How does home wiring affect attainable VDSL 2 data rates?

Home Wiring and DRY DSL

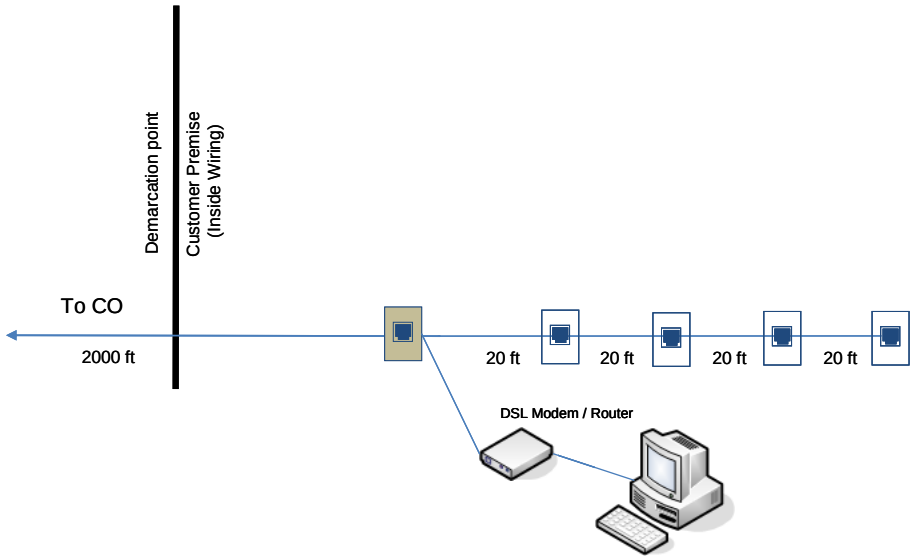
The purpose of this document is to compare measured results of attainable VDSL2 data rates in a DRY DSL application in various wiring topologies. In a DRY DSL application, there are no phones or fax machines connected in the home, no splitters or microfilters. However, the existing home wiring is still present. Homes are typically wired in either a daisy chain or star configuration; these configurations are discussed, specifically comparing the characteristics that will most significantly affect VDSL performance, specifically impedance changes due to the presence of bridge taps and loading of the LINE in the DSL frequency band.

All of the Tests presented in this document were performed in 17a profile over 24 guage wire. In order to establish a baseline to compare the test results with, the data rate measurements were first taken with a direct connection from the DSLAM to the modem with a 2000ft CAT5 cable.

Home Wiring Scenario A: Daisy Chain

The first test scenario is the daisy chain configuration. In a daisy chain, one set of wires is run throughout the entire home with telephone outlets branching off.

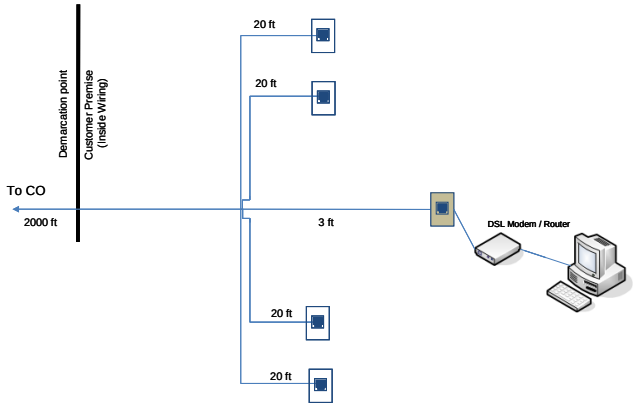
The DSL modem is connected along the same pair of wires as the rest of the home. The diagram below shows the modem at the very front of the chain. In fact, the modem could be connected anywhere along the chain. In this case, the remainder of the chain after the modem acts as a bridge tap. The DSL signals that travel along the chain to the modem will also continue down the rest of the chain and will be reflected back to the modem. If the modem were installed at the very end of the chain, the bridge tap effect would be removed.



