EXECUTIVE BRIEF

HPON: Transforming HFC networks for an all-fiber future

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The process of converting HFC plant to an all fiber network can be a long journey and involve multiple logical stop points that drive fiber gradually deeper into the access network. This evolution process can hel p provide a pathway for bandwidth expansion for years to come, while enabling service providers to make prudent, demand-based investments. To achieve these benefits, it is critical for service providers to choose an all fiber evolution strategy that is compatible with the current infrastructure at the headend, in the field and at the home. The chosen technology must also have a long shelf life and offer a simple migration path to widespread fiber-to-the-premises (FTTP) deployment.

While many today equate a transition to all fiber with a move to binary-modulated passive optical network (PON) based architectures, new options have begun to enter the market. One such architecture known as hybrid PON (HPON) satisfies all the requirements given above and helps service providers embark on the long journey of all fiber migration in a way that is both seamless and future-ready.

HPON – A New Choice for FTTP Transformation

The HPON architecture begins as a natural extension of current fiber deep initiatives. Initially, service providers can push fiber a bit deeper (e.g. down to 250 Homes Passed), upgrade the HFC plant to 1GHz or 1.2GHz, and move to an 85MHz upstream. These steps provide a platform that can enhance service providers' near-term DOCSIS 3.1 capabilities, while delivering an equivalent capacity of 10G/1G EPON for subscribers at the top billboard tier. For about 20% of the cost of pulling FTTP to all subscribers, the service provider has significantly extended the lifespan of the HFC plant, while taking 'success based' steps towards an all-fiber network.

As top billboard tier subscribers outgrow HFC, the operator will need to move that small handful of subscribers to FTTP. With the HPON strategy, every time fiber is pushed deeper, sufficient dark fiber is pulled with FTTP everywhere as the end game. In this case it is pulled from the nearest optical node to the premises. These are all costs that would have been part of a full FTTP upgrade anyway, but have now been deferred in time.

Powering PON for Increased Density, Performance and Scalability

Because of the typical cable operator distance requirements and the scarce trunk fibers, it is nearly always the case for PONs to utilize remote optical line terminator (OLT) or PON extender locations very close to the fiber splits. These installations typically perform OEO operations to enhance both the fan-out and the reach of PONs, and often perform wavelength translations and aggregation to more fully utilize trunk fibers as well. Therefore, many of today's commonly accepted PONs are not truly passive at all, but can actually be considered powered optical networks.

The HPON architecture leverages these powered locations, using an active RFoG solution that facilitates the complete reuse of existing DOCSIS infrastructure. In addition to delivering massive data capacity, HPON simultaneously enables vast numbers of fiber splits covering up to 1024 HHP. Yet the system requires minimal processing power, utilizing less than 75W to achieve 512 HHP, which is about half of the power consumed by a typical 4X4 node in deployment today.

With HPON, once the first FTTP user is lit up, the rest of the neighborhood is ready for FTTP service, with only the final fiber drop needing to be pulled. Also, operators can push optical nodes deeper at this time and eliminate even more of the HFC network's active components.

An additional benefit of HPON is that it is agnostic to the underlying technologies being transported over the FTTP network, and will support a simultaneous mix of these technologies. So, one customer can subscribe to 10G/10G EPON if needed, while other customers can be served by DOCSIS 3.1.

Note that HPON-based D3.1 has some interesting inherent advantages. Because the downstream and upstream are carried on separate wavelengths, their spectrums can overlap. In the downstream, spectrum can range from 54-1218MHz. This allows all legacy signals (e.g. STB OOB, FM music band) to be carried in their original spectrum and avoid the the issues caused by moving the upstream split on existing HFC.

HPON-based DOCSIS 3.1 has even greater benefits in the upstream. With OBI-free operation and enhanced SNR, the upstream can operate freely at 204MHz with up to 4096-QAM modulation. This is almost a 2.5G PHY rate and nets almost 2 Gbps of data capacity. Most importantly, the data rate is sufficiently high to offer a Gbps upstream service tier. This is something that 1G EPON, GPON and 10G/1G EPON cannot claim.

The significance and benefit of a move from a processing intensive PON OLT operation to a minimal processing transparent HPON architecture cannot be overemphasized.
In case of traditional PON, each iteration

of speed increase would result in a change in the OLT and the PON extender as well as the ONU at the house. In the HPON architecture, a vast majority of the devices remain in the network unaffected as improvements in speed; capacity and throughput get worked out over the next several decades.

Conclusion

As service providers evolve their networks from HFC to all fiber, a deployment of an HPON system that leverages active RFoG components provides several benefits. In addition to supporting a wide range of service tiers using existing CPE and operational systems, this approach enhances data capacity, increases fiber fan-out and improves DOCSIS performance, both upstream and down. Most importantly, HPON enables a well-ordered migration to FTTH, preserving existing plant and equipment investments well into the future, while enabling success-based FTTP investments.