SOLECTEK
BROADBAND WIRELESS NETWORKS

White Paper:

Using Sub-Channels for 2X Link Capacity

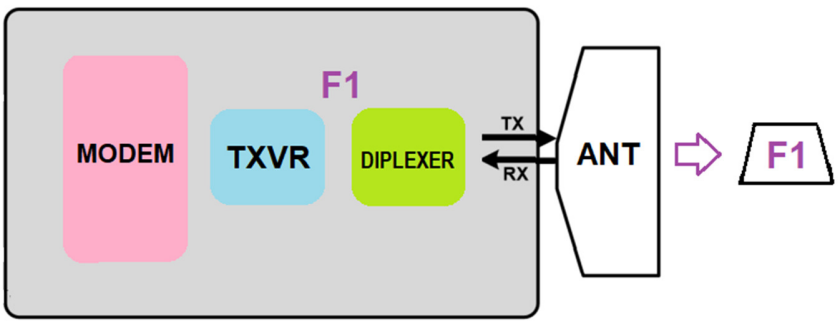
Introduction

Explosive growth of Internet data traffic continues to put a lot of pressure on backhaul networks. Microwave links, as part of backhaul networks for many carrier and private networks, are subject to same demands for increased capacity.

Increased capacity most often means more complex hardware and significantly higher costs and the challenge for equipment vendors is to provide multi-gigabit speed at a reasonable cost point. This document describes a new technique to get more from the same hardware, i.e. leverage the same hardware to squeeze out twice the capacity. With radio systems designed properly for the "sub-channel" use, one can achieve the same capacity increase as the traditional 2+0 configuration without adding any hardware pieces.

In the next sections, various options for increasing the link capacity will be described first and then the concept of sub-channel utilization will be introduced.

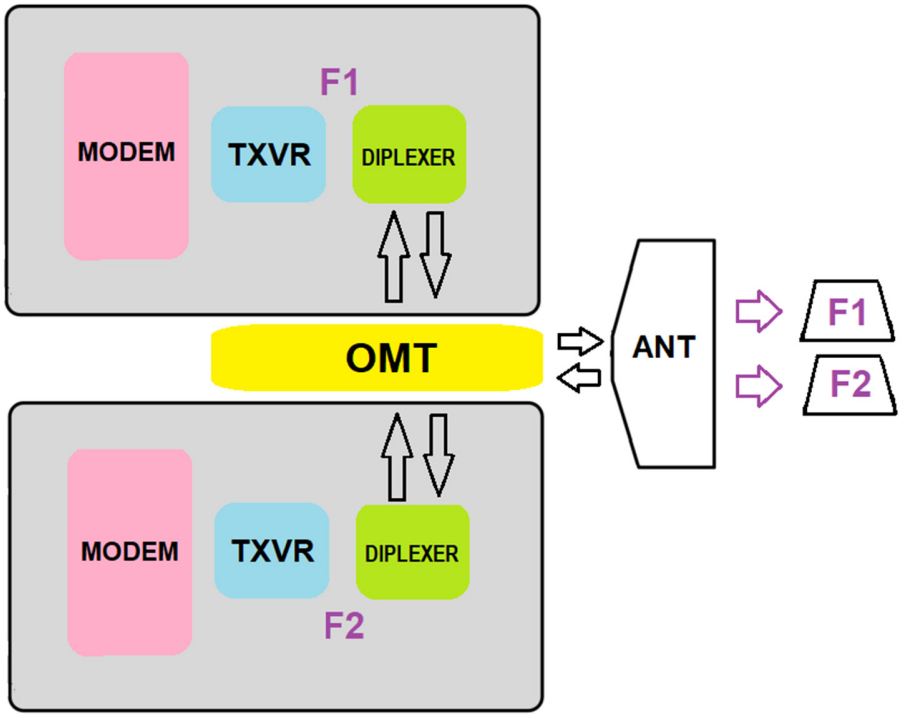
A Simple Microwave Link (1+0)



Many of the microwave links deployed today are configured in the “1+0” manner, which is basically one primary radio link + zero redundant backup path.

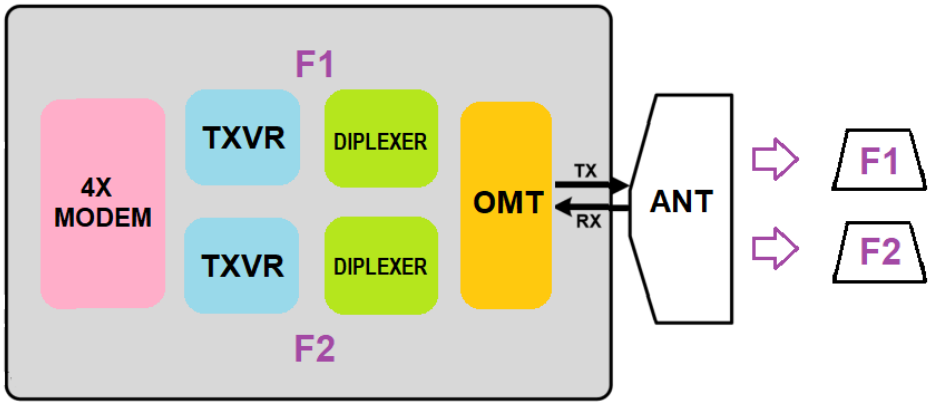
The diagram shows a radio consisting of a modem, a transceiver (transmitter + receiver), and diplexer (combining Tx and Rx to launch into antenna w/o signal interference and loss). Obviously, capacity of a 1+0 link is limited to the maximum capacity that one radio path can handle, which is essentially governed by modem modulation (up to 4096QAM and limited by link distance) and channel BW (up to 160MHz and depends on user’s channel assignment by local government).

Doubling of Link Capacity with Two Radios (2+0)



This is the traditional way of increasing capacity – use two radio units (each operating at a different channel) and combine the signal using an external OMT device. The drawback is that (a) the equipment cost is more than double (two radios + OMT) and (b) tower loading is also more than double for the same reason.

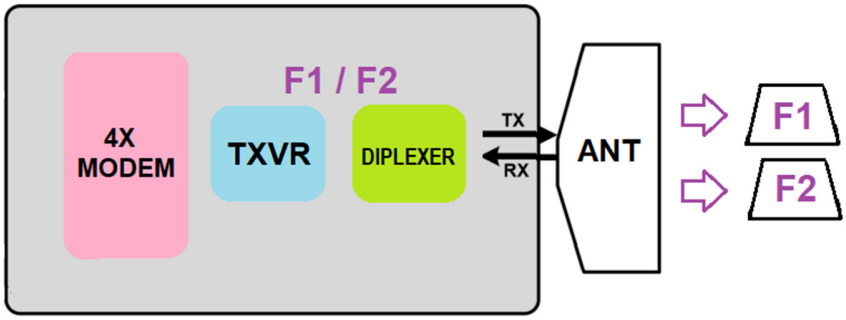
Doubling of Link Capacity with Dual Transceiver Radios



The concept is similar to the 2+0 case above, except that there is a twist in hardware configuration. The radio consists of multi-modem core processor and dual transceiver (DT) so that two independent RF chains are implemented in a single radio terminal. The effect is that the radio cost and tower loading is less than double due to a single terminal can share many common parts (digital section, modem, etc) for the two RF chains. There is also less assembly/installation needs for end users as opposed to the standard 2+0 design. The OMT is custom designed as an internal part so it is more compact and cost effective as well.

Note that in order to do this, your modem processor has to have multiple modem cores to launch an independent signal stream to each of the two transceivers. The diagram here indicated “4x modem” rather than 2x modem, as 2x modem is sufficient for the case at hand. This topic will be covered below in the section where everything is combined.

