SOLECTEK
WHITE PAPER

Load-Balancing in High-Capacity KM Series Microwave Links

OPTIMAL BALANCE IN THROUGHPUT, RELIABILITY, AND DISTANCE

Introduction

Load balancing is useful in situation where one has multiple radio paths that can be used for data transport. Radio technology advances in recent times allow building dual radio chains or even quad radio chains for a single PTP link.

The Solectek KM Series radios can be build in the following ways:

- Single-carrier radio — one radio chain in a radio terminal (1+0)
- Dual-carrier radio — two radio chains in a radio terminal (2+0, 1+1)
- Quad-carrier radio — Two dual-carrier radio terminals mounted on a coupler (4+0, 2+2)

In all of the above cases, the assembly will be mounted on one single-polarization antenna.
(Note: dual-carrier radios can be built in two different frequency bands, e.g. one chain in 11GHz and the other in 18GHz. In this case, each radio chain must be connected its own antenna via flextwist waveguide.)

In the case of using multiple paths concurrently to increase link capacity (2+0 or 4+0), The payload traffic must be split into such paths and combined at the other end seamlessly as if there is only one path from the user perspective. A properly engineering load-balancing scheme allows sharing of all paths in an equitable way. If one path is not available, load balancing will automatically redistribute the traffic among the available paths.

In a radio link design, load balancing can be used to optimize the radio link resources to give the user the best balance of desired objectives in terms of link capacity, link distance, antenna size, and link reliability.

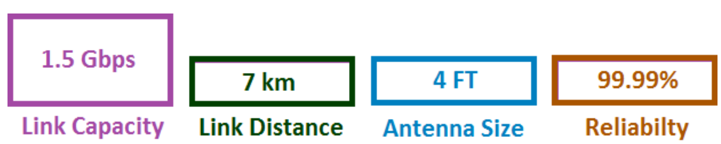
The balancing act for the link designer is to select the most important parameter while compromising on the others. Load balancing will help you achieve this goal and allow you to build a higher-performance link with 2+0 or 4+0 when compared to a single–carrier case (1+0). The following examples are specific ways that you can use load balancing to make the most out of the system for your own needs.

A single-carrier (1+0) deployment in New York City may give you the options as shown right. In order to get high link capacity at high reliability, you have to use larger antenna and top-level modulation of 4096QAM, which limits the link distance. The use of dual-carrier radios offers the following benefits.

4096QAM, 80MHz BW @ 18GHz frequency band

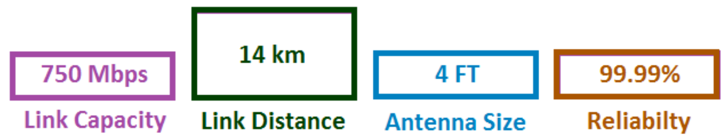
1. Doubling the link capacity

This is the easiest consideration. One can keep all of the parameters the same (modulation and BW) as the 1+0 case and simply use the second chain to increase the payload capacity.



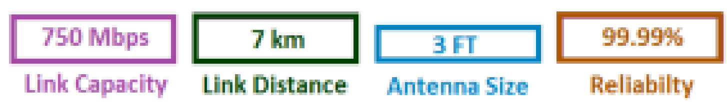
2. Longer link distance

If you want to increase the link distance while maintaining all other aspects the same, then you can use the second chain in the following way. (1) reducing the channel BW in half — this will add 3dB to the link budget or (2) more effectively, use lower order modulation—this will allow radio to increase Tx power and Rx sensitivity also improves for a net gain of 6 to 10 db. In either case, link capacity drops in each radio chain, but you now have two radio chains, so you can reduce capacity of each chain by half and still maintain the original link capacity.



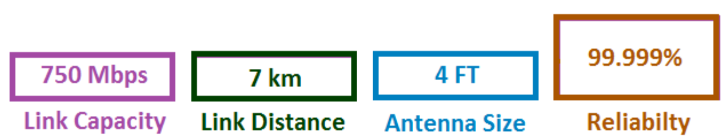
3. Smaller antenna size

The 1+0 case uses larger antennas than you would like. Larger antennas are more expensive in terms of equipment cost, transportation expense, tower lease payment, and tower install expense in addition to aesthetics issues. Reducing one size (1Ft or 30cm) typically drops 6-8 dB in link budget. Again, much like the distance case above, you can reduce the modulation or bandwidth to recover the link budget drop cased by smaller antenna use. Modulation/bandwidth change will reduce the link capacity of a single radio chain, but addition of the second radio chain will add back the link capacity drop.



4. Reliability

The application for the link may be mission critical, which demands higher availability figure than 1+0. Again, in this case, modulation/bandwidth change will allow increase of the link budget, which will add reliability against rain fading and multipath fading.



5. Licensing Costs

The above cases show ways to achieve certain design objectives by using large channel bandwidth . In certain countries, regulatory bodies may not allow larger channel bandwidth to avoid frequency crowding. Also, license costs may increase in proportion to channel bandwidth. In those cases, use of a single, small bandwidth in a co-channel deployment with dual chains may provide a way to reduce operating/maintenance costs over the long term use of the link. In any case, one can choose to activate only one chain and leave the other inactivated to avoid licensing costs of both chains at any time.