investment, to turn them into something saleable. The objective is then to enjoy a period where that innovation commands a premium bringing the return on investment. The emergence of competition is then inevitable and followed by a commoditization phase, where only price differentiates competitors. Finally consolidation into a smaller number of suppliers can lead the market to another short period of stability before the cycle renews.

From the operators' perspective, this White Paper, about Intelligent Network Selection and OTT, concerns their survival in the last two steps of the cycle.

2 Who this paper is for

This paper addresses the communications infrastructure of network operators, be they Telcos or new entrants. But as we explore what it means to provide a seamless user experience across different network types, we'll also look at the increasingly content based services that the infrastructure supports and that users care about. Those are services that subscribers want to continue consuming with as little hassle as possible while they're on the move. This White paper is also for and about OTT TV and other service operators in the content value chain.

2.1 THE MEANING OF OTT

The expression "Over The Top" dates from the First World War, when it was a reference to soldiers having to go over the top of the trench walls. The definition of OTT used in this white paper dates back to about 2007, when the first iPhone became a success. It is the delivery of services across network resources provided by a third party. Skype or YouTube were early examples and today the never-ending commercial success of Netflix is showing that this is more than a flash in the pan. There are now almost 40 million clients choosing to pay about 100$ a year to subscribe to that service.

Network providers like Telcos are looking for ways to offer services to their competitors' clients, as in the case of French Telco SFR's Home security package available to any broadband subscriber. In the same vein IPTV operators are providing content apps that run on connected TVs and so work not just on their own networks, but also their competitors'. Anyone familiar with the Telco space will appreciate the significance of this, but for others it must be stressed that network operators have traditionally supported just those services that exclusively ran on their own networks. A fundamental change is happening here.

Content operators, like pay TV providers, are moving to OTT models but with even greater conviction. Content originally broadcast with DVB technologies over satellite, cable or terrestrial networks is now also made available to apps in consumer devices that only have IP connectivity. Noteworthy examples include satellite operator BSkyB's Sky Go, cable operator Comcast's Xfinity Streampix and French Digital Terrestrial operator TDF's catch-up TV service Salto.

There are two distinct strands of OTT, Inbound and Outbound. Inbound OTT allows subscribers to access an external service provided by third parties with or without the operator's blessing. Indeed operators are often still sitting on the fence here as on the one hand they all want to give access to a YouTube service targeting User Generated Content (UGC) like funny cat videos, but they want to block it when users watch HD versions of pirated content.

2 Who this paper is for

Outbound OTT is the more recent phenomenon where content and service providers alike are engaged in a race to make their own offering available as widely as possible, beyond the reach of their traditional distribution network. The technologies used for Outbound OTT, originating mainly from the web, also give greater reach to operators' services within subscribers' homes. So for example when a TV operator develops a mobile app to offer its live and on-demand content say on a tablet over Wi-Fi, subscribers not only get to use the service on the move, but also in their gardens, or parts of the home where there is no TV.

2.2 THE BREADTH OF OTT OFFERINGS AND UX DIFFERENTIATION

When it started five years ago OTT was simply free IP telephony from a Telco perspective and YouTube from a content operator perspective. But now it has evolved into a wide range of offerings for both kinds of operator. Video is a central part of any OTT offering and because of the new unmanaged networks that are used, Quality of Experience, or EXPERIENCE CONTINUITY, has become a key differentiator.