Doubling of Link Capacity by Using Sub-Channels with Single Transceiver



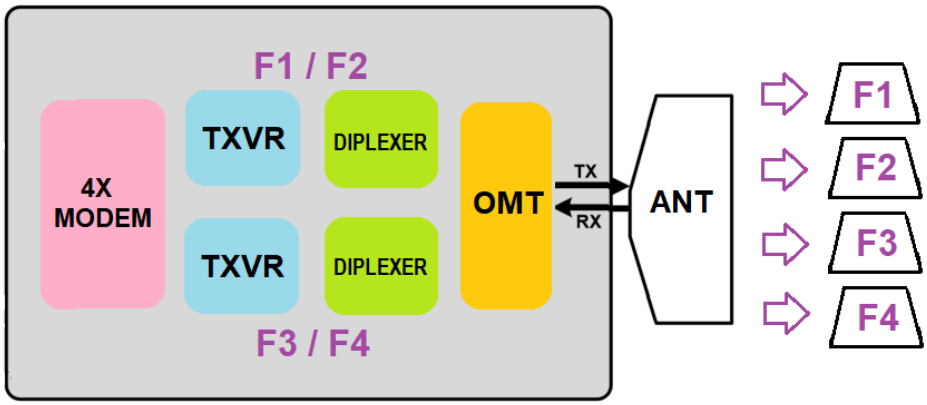
A more economical way of double capacity is to use the concept of sub-channels. Essentially, a multi modem-core processor can launch two independent data streams into a SINGLE transceiver, using two different RF channels, as opposed to using two transceivers in the above cases. The result is a significant hardware reduction and cost savings coming from the removal of many costly parts (one transceiver, one diplexer and the OMT used to combine signals from two transceivers). The simplified hardware also reduces the weight of the radio for easier tower loading. In a sense, the hardware is the same as 1+0, except for advanced software for signal handling powered by multi-modem core processors.

There are a couple of limitations – (a) power is divided between the two sub-channel streams, which means the link budget is reduced by 3dB, (b) the two sub-channels need to be allocated within the range that the diplexer can handle. If you can overcome these restrictions, using sub-channels provides an almost “something for nothing” gain when you need to increase the link capacity.

Thus, a single radio can be used to achieve 1Gbps link capacity – For example, each sub channel can carry 500Mbps at 2048QAM in 56MHz BW and using two sub channels would allow the same hardware to get to 1Gbps.

NOTE: Solectek provides payload/header compression in KM Series, but all throughput calculations DO NOT include any increases expected from compression, as throughput gains coming from compression depend heavily on the customer data patterns and thus are not dependable for network capacity planning.

Quadruping of Link Capacity (4X) by Using Sub-Channels with Single Transceiver



This scheme essentially incorporates the sub-channel scheme just discussed in a dual-transceiver radio terminal. The net effect is that a single terminal carries four independent signal streams, F1 to F4, similar to a standard 4+0 configuration, except that in this case, all of the data is carried by a single radio terminal with a single-polarization antenna. (same restrictions as in the above single transceiver case, i.e. to put all 4 channels within the diplexer range, are applicable here).

It is worth noting a few unique aspects to this way of achieving 4+0:

- Achieving this configuration requires the modem processor to have 4 modem cores. Most often radios are designed with 2 modem cores, which can be used for 2+0 only. (Solectek KM Series comes with a 4x modem processor as a standard feature.)
- 4+0 with 2x modem processor radio designs requires two dual-transceiver radio terminals for much higher costs or complicated external branching circuits.
- 4+0 without using sub channels requires two dual-transceiver radio terminals for much higher costs or complicated external branching circuits.
- Being able to use a single-polarization antenna greatly simplifies installation and tower logistics.

You may wonder why you would need to go so far as quadrupling of link capacity. One common reason is the channel BW restrictions posed by your spectrum authority. Radio datasheets often claim multi-gigabit performances, but top-level performances require using very large bandwidth. In fact, Solectek KM Series radios can operate at 160MHz channel BW!

For example, operators may be limited to small channels such as 30MHz. If your goal is to achieve 1Gbps over the link, then a 4-stream operation will be required, as each stream would be limited to 250Mbps in a 30MHz BW operation.