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Motivation for Quality Verified Broadband Services

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Executive Summary

Hitherto, Broadband products and networks have been characterized predominantly by their speed. Speed has been used as a proxy metric for the "goodness" of a broadband connection. Speed is easily understood by consumers and has underpinned broadband product development and marketing for two decades. It has also spawned a whole industry of speed-test web sites and competitor benchmarking activities (by service providers, regulators [1] and independent measurement companies) using speed probes.

The Broadband Forum has been instrumental in driving the Broadband industry to improve speeds. It has successfully nurtured successive generations of broadband technology from embryonic systems through to mass deployment spanning ADSL, VDSL, G.fast, GPON and a range of other technologies. This has resulted in increasingly widespread availability of Gigabit broadband connections which underpin the "Gigabit Society".

In the early days of broadband development, increasing speed (such as from 1 Mbit/s to 10 Mbit/s) made a noticeable difference to application performance such as faster web-page load time or the ability to support an HD video channel. In today's Gigabit broadband era, we are now experiencing diminishing returns in terms of the ability of further speed increases to materially improve an application's performance. Speed is necessary, but it is not sufficient. The time has come to consider the quality of broadband (and not just its quantity). This will become increasingly important to a new generation of applications like Cloud-based gaming and holographic communication. The focus on quality is necessary to take the utility of today's Gigabit broadband connections to the next level.

This document describes the motivation for the Broadband Forum work on quality-based broadband delivery enshrined by the term QED – Quality Experience Delivered. Specifically, it focusses on a measurement and analysis framework known as Quality Attenuation. Quality Attenuation enables a high fidelity analysis and understanding of network performance. Consequently, Quality Attenuation can identify where to optimally focus resources in the design and operation of a network in order to improve customer experience.

1 Introduction and Broadband Business Model

As of 2019 we are living in the Gigabit broadband era, with customers in many countries now able to purchase Gigabit broadband services. However, we are reaching a point of diminishing returns in terms of access connection speed. In the early days of broadband, connectivity was primarily based on ADSL technology and access speeds were typically in the 0.5 to 8 Mbit/s range. Hence, increasing a customer's broadband connection speed by 10 Mbit/s made a noticeable difference. Their browsing experience improved and they could then, for example, simultaneously access more than one concurrent HD video stream. However, in the Gigabit era, adding another 10 Mbit/s (or even 1000 Mbit/s) to a customer's Gigabit broadband access connection is unlikely to result in any perceptible improvement for the majority of their applications (and hence may be considered of limited incremental value). As a result, service providers are increasingly looking beyond just speed and turning their attention to "quality broadband". However, if you cannot measure and manage quality, you can only differentiate on quantity. This needs to change; it is time to think smarter, not just bigger.

Historically, the broadband business has been based on the "bandwidth model" as summarized below. Service Providers invest in network bandwidth to increase broadband speeds, the end-user uses a speed test as a proxy for measuring how good their broadband is and they assume that a higher speed measurement equates to better application outcomes. In turn, this influences their customer experience and hence metrics like NPS (Net Promoter Score) and their consequent propensity to churn or maintain (or even increase) their purchasing from the Service Provider.
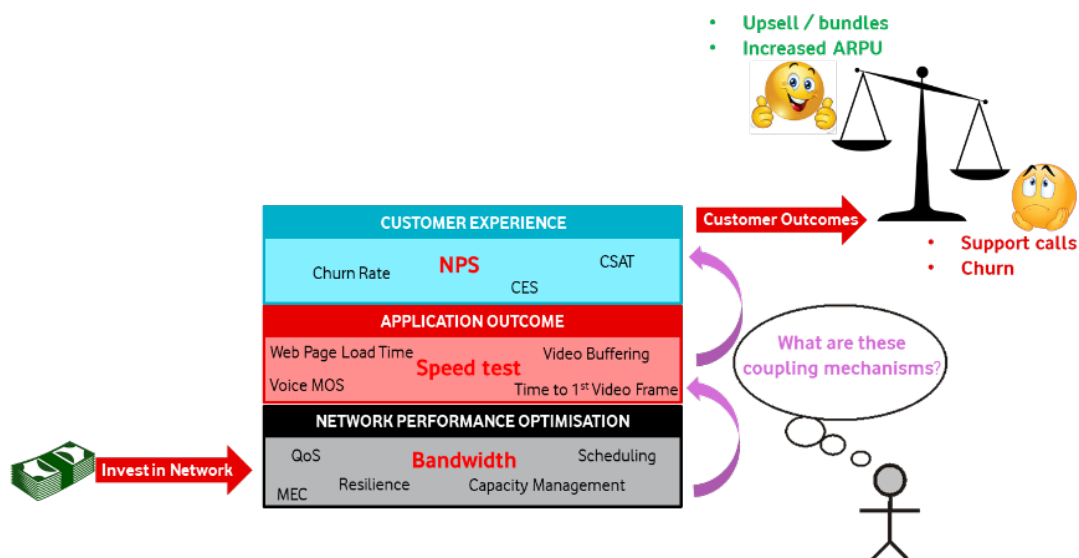

Figure 1: Bandwidth-based Broadband Business Model

The problem with this "bandwidth model" of broadband is that the coupling mechanisms between access bandwidth, application outcome and resulting customer experience are becoming weaker[1] in the Gigabit era. Investing increasing amounts of capital in network bandwidth when customers won't appreciate the difference (and hence won't value or pay for the incremental speed) is not a sustainable business.

Bandwidth (or speed) has historically been easy to market; "mine is faster than yours so it must be better". The "quality" of broadband is currently less tangible. It is not a simple scalar metric since it has multiple facets: reliability, stability, consistency and predictability (or, mathematically speaking, stationarity) to name but a few. At the network layer, the common attribute of all broadband access technologies is that they

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[1] "Bandwidth is important although not enough to reduce subscriber churn", Julie Kunstler, Ovum, BBF BASE event October 2018 (based on Ovum survey)

convey the customer's application data via IP packets. An IP packet traversing a broadband network will get delayed, and it may get dropped. The statistical distribution of this "attenuation" of quality (compared to a perfect scenario of zero loss and zero delay) is what determines how well a customer's applications will perform and hence the customer experience. So, being able to measure, analyze and model this quality attenuation is critical to moving the broadband industry forward and beyond the simplistic (and unsustainable) bandwidth model. Indeed, "insufficient bandwidth" really means: "At the offered load, the resulting packet loss/delay exceeds the acceptable performance bounds of the user's application".

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2 QED and Quality Attenuation

The Broadband Forum instigated an initiative called Quality Experience Delivered (or QED). This project has studied the approach known as Quality Attenuation (or ΔQ, pronounced "Delta Q"). ΔQ provides a mathematically robust performance measurement and analysis technique that integrates both packet loss and packet delay instead of treating them separately. It enables the quality attenuation (e.g. between application client and server) to be deconstructed into packet loss plus three separate latency components in each direction, hence six latency metrics in total instead of a simplistic Round Trip Time (RTT). This approach enables each component to be analyzed independently since they are mathematically composable (unlike averaged ping measurements). The components are:

- Geographic delay (G), including transmission time impacted by geographic distance and the speed of light
- Serialization delay (S), the time to clock packets in and out of equipment
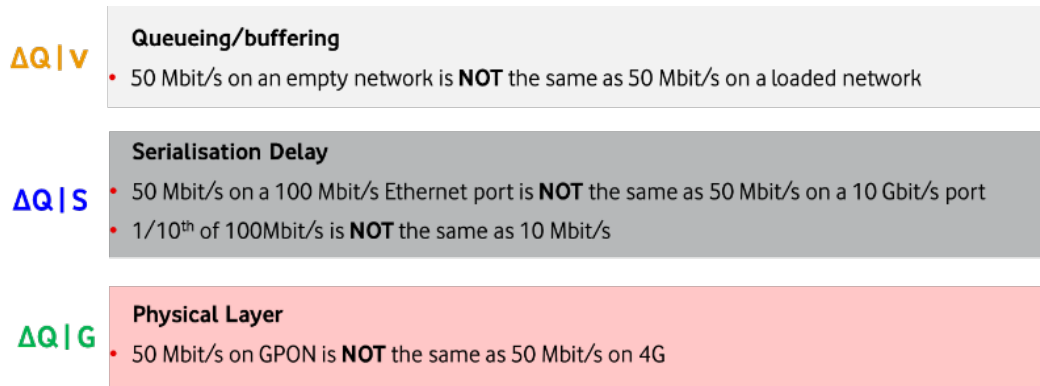- Variable delay (V), due to scheduling and buffering (this is where most packet loss occurs)

Figure 2: Not All Bandwidth is Created Equal

ΔQ encompasses the statistical distribution of these parameters which provides a powerful tool for architecting and trouble-shooting broadband networks in order to optimize their performance. This addresses the naivety inherent in the bandwidth model of broadband, which assumes that bandwidth is a fungible commodity.
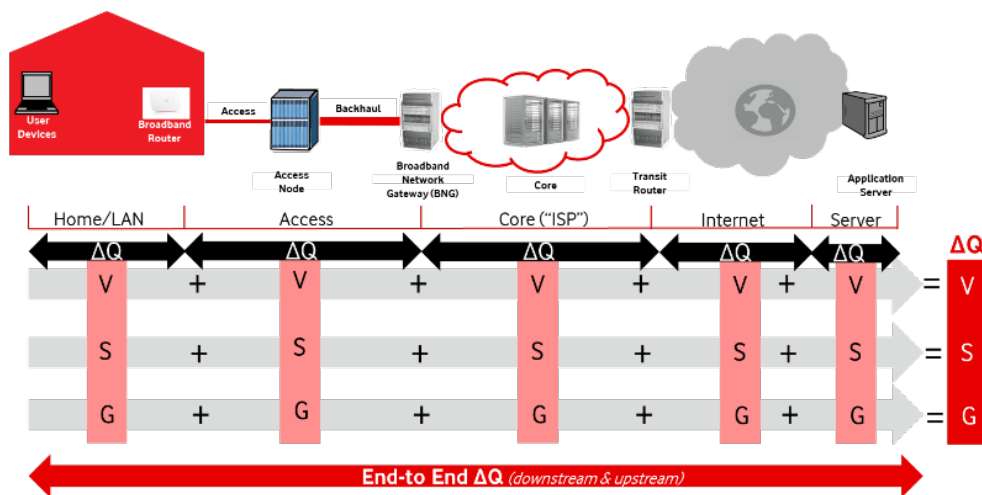

Figure 3: Quality Attenuation in the end-to-end Broadband Digital Supply Chain

The Broadband Forum's QED initiative covers the theory, mathematics and measurement technique required for using ΔQ analysis. It also explores various use-cases such as architecture optimization, equipment selection, network health checks, root cause analysis, lab emulation, performance KPIs and wholesale/enterprise SLAs. It explains the link to application outcome Quality of Experience (QoE) and provides numerous example results spanning a range of broadband access technologies (and WiFi). Finally, the QED initiative explores "frictionless" deployment approaches of ΔQ measurement capabilities such as using existing protocols like TWAMP or using virtual probes.

3 Conclusion

In conclusion, 'bandwidth' is an increasingly weak proxy for the application outcomes that customers value. While fast speed test results are nice, what customers actually want is for all their applications to work consistently well; such as video streams without glitches or buffering, fast web page load times etc. Future applications like interactive holograms[2] using lightfield technology will increasingly make it apparent that bandwidth is necessary but not sufficient (hence speed tests are also of diminishing value in the Gigabit era). Understanding quality can help us better link network investment to application outcomes and customer experience/satisfaction. Quality Attenuation will enable the broadband industry to move beyond the increasingly unsustainable bandwidth model (where perfection is considered to be 'infinite' bandwidth) towards a new quality-centric paradigm where perfection is zero defects (packet loss and delay). It is a lot easier for broadband engineers to measure how close we are to zero than to infinity!

We need to re-think the broadband business model from "never enough" (bandwidth) to "always sufficient" (quality). Instead of focusing exclusively on how to make broadband networks faster we need to think more about how we engineer them to be "invisible" so that for example the customer doesn't notice that there is a network between their application client and its server.

A Quality Broadband approach can lead to more cost-effective networks and more efficient use of capital (vital to both private companies building broadband networks and also to those responsible for leveraging public broadband subsidies). Why increase the speed of a network beyond the point at which it produces any noticeable benefit to a user's application outcome? In the Gigabit era, improving quality can have greater impact on user experience (and hence the utility of our broadband networks).

There will undoubtedly be marketing challenges in making the shift from bandwidth to quality [2]. For example, what terminology do we use to explain "better quality" to customers if we are selling quality of bandwidth instead of just quantity of bandwidth? The Broadband Forum's QED initiative gives us the tools and techniques to start addressing the engineering aspects of the move to quality broadband as we embark on this critical transformation.

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[2] https://mediacentre.vodafone.co.uk/news/vodafone-makes-uks-first-holographic-call-using-5g/

4 Terminology

4.1 References

The following references are of relevance to this Marketing Report. At the time of publication, the editions indicated were valid. All references are subject to revision; users of this Marketing Report are therefore encouraged to investigate the possibility of applying the most recent edition of the references listed below.

A list of currently valid Broadband Forum Technical Reports is published at www.broadband-forum.org.

Document	Title	Source	Year
[1]	*UK fixed-line broadband performance*	Ofcom	2011
[2]	*Gigabit broadband: Is it speed for speed's sake?*	Ovum (Michael Philpott)	2016

4.2 Abbreviations

This Marketing Report uses the following abbreviations:

ADSL	Asymmetric Digital Subscriber Line
GPON	Gigabit Passive Optical Network
HD	High Definition
MD	Marketing Draft
MR	Marketing Report
QED	Quality Experience Delivered
VDSL	Very-high speed Digital Subscriber Line
WA	Work Area

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