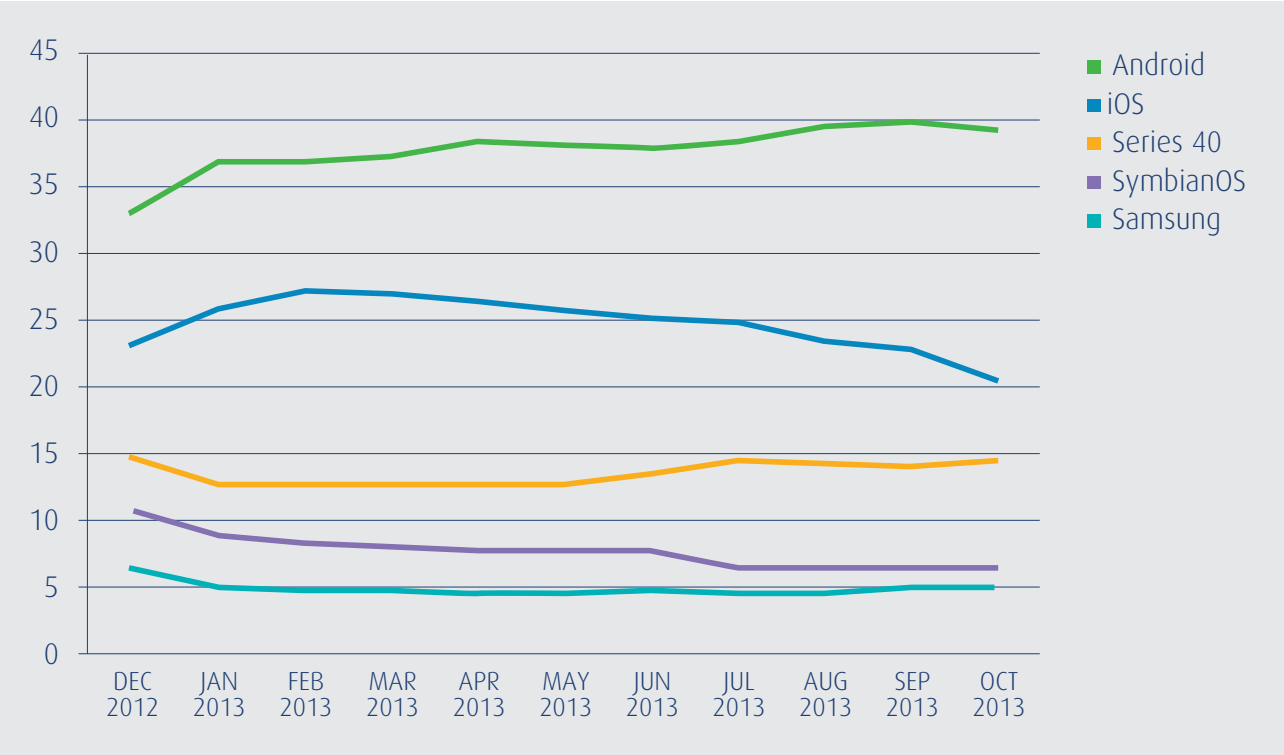
Emerging Carrier Wi-Fi is enabling heterogeneous networks (HetNet) to offer such EXPERIENCE CONTINUITY and presenting real opportunities for operators to differentiate beyond merely offering more bandwidth or lower latency.

Section 3.3 summarizes how this can be done through the application of network policy to "right-load" onto either Wi-Fi/broadband or 3G/4G/LTE, to enable the best EXPERIENCE CONTINUITY.

Geographical, temporal and technical constraints must be met using network and device policy and Smart Data Analytics to provide the real-time information needed.

3 Technological issues to be addressed

When 3G networks were first rolled out barely a decade ago, they remained largely empty of traffic. Data proliferation only really started to stress cellular operators' backhaul infrastructures, as well as causing congestion at the radio access level, when smartphones became accessible to a significant proportion of operators' subscriber bases. The iPhone and iOS may have started the smart phone revolution back in 2007, but lower cost Android devices are probably responsible for its massive success. Mobile bandwidth shortage is actually quite a recent phenomenon.



The expansion of Wi-Fi both in public hotspots and from residential gateways has led Wi-Fi Offload to become the incredible opportunity it is today.

