



## Carrier-in-Carrier Technology

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**Carrier-in-Carrier technology** is one of the key techniques the satellite industry has adopted to enable customers to save on bandwidth costs. It allows a full duplex satellite link to be allocated the same transponder space as a single carrier using Applied Signals patented technology - Adaptive Cancellation - to place carriers directly on top of one another in terms of frequency.

With Carrier-in-Carrier technology (and suitable ground equipment), certain satellite networks can increase space segment savings when compared to more traditional methods of duplex satellite services.

In combination with other advanced FEC and modulation techniques, Carrier-In-Carrier provides increased efficiency for satellite networking compared to traditional methods of transmission.

By implementing these techniques with Telesat satellite capacity, customers can achieve 30% or more savings in assigned space segment compared to traditional transmission techniques.

### **How does Carrier-in-Carrier work?**

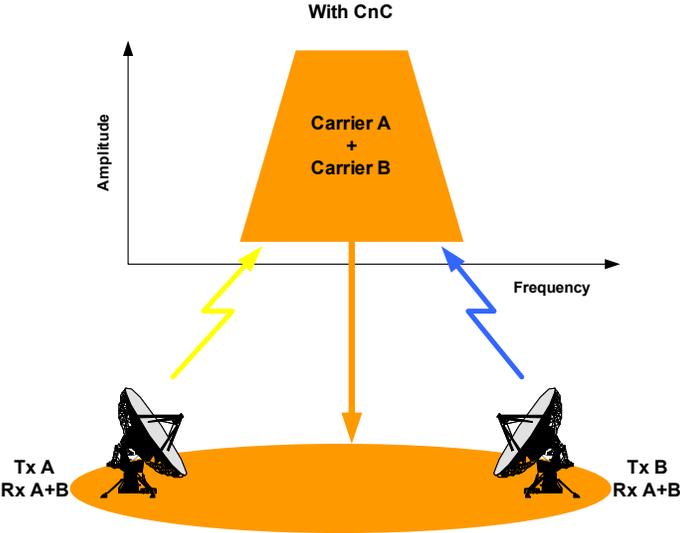
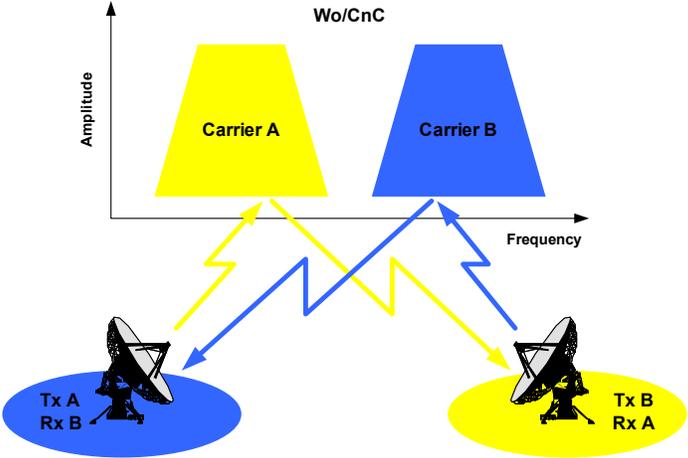
Standard duplex services assign separate frequency allocations for transmitting and receiving of data. Carrier-in-Carrier technology is able to distinguish between the transmit and receive signal, by implementing adaptive filtering and phase lock loop signal processing, thereby filtering one service from another.

Parameters that the Carrier-in-Carrier processes for the signals are as follows:

- Amplitude
- Frequency
- Phase
- Round trip delay

Using the above, an estimate of the transmitted signal is subtracted from the composite received signal, leaving the actual 'far-end' signal to be processed.

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## **Considerations for Carrier-in-Carrier Links**

When designing a Carrier-in-Carrier link, the following must be taken into consideration:

- At least one link of a traditional SCPC Duplex service must be a bandwidth dominated link in order to achieve bandwidth savings with carrier-in-carrier.
- The Duplex service must be allocated within the same transponder and the transmitting station must be able to receive its carrier from the satellite.
- The transponder does not demodulate/remodulate the signal (i.e. processes).
- The combined carrier performance must be within the specified Power Spectral Density Ratio of the Satellite.
- Uplink power control can be used, however it is not recommended to run a wide range of transmit power level changes; manufacturers recommend no more than 3dB.
- To maintain the desired BER, a small amount of additional link margin is required when compared to non Carrier-in-Carrier modulation. This is due to the additional residual noise created by the process. The amount is dependant upon the manufacturer's recommendation for the product and its configuration.
- The most efficient usage of capacity in terms of bandwidth AND power assignment is recommended.
- Spreading the smaller carrier within the larger predominant carrier by using lower order modulation is recommended as this can increase availability, assign less satellite power and reduce HPA/BUC size/back-off.

## **Commissioning Carrier-in-Carrier services**

Before enabling Carrier-in-Carrier, Telesat recommends testing each direction of the service to confirm correct operation. This may be achieved with smaller initial carriers within the total block allocation, or by utilizing additional test capacity within the satellite.

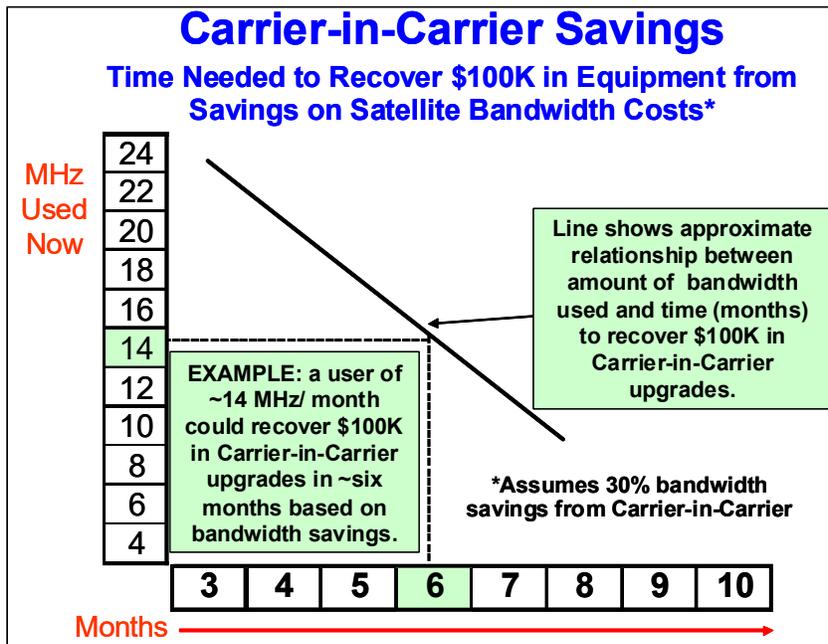
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Only after correct operation and performance of the service is confirmed should Carrier-in-Carrier be enabled. Telesat will assist customers during the test process, including identifying test capacity as necessary.

## Validating Carrier-in-Carrier Performance and Potential Cost Savings

It is recommended that once a service is operating within Carrier-In-Carrier mode, verification of performance is measured by Eb/No degradation.

An example of potential cost savings from a Carrier-In-Carrier link vs. standard SCPC is shown below:





## **Summary**

Carrier-in-Carrier is one of various techniques that the satellite industry is utilizing to help reduce bandwidth costs for customers and improve network performance. It may be a solution that can provide advantages for your network implementation, or it may have limitations given hardware costs at each site and other factors.

Please contact your Telesat sales representative if you would like to learn more about the suitability of Carrier-in-Carrier for your operations or to discