The Technetix One Touch Network™

White paper

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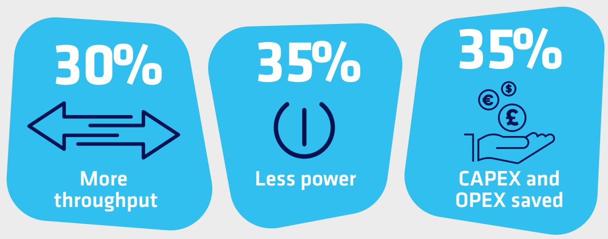
THE ONE TOUCH NETWORK

EXECUTIVE SUMMARY

In today's competitive market, DOCSIS 4.0 and 1.8 GHz spectrum expansions are two of the best tools available for operators to extend the lifetime of their existing HFC networks. This is while knowing that consumption and speed requirements will also continue to increase in the future. Since the rate of the growth is the biggest unknown, operators are considering their options between 1.2 GHz high split and 1.8 GHz DOCSIS 4.0.



Although traditional approaches to spectrum expansion and outside plant upgrades are being considered, there are some drawbacks that must be examined. These include heavy upfront capital and operational investments, increased power draw in the outside plant, reduction in signal quality and capacity and most importantly, multiple disruptions to customers throughout the upgrade process.

At Technetix, a revolutionary range of amplifiers named One Touch has been developed to transmit downstream and upstream signals without the need for diplex filters or echo cancellation. This means One Touch amplifiers can be operated at any frequency split with no guard band between upstream and downstream. This ecosystem will also allow operators to maintain legacy set-top box out-of-band carriers throughout future spectrum upgrades.

One Touch amplifiers will drop into existing amplifier locations without respacing the plant. This is while also ensuring that the upstream and downstream signals are transmitted at the highest quality, so operators can achieve the best orders of modulation and throughput in the network. Furthermore, the amplifiers position operators for future 3 GHz deployments.

By deploying Technetix One Touch amplifiers, operators will typically be able to achieve 30% more throughput, save 35% power in 1.8 GHz deployments and reduce the overall cost of amplifier upgrades by 35%.

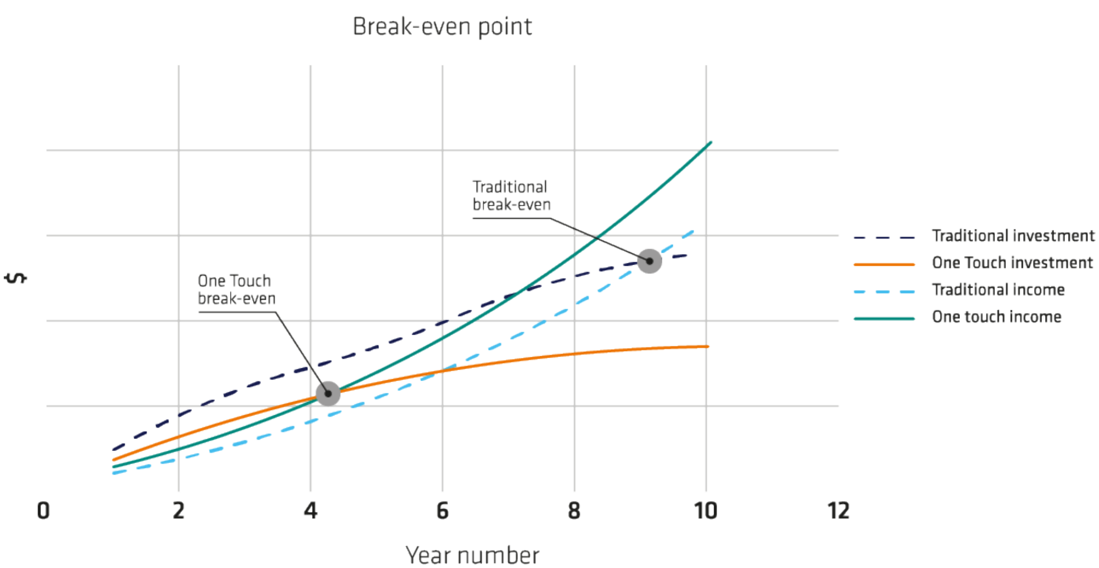


Figure 1_One Touch summary

REVISITING THE SAME LOCATIONS

One of the most expensive parts of an upgrade is the 'windshield time' for technicians to get to and from locations. Traditional amplifiers must be revisited numerous times to reach their end-state (ultra-high-split with 1.8 GHz downstream) due to the following limitations:

- Housing bandwidth
- Amplifier module bandwidth
- Amplifier tuning (pads and EQs) setup

With labor shortages in the skilled labor force, this is proving more difficult and will cause more disruption as a part of the multi-step upgrade.

One Touch amplifiers overcome these challenges through its innovative diplexer-free design. These amplifiers can be deployed now, operating at high-split 1.2 GHz in the downstream, while having the full range capability of ultra-high-split and 1.8 GHz in the downstream and anything in between. This is all while never having to revisit the amplifier location after deployment, due to the self-tuning capabilities of the One Touch range.

The path forward and the breakpoints mentioned above can be schematically summarized in Figure 2 below:

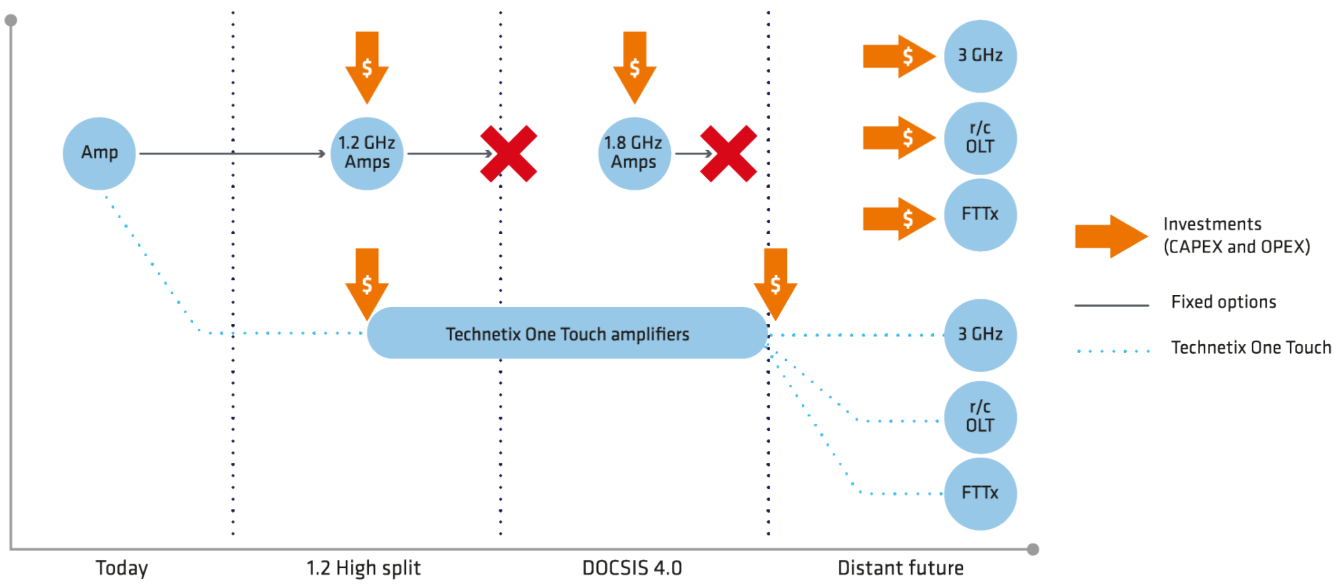


Figure 2_Future upgrade paths

Note that the One Touch ecosystem also positions the operator for future 3 GHz or any other outside plant evolution with minimal investment, when compared with traditional approaches, which require a full rebuild.

COST BENEFIT ANALYSIS

Knowing that traditional amplifier locations must be visited at least twice to enable ultra-high-split upstream and 1.8 GHz downstream, a cost model can be created to analyze the cost savings when using One Touch amplifiers. Figure 3 schematically shows multiple trucks for the traditional amplifier installation and alignment when compared to a single roll-out for One Touch amplifiers:

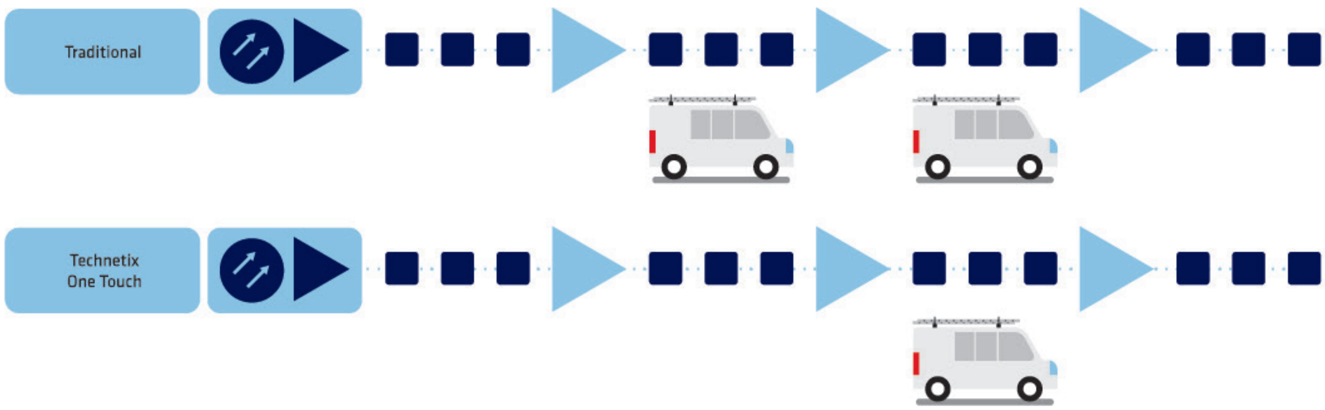


Figure 3_ Traditional truck rolls vs One Touch

As demonstrated, the One Touch ecosystem will require a booster in certain instances. Based on the numerous histograms received from our industry partners, we project boosters are needed ~20-25% of the time.

For the purpose of the cost model and to ensure we also consider the worst-case scenarios in the outside plant, we have considered scenarios where at least 50% of boosters are used in the outside plant.

Considering parameters such as the number of boosters along with truck roll costs and net present value discount rate uncertainties, a simulation can be performed to assess whether a One Touch system will be more cost effective in comparison to traditional approaches. The simulation results are shown in Figure 4:

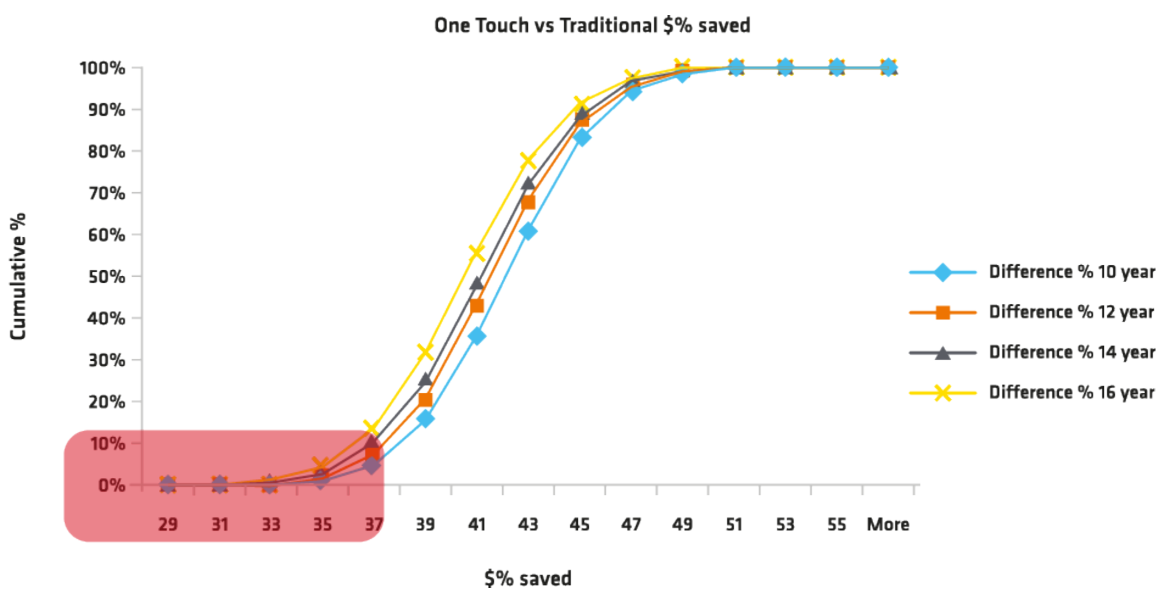


Figure 4_Cost savings analysis results

The red box above highlights the worst-case scenarios in the simulation, where a much higher than anticipated number of boosters are used, in combination with the cheapest rates for truck rolls and discount rates.

Figure 4 demonstrates that the shorter the time frame of the investment, the higher the benefits, although not substantially, as demonstrated in the "Difference % 10 Year" vs "Difference % 16 Year" curves. Since operators' net present value analyses are more often within 8-10 years, we can conclude that on average, a One Touch upgrade will cost 40% less than traditional amplifiers. In worst-case scenarios (highlighted above), the savings are still in the 35% range.

With cost benefit analysis in mind, we now examine the diplexer-free concepts and plant performance modelling.

DNN CONCEPT AND PRINCIPLE OF OPERATION

To prevent a bi-directional amplifier from oscillating, the up- and downstream path of that amplifier needs to be highly isolated. If the isolation is too low, some of the output signal from the upstream can leak into the downstream amplifier which can then leak back through to the upstream amplifier. This phenomenon is known as oscillation.

In traditional approaches, the up- and downstream path of an amplifier are isolated by diplex filters. This is technically a good solution but unfortunately not very flexible, as it cannot accommodate any future split changes, nor very spectrum efficient since diplexers have a significant crossover area.

In this new concept the high isolation is achieved by using innovative high isolation couplers instead of traditional diplex filters. Since the couplers are wideband, this amplifier will not suffer from the loss of flexibility or low spectrum efficiency (since there is no crossover area). It is a truly wideband, bi-directional amplifier.

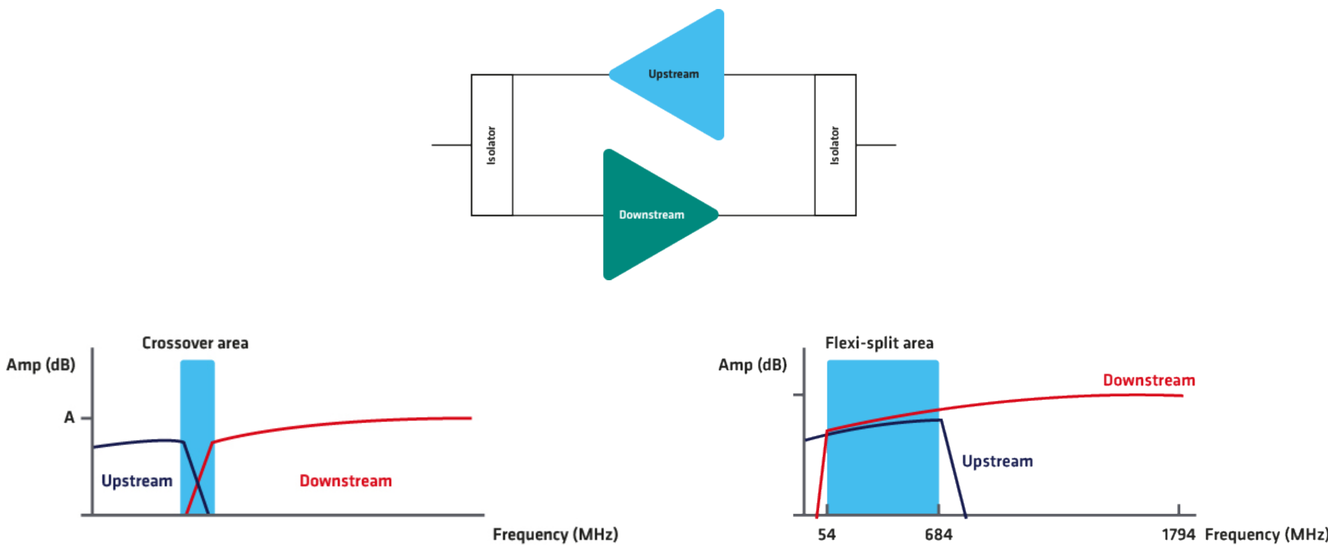


Figure 5_– Direction Neutral Amplification

This results in an amplifier with an upstream frequency range between 5 MHz to 684 MHz and, simultaneously, a downstream frequency range of 54 MHz to 1800 MHz. Any combination of upstream and downstream range is instantly supported without any change in the amplifier architecture, this makes it a flexi-split solution with the best possible spectrum efficiency and allows new possibilities compared to amplifiers with traditional diplex filters:

- More efficient use of the spectrum due to lack of crossover area
- Real time frequency split change; better response on the upstream and downstream capacity needs
- Mixed upstream and downstream signals in the flexi-split area
- Full DOCSIS 4.0 support from day one

Of course, this new concept also has a challenge, namely the maximum achievable gain. In the upstream and downstream the gain capabilities are 15 dB and 35 dB, respectively. In the sections below we will explore how this challenge can be overcome.

NETWORK PERFORMANCE SIMULATIONS:

To have a baseline for comparison in network simulations, we have considered a 6 dB step down output power scenario, which is being considered by several operators in the North American market. In the figure below, the orange line highlights the step down output power scenario in comparison to the blue line, which is One Touch output power.

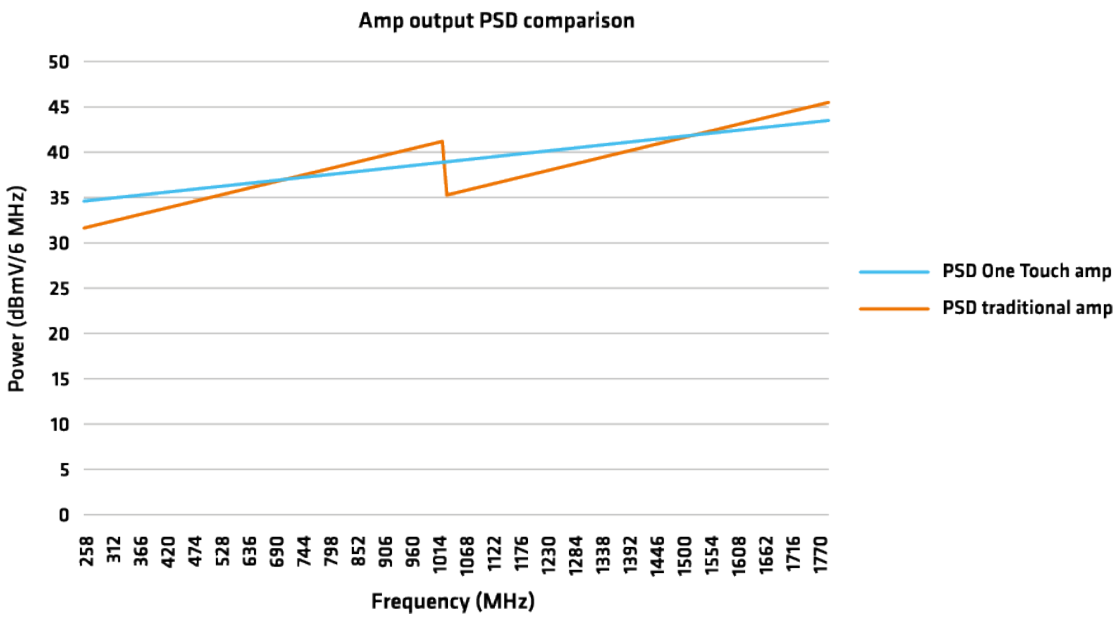


Figure 6_Traditional vs One Touch output power

It can be observed that although the One Touch amplifiers have a more conservative output power, they are not too far off from where the operator's reference output power would be in a traditional setting. This is particularly the case with legacy output levels (258 – 1000 MHz), to ensure the previous generation of set-top boxes and modems remain as stable as possible.

Although the gain capabilities of One Touch amplifiers are lower than traditional ones, the higher gain will not be needed in the outside plant in the majority of cases. As previously mentioned, 35 dB of gain at 1.8 GHz should cover 75-80% of the span losses in the outside plant. This has been schematically shown in the Figure 7 below:

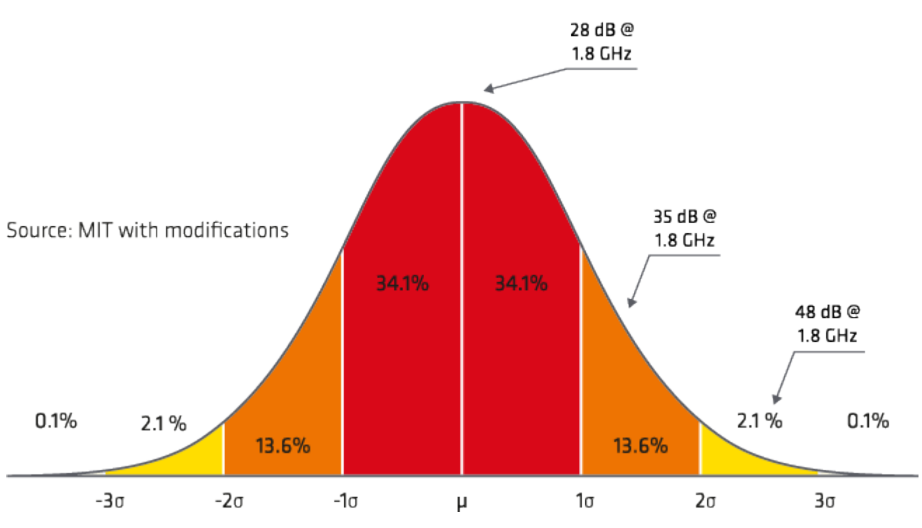


Figure 7_Gain (span loss) histograms

It should be noted that in 20-25% of instances, booster amplifiers may be needed. This challenge can be overcome with Technetix' booster amplifiers, which are also diplexer-free, making them fit into the ecosystem seamlessly. This, combined with the self-aligning capability of our amplifiers, eliminates the need for complex plant design. In other words, the One Touch ecosystem can be viewed as drop-in plug and play, with no need to redesign or retune amplifiers in the future.

Not overdriving the amplifiers from a gain and level perspective has two main benefits: the primary of the two would be a substantial increase in signal quality and throughput, along with reduction in power draw in the outside plant. We generally expect a 30% increase in throughput and capacity in the outside plant while reducing the power draw by roughly 35%. These numbers have been validated through numerous plant model studies carried out with our industry partners.

Figure 8 below demonstrates the difference in signal quality in a cascade between the One Touch ecosystem and traditional:

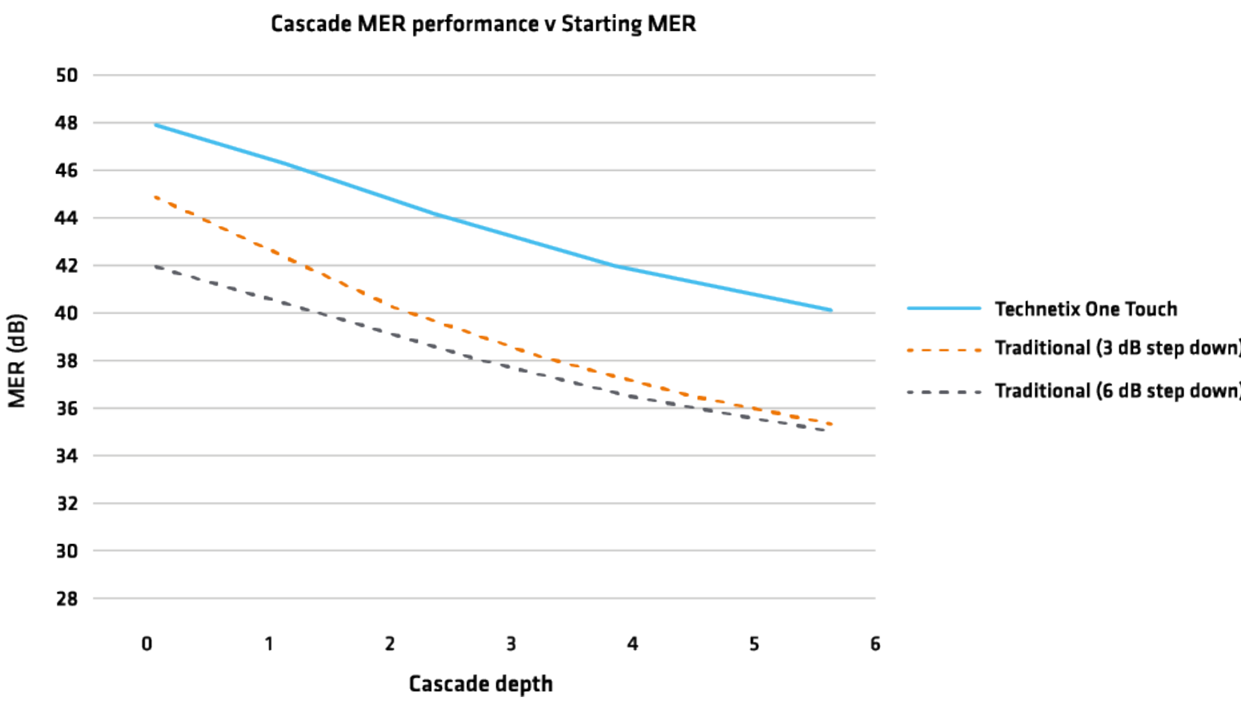


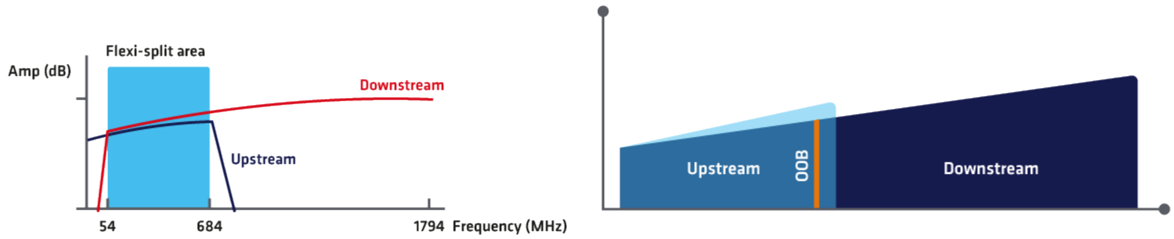
Figure 8_Cascade MER comparison, One Touch vs traditional

It can be observed that due to the nature of One Touch amplifiers, a cascade of six amplifiers can maintain a much higher signal quality in comparison to traditional amplifiers. This can not only enable much higher capacities, it can also mitigate future node splits by a considerable amount.

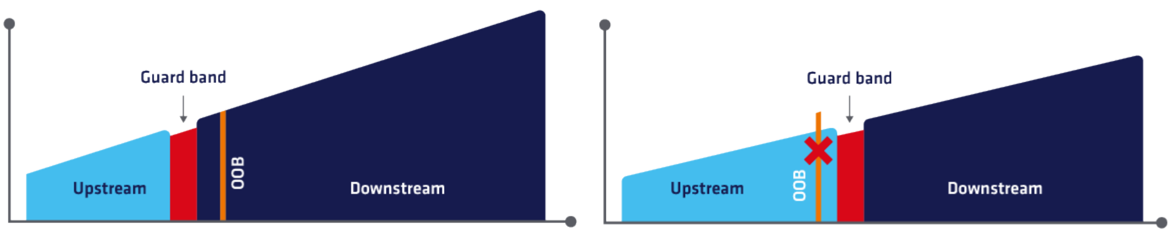
SET-TOP BOX OUT-OF-BAND (OOB) CARRIERS

One of the main challenges of future upgrades is the out-of-band carrier for set-top boxes. This carrier, which resides in the downstream portion of the spectrum, will have to be eliminated prior to any future spectrum expansions beyond 85 MHz. This can be an incredibly costly and complex problem to tackle, knowing that there are millions of legacy set-top boxes out in the field that use this carrier today.

The One Touch ecosystem will allow the operators to maintain this carrier in its current location, even when expanding the upstream to 204 MHz and beyond, due to the diplexer free nature of our amplifiers. This has been schematically demonstrated in Figure 9:



One Touch amplifier spectrum view



Amplifier spectrum view (Traditional)

Figure 9_Out-of-band and carrier in One Touch ecosystem

CONCLUSION

As operators evaluate their options for future upgrades, they are faced with many complex challenges, such as CAPEX/OPEX intensity, network powering and labor scarcity. Traditional approaches to upgrading the HFC network have proven to be reliable, but they can have several drawbacks. This includes numerous visits over the years to the same locations, increase in the number of disruptions to the customer and an increase in power draw in the outside plant.

The Technetix One Touch network aims to utilize the same reliable methods that have proven to work in the past, while building upon our newest diplexer-free technology to overcome all the challenges mentioned above. Although One Touch upgrades may require additional boosters and a shift in plant design methodology, the benefits of the ecosystem can far outweigh the challenges. We are continually working on optimizing gain/level capabilities and self-aligning algorithms to further simplify future deployment and alleviating the need for complex plant designs altogether.