Any operator seeking to deliver content OTT is now at least considering use of Content Delivery Networks (CDNs). Global CDN providers like Akamai or Level 3 may offer good overall solutions for global distribution, but when it comes to the last mile delivery other stakeholders come into play. CDN selectors will choose a specific CDN route on a per session basis depending on location, time of day and pricing options. CDN (con) federations are another solution that has not yet really taken-off, involving different CDNs cooperating for more efficient end-to-end content delivery. But in all these cases, the last "10 meters", where Wi-Fi offload fits in, still needs to be addressed for many mobile devices.

3 Technological issues to be addressed

Most devices need some specific connection management software for Intelligent Network Selection. As discussed below, policies are used to decide where and when offloading from cellular to Wi-Fi should happen and vice versa and these need to dovetail with the device connection management.

Access Network Discovery and Selection Function (ANDSF) is an evolving 3GPP standard that enables the implementation of policy-based decisions on devices. ANDSF is designed to interact with the core network's Policy Charging and Rules Function (PCRF), which is where policies are traditionally managed in mobile networks.

Hotspot 2.0 is also often part of the offload debate. The two key building blocks required for Hotspot 2.0 to have an impact are EAP-SIM and 802.11u.

The Extensible Authentication Protocol for Subscriber Identity Module (EAP-SIM) authentication has actually been around for some 10 years with GSMA hosting the first round of tests in 2004. EAP-SIM has not yet been widely deployed but does appear at last to be getting off the ground.

By contrast 802.11u network discovery & selection is a technology that is only just now reaching handsets and access points. 802.11u is an amendment of the core IEEE 802.11 Wi-Fi standard dating back to 1997. Implementing this protocol typically requires a forklift upgrade of hotspot infrastructure and therefore it will be quite some time before we see any widespread adoption. Also, some of the main problems addressed by 802.11u can be solved by other simpler means like provisioning clients with the hotspot SSID that forms part of a service.

3 Technological issues to be addressed

3.1 THE VARIETY OF USE CASES

The technical solutions operators deploy must be very flexible as the use cases are already varied and in constant flux.

3.1.1 LOOKING ONLY AT VIDEO USE CASES:

- Delivering the HD on-demand video streaming that underlies subscription VoD offerings like those from Netflix, which are still growing in almost all markets around the world,
- Anticipating and delivering massive file downloads (e.g. several GB for a major OS upgrade or a movie),
- Delivering live High-Definition TV video streaming with sporting events being a key driver, as we will again see at the 2014 football world cup and 2016 Olympics in Brazil,
- Providing low-latency access to many smaller objects (e.g. serve data the smart HTML5 way filling up a web page one screen at a time, as it is scrolled through, as say with the results of a Google image search),
- Enforcing content delivery policy with rules as to how and when content is delivered to users,
- Retaining the ability to differentiate the user experience. Indeed services must be tiered, as some users will want to accept lower quality from time to time in exchange for lower subscription rates, while premium access must be made available to certain segments.

But less data-hungry use cases than video may be critical for an operator's competiveness in other business situations. For example health-care professionals may need to maintain a secure data connection while providing remote care within a wide geographic area. Operators can in turn help businesses be more competitive by providing better EXPERIENCE CONTINUITY to their workers.

3.2 REAL-TIME USER ANALYTICS

For content or network operators to offer the best EXPERIENCE CONTINUITY, decisions must often be made in real time or near real time (seconds rather than hours or days). There is still a lot of hype around the concept of Big Data and its promise to manage and obtain value from large volumes of data, but at least some of those promises are already within reach. The older field of Operational Intelligence defines a lot of the real time raw data that can be gathered and turned into intelligence or useful information. This includes monitoring of multiple technical metrics such as network latency, but also their user-centric equivalents like start-up time.

Analyzing the trends of a given metric is an obvious way of adding meaning to the data, but the real value-add comes from correlation between data from different sources and the ability to cross reference this with business rules. So for example if some subscribers are experiencing bandwidth issues for a given service whilst others in the same locations have plentiful bandwidth, the fault probably lies with the service itself, not the network. Note that if congestion can be identified in real time, analysis taking some days is usually required before a definitive diagnosis can be given. Indeed, for Intelligent Network Selection to take place comfortably in real-time, careful planning is required and integration with the operator's NOC team.

3 Technological issues to be addressed

In the example above we see the importance of both understanding where network congestion is occurring and how to measure offload efficiency/QoE in these areas. In congested cells, correct dynamic network selection is significantly more efficient than when similar offload/network selection is applied in non-congested cells. Early deployments have already shown that this difference in effectiveness of dynamic network selection between congested and non-congested cells is at least 10%.

Analysis of data from live deployments of Birdstep's EXPERIENCE CONTINUITY solution in different markets has shown that 15% to 25% of all Wi-Fi within the operator's footprint comes from the EasySmart client. In sheer volume this is equivalent to 40-50% of the cellular traffic since Wi-Fi is more heavily used than cellular for data-heavy services like video streaming.

But the whole point of any user experience policy must be to improve how services are experienced in the difficult cases.

When users are in non-congested cells, Birdstep has measured that the effective offload to Wi-Fi typically represents 15-20% of traffic. But in congested cells the offload ratio climbs to 20-25%.

3.3 HETNET POLICIES

Network operators want to maximize return on investment just like any other business and so a core objective is to manage resources in an optimal fashion. This paper focuses on how interests on this count are converging between content and network operators.

Content operators need their content to be viewed so as to maximize revenue generated, without raising carriage costs too high. In some cases scarcity can grow demand, but in other cases fighting piracy might require immediate availability everywhere. We will explore in section 3.4 how such tensions and contradictory drivers can be resolved.

From the network operator perspective, optimizing use and reuse of existing infrastructure is paramount. From a financial perspective, the billions required in capital investment may take many years to amortize.

Setting up and evolving a set of rules to achieve these goals usually relies on managing resources with a set of policies.

3 Technological issues to be addressed

3.3.1 TO PROPERLY DEFINE THESE RULES OR POLICY, WE WILL USE FIVE OTHER TERMS, SO LET'S DEFINE THEM FIRST:

- **Flow** is the path taken by IP data packets within a network, as it moves from its source to a data repository or a data user,
- **Bearer** is the source-to-destination connection in the network that transports the Flow,
- A **device** is simply a piece of equipment used to source or consume the flow,
- The **subscriber** is the end-client who actually consumes the service provided,
- Network **resources** are all the different technical components that make up a network.

With this in mind, policy can be defined as a set of rules associated with a flow, a bearer, a device or a subscriber, which defines how resources are allocated to that flow, bearer, device or subscriber.

Policies can be used to manage many operational aspects including network resources, device resources or content delivery. When Wi-Fi is used as just another network, we are clearly in the domain of heterogeneous networks or HetNets.

The aim of these HetNet environments is to create an extremely high-capacity network that strives to use the best access bearer technology for the particular subscriber, device or flow.

As HetNets bring increased complexity and costs, a key challenge for operators lies in deploying the necessary network intelligence to seamlessly integrate access technologies for optimal device network selection. Birdstep calls this Always Best Connected.

Users are generally only concerned with the quality of experience they receive and not the underlying access technology; i.e. cellular or Wi-Fi. The goal for operators is to manage the device connectivity transparently and seamlessly as the user roams across a HetNet environment consisting of cellular and Wi-Fi access technologies with differing characteristics and levels of congestion. Achieving a consistent user experience is enshrined in Birdstep's new two-word motto of EXPERIENCE CONTINUITY. The company's Always Best Connected technology is enabled through EasySmart Client software and an ANDSF server. To enable a wide and easy adoption across devices, the client software has been kept to the smallest footprint possible. As soon as a sufficient number of devices have been enabled with the software, service providers can apply the server-side ANDSF solutions to deliver a complete EXPERIENCE CONTINUITY solution. They can then monetize their HetNet by offering differentiated services based on network and subscriber information obtained through near real-time analytics.

The best granularity of control over a device's network selection decisions across a HetNet environment can change over time. Operators will define policies and improve them over time to determine when, where and under what conditions a device will move between cellular and Wi-Fi. These decisions take into account a wide variety of contextual information used for network selection decisions, including access technology awareness, time, location, network congestion, and individual subscriber information.

For all these reasons, and because we are just at the beginning of the new user centric paradigm, HetNet operators need a flexible solution to make them agile enough to win the EXPERIENCE CONTINUITY battles ahead.

3 Technological issues to be addressed

3.4 CONTENT DELIVERY POLICIES

Keeping a user session open as traffic flow is routed from one network infrastructure to another requires detailed policies. A balance must be reached between the interests of the three parties that are the end user, the network operator and the service provider / content owner. The end-user cares above all about having a seamless experience, the network operator must manage costs while offering the best possible network conditions and the service provider or content owner combines all of these requirements being equally concerned about costs, EXPERIENCE CONTINUITY and differentiating their service.

3.4.1 AS WITH CDN INTEROPERABILITY, DIFFERENT KINDS OF POLICY MUST BE ENFORCED. THESE TYPICALLY INCLUDE:

- geographical constraints linked to rights availability or pricing within different markets and territories where rights-holders wish to differentiate so as to maximize revenues or discourage piracy,
- temporal constraints where content must be made available for only a limited period due to rights windows. As interoperability develops we expect temporal policies to be able to handle very short windows so as to incentivize usage during off-peak hours,
- technical constraints (e.g. high definition vs. standard definition Images or Apple's HLS streaming vs. Microsoft's Smooth Streaming)

It becomes critical to manage these policies when different network infrastructures are to be used, since they must all be coordinated. All these constraints should ideally be managed by the service operator at a high enough level to avoid creating the frustration of displaying content in a catalogue and then having to notify the user that they are not eligible to buy it or that it is only available in a format they are not interested in.

It is unclear to what extent content policies are currently changing to adapt to the influence of digital content and delinearization. When digital networks were first used to distribute content, the new systems mimicked traditional broadcast distribution. But the music industry went through a watershed a decade ago with the simultaneous emergence of the ubiquitous MP3 audio format and peer-to-peer file sharing. iTunes, Deezer or Spotify today represent completely new music distribution models.

The OTT business models mentioned in this White Paper are part of the TV industry's response to a similar threat. A likely short-term outcome is that box-office hits will be made as widely available as possible. Indeed the incentive to pirate them is high. Long-tail content may however be distributed with more sophisticated policies. However the lack of clarity until now means that any technical solutions put in place must above all be agile and allow for quick and easy change of content distribution policies.

4 The User eXperience takes centre stage

The gradual shift that has brought users/customers/subscribers to the center concerns domains well beyond the TMT (Technology, Media and Telecommunications) markets. For example the marketers of mass consumer goods like chocolate bars or soft drinks are using technology to enter one-to-one relationships with consumers as they flash a unique code on a product wrapping. This is an example of Internet technology giving a huge acceleration to a phenomenon that has been happening for at least half a century.

Henry Ford's remark about the 1909 T model that "any customer can have a car painted any color that he wants so long as it is black" must be one of the most heavily used quotes in business presentations. But as our societies and economies evolved throughout the 20th century, the relationship between suppliers and consumers has been changing. In the second half of the century Customer Care Management (CRM) came about as corporations realized they needed to be more attentive and cater better for consumers in order to sell more products or services. Among the last to join this movement were the big incumbent Telcos whose awakening to competition was often brutal so that they passed through this transition much more quickly than say automobile manufacturers.

But if having a finely tuned CRM program was the objective at the end of the last century, the 21st has started at least as the century of Customer Managed Relationships. Customers expect individual care. If they don't get it, the Internet and (de)regulation mean that an alternative provider is little further than a mouse-click or button-press away.

The whole approach to content delivery must be (re)evaluated in this new world where users are no longer passive recipients of services but active stake holders in the subscriber/service provider relationship. In this light, the ease of logging in and out of networks while on the move will be an important differentiator.

A key part of the battle is to shift away from a network centric model that measured Quality of Service (QoS), usually expressed with technical parameters like network jitter or packet loss. Indeed the sum total of the quality metrics used for different parts of the OTT delivery chain does not equate to the quality that the user experiences. It is therefore impossible to manage EXPERIENCE CONTINUITY effectively by simply collecting and aggregating different QoS data.

The new focus on the consumer requires measurement of success based on parameters that are actually perceivable to the subscriber. Quality of Experience (QoE) measurement captures aspects such as service availability or video image quality. Video quality is often quantified using a standardized scoring system called Mean Opinion Score (MOS). Quality monitoring vendors now supply devices than can automatically measure this at different locations in a network. But in the context of Wi-Fi offload, the most important part of the experience is its continuity. Having to re-enter network credentials in the middle of a video chat is not acceptable. Even on the move, the user's experience must be as seamless as possible.

4 The User eXperience takes centre stage

The marketing promise of "any device" on "any network" at "any time", "any where" requires tools to build the next generation of services. The "network-centric" world where resources were controlled and planned-for centrally, is shifting to a "user-centric" view where things must be re-configured on the fly to maximize EXPERIENCE CONTINUITY.

In the cut-throat world of OTT competition, the only data that really counts in the end is the user's quality of experience.

After all the hype about Big Data, we are beginning to see the first real changes coming from its use as we start to merge the understanding of user experience, user behavior and business rules and policies.

4.1 IT ALL STARTED WITH SIP

SIP, Session Initiation Protocol, is an application layer control protocol. It represented a breakthrough by allowing a user session to be extended across different networks. It enabled the "iPhone-era", which started only half a decade ago, ushering in the mobile Internet with OTT Voice over IP and then video.

Over a decade earlier, SIP had been developed as a signaling protocol for Internet Telephony. Its role was to establish a session within which the user could perform a specific set of interactions including making a phone call. But SIP sessions can also be used for other real time applications like videoconferencing, gaming or any other Web based service. SIP Servers support many features including personal mobility, time-of-day routing and call forwarding, based on the geographical location of the person being called.

4.2 SINGLE SIGN-ON, A PRECURSOR TO EXPERIENCE CONTINUITY

Single sign-on dates back to the early days of the public Internet, almost 20 years ago. When the first truly interactive services appeared, taking the Web experience beyond static web pages, users needed to log on. But users had to log-on separately with different passwords to the various services, such as the ISP portal, the photo sharing service, or the chat server. The same was true within the enterprise where employees had to store multiple credentials for the various internal Intranet services. With the concept of single sign-on, user EXPERIENCE CONTINUITY became possible as the notion of sessions was extended beyond web-based phone calls.

4.3 THE LINK WITH OTT

The operator's perspective is changing as offload evolves from just being about getting data off scarce spectrum and backhaul onto the broadband infrastructure, to playing a pivotal role in delivering the User eXperience (UX), underpinning mobility as a whole. Offload itself will eventually become commoditized in the sense of being an integral part of mobile traffic management, with the differentiation now coming from its intelligent application to EXPERIENCE CONTINUITY. This has become a focal point of differentiation, driven largely by growing consumption of premium OTT services.

5 The business case for policy based Intelligent Network Selection

New pay TV business cases have to address the issue of deploying technical infrastructure, usually costing millions of dollars, while also building a revenue model often based on subscription. When subscriber projections can sustain a massive investment, it turns out that in the good old days of set top boxes, 70% of Capex would be consumed by that very device in people's homes. Now users increasingly have their own devices such as tablets or smartphones to consume content on the move. This change is rippling through the industry and creating opportunities. Not only can content producers go direct to the consumer, cutting out some of the stakeholders, but they can also do so at a diminishing cost.

Mobile Data Offloading came about as a solution to help ease the burden of cellular networks. But once in place the seamless hand-over and authentication work just as well for Wi-Fi-only devices.

This huge opportunity is being seized as we see in cases like the recent announcement by HP and Birdstep about their latest Android and Windows devices that will come out-of-the-box with preloaded software to enable automatic hotspot authentication.

Offload is often considered just as a way of lowering costs. While this is still an important motive in many cases, offload can have an even greater economic impact by delivering the best possible EXPERIENCE CONTINUITY. This is achieved by taking account of factors more relevant to the customer, such as the status of their battery or the quality of the service they are consuming, and not just by blindly offloading data to relieve congestion on the mobile infrastructure. Indeed offloading must not be applied systematically and requires carefully planned business rules and policies. It is in this sense that we can speak of the Offloading of old being commoditized and the new challenge being Intelligent Network Selection.

For example, several cases may be considered for a subscriber that is viewing video over a 3G/4G cellular network while on the move. If the cellular network is congested and the newly discovered Wi-Fi network is not, then offloading should probably occur in all cases.

If however neither network is congested, then an operator may wish for offloading to Wi-Fi to only occur in the case of say free YouTube video sessions that don't generate any revenue, keeping all premium services on the cellular network, where quality may be guaranteed.

There may be cases where the cellular network has limitations over individual connection bandwidth and the available Wi-Fi network has spare capacity. In such a case, if the premium service is say a pay TV video and at the same time the user's device is a tablet with a high resolution screen, the best possible service may be delivered by offloading the streaming session to Wi-Fi. Then the video can be viewed at the highest possible resolution. If however the device is already streaming at full resolution on the cellular network, it may be preferable not to offload that streaming session at that time.

So the business rules and network policies will be varied and depend on many factors, but will always shape the User Experience through intelligent real time "right-load". The rules and the policy must be focused primarily on the user's cOntinuity of eXperience, for otherwise switching back and forth between networks serves no real business purpose.

Although cost reduction is an important driver for Mobile Data Offload, it is dangerous, or at least counterproductive, to pursue capex or opex savings, or even monetization, as primary goals at the expense of the user experience. In the end, if users aren't satisfied they'll go elsewhere and nothing will be left to monetize or reduce cost for.

Best-effort is no longer good enough. Services must be capable of segmentation into different categories. Some users may want to accept lower quality from time to time in exchange for reduced subscription rates. But operators must be able to offer premium services to certain customer segments. These might be the high ARPU clients willing to pay a premium, or clients that have threatened to leave. There is also a marketing incentive, as marketers gain more flexibility and love nothing more than segmenting their offers into highly targeted packages. In many cases there will also be a resource limitation driving this, as there just isn't enough bandwidth for everybody to stream everything all the time at top quality.

EXPERIENCE CONTINUITY will always be a key factor. A subscriber may not at first understand that sometimes the quality has to be reduced, but if this is in a managed situation where the operator can explain what is happening, then a relationship of trust can be retained.

Having better control over quality of service delivered to end-users can put an operator in a stronger position to negotiate exclusive content rights. Rights holders will be delighted at the prospect of segmenting the offer so that a given piece of content can be sold in multiple packages at different qualities.

5.1.1 WHAT THE EXPERTS SAY ON THE BOTTOM LINE:

"Our research shows that Wi-Fi is the most significant variant in the cellular equation, but it's a difficult nettle to grasp. MNOs may have to relinquish their iron-like grip on operational control in order to get the best financial outcome here. If they are prepared to work with companies like Birdstep who can take policy responsibility for the quality of a connection, then MNOs don't have to give up an inch on Quality of Experience. Those who can take a leap of faith will get an order of magnitude step change in their Capex requirements, and that will fall straight to the bottom line."

PETER WHITE, CEO AND PRINCIPAL ANALYST AT FAULTLINE
(WWW.RETHINKRESEARCH.BIZ)

6 Wrapping up

If you've got this far, first of all thank you. You will be aware of the meaning of OTT and the importance of harnessing user experience for service differentiation. Hopefully some of the technical issues will be clearer and we will have convinced you that EXPERIENCE CONTINUITY is the key that can enable the business cases of policy-based Intelligent Network Selection.

It is our contention that most stakeholders involved in mobile and fixed online services have or will rapidly come to understand the central position of EXPERIENCE CONTINUITY for the competitiveness of their offerings.

But with HD gaining ground in the mobile market and 4K or Ultra-HD already on the horizon for fixed networks, bandwidth restrictions will be with us for the foreseeable future. Services cannot simply be provided anymore through the Internet's traditional best effort approach, but will need to be delivered at the right level of quality in a consistent manner, which is what Birdstep calls EXPERIENCE CONTINUITY. For this to happen, network infrastructure providers will need to work hand-in-hand with service providers and understanding real user behavior will be their first collaborative effort. Only then can the right policies be defined for truly Intelligent Network Selection to ensure real EXPERIENCE CONTINUITY.

6.1.1 CLOSING QUOTE:

With Over The Top (OTT) services becoming commoditized and the increasing resistance from subscribers to commit to multi-year, binding contracts, a critical way operators can reduce churn is by delivering a continuously connected experience. It must be effortless for customers to connect to what is important to them, removing the expense and complexity of connectivity, regardless of the underlying network technology.

> "A consistent continuity experience is made possible with the growing adoption of intelligent Wi-Fi offload which includes sophisticated policy creation and enforcement of business rules on the device. In addition, Big Data is moving from hype to reality through actionable analytics in network usage patterns, which enables truly intelligent network selection".
>
> ADRIAN SMITH,
> CELLULAR TECHNOLOGY EXPERT, ADVISOR TO HP, PARTNER AT IGNITION PARTNERS

7 Annexes

7.1 EXAMPLE OF A NETWORK POLICY MANAGEMENT TOOL

The fields on Juniper's Contrail Controller

FIELD	DESCRIPTION
Network Name	Enter a name for the policy you are creating.
Associate Networks	Click this field to select from a list of available networks the networks to be associated with this policy. Click one network at a time to one or more networks in the field. The selected networks are listed in the field. To remove any selected network, click the X to the right of the network.
Policy Rules	Use this area to define the rules for the policy you are creating. Click the + (plus sign) to open up the fields for defining the rules. Each field is described in the following rows.
Action	Define the action to take with traffic that matches the current rule. Select from a list: Pass, Deny.
Protocol	Define the protocol associated with traffic for this policy rule. Select from a list of available protocols (or ANY): ANY, TCP, UDP, ICMP.
Source Network	Select the source network for traffic associated with this policy rule. Choose ANY or select from a list of all sources available displayed in the drop-down, in the form: domain-name:project-name:network-name.
Source Ports	Use this field to specify that traffic from particular source port(s) are associated with this policy rule. Identify traffic from any port or enter a specific port, a list of ports separated with commas, or a range of ports in the form nnnn-nnnnn.
Direction	Define the direction of traffic to match the rule, for example, to traffic moving in and out, or only to traffic moving in one direction. Select from a list: <>(bidirectional), > (unidirectional).
Destination Network	Select the destination network for traffic to match this rule. Choose ANY or select from a list of all destinations available displayed in the drop-down, in the form: domain-name:project-name:network-name.
Destination Ports	Define the destination port for traffic to match tis rule. Enter any for any destination port, or enter a specific port, a list of ports separated with commas, or a range of ports in the form nnnn-nnnnn.
Apply Service	Check the box to open a field where you can select from a list of available services the services that you want to apply to this policy. The services will be applied in the order in which they are selected. For more information about services; see Service Chaining.
Mirror to	Check the box to open a field where you can select from the list of configured services the services that you want to mirror in this policy. You can select a maximum of two services to mirror. For more information about mirroring; see Configuring Traffic Analyzers and Packet Capture for Mirroring.