Home Wiring Scenario B: Star Configuration

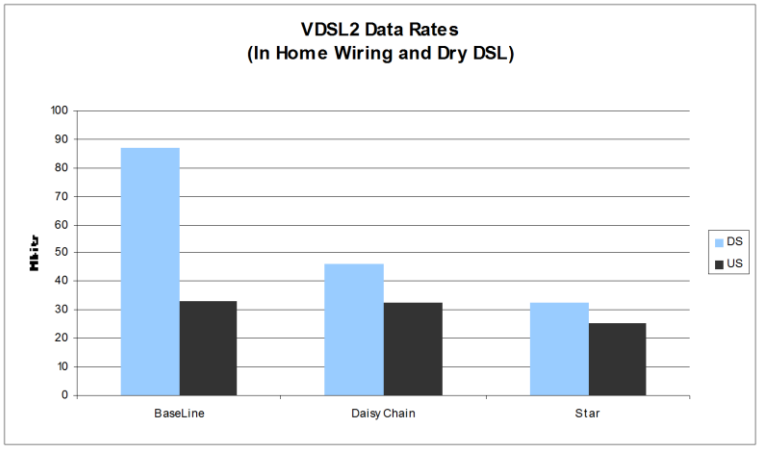
The second test scenario is the Star configuration. In this case, all of the wire pairs in a home are connected in some centralized location. In most cases, there is a distribution bridge located somewhere close to the demarcation point at the customer premise.

Each line segment in now connected in parallel to the LINE-to-modem connection, and is therefore considered a bridge tap. In the daisy chain configuration, we were able to achieve an "ideal" situation by moving the modem to the end of the line. This is not possible in the star configuration given the parallel connection.



Test Results: VDSL2 Data Rates in DRY DSL Application

The attainable data rates for the Daisy Chain and Star configurations are shown in the Table below. Please note that the baseline data rates (i.e., direct connection DSLAM to modem) were measured at 86.7Mbits/s downstream, 32.9Mbits/s upstream.



In the daisy chain configuration, there is a 47% reduction in downstream and 1% reduction upstream.

In the star configuration, there is a 62% reduction downstream and 23% reduction upstream.

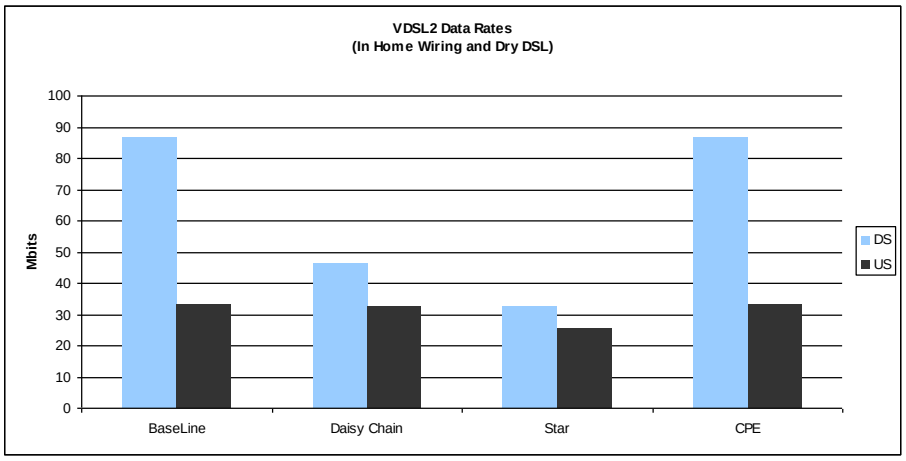
Recommendations for improving VDSL2 data rates in DRY DSL

The reductions in attainable data rates shown above are caused by the bridge taps that are present in the home wiring. In order to improve the level of service at the customer premise, these bridge taps need to be removed.

Even very short bridge taps can significantly affect VDSL2 service. Calculations show that bride tap segments of just 3ft in length can change the impedance seen by modem more than 50%. This change in impedance will result in high reflection and a smaller amount of power transferred to the modem; results will be significantly decreased VDSL2 data rates.

The first is solution is to run a dedicated pair for wires from the demarcation point to the modem. If the rest of the house wiring is removed from the loop, data rates will increase back up to the baseline. However, it is difficult for the customer or a future-resident in the home to turn phone service back up. Should the customer want to go back to Phone service, another truck roll will be required to reconnect the original wiring.

The second option is installing a splitter at the demarcation point. This seems a little strange at first, because there is no phone service present and therefore filtering is not required. However, the high impedance nature of the filter isolates the home wiring from the modem. CPE splitters eliminate bridge taps, separating DSL and POTS at the input of home network. As shown in the table below, installing a splitter (in either the daisy chain or star configurations), the data rates increase up the baseline maximum rates. An installer will need to go out to do the splitter installation and wire to the modem, but should the customer re-order telephone service, no other tuck roll will be required.



Summary

In summary, bridge taps segments in home wiring cause changes in impedance, insertion loss, and group delay. The variation in these parameters is cause by the signal reflection which in turn results in less power being transferred to the modem and very significant changes in attainable data rates.

Homes are all wired differently – in order to provide the best level of service possible, it is necessary to remove the home wiring from the equation as much as possible. CPE splitters eliminate bridge taps in home wiring by isolating the DSL at the demarcation point in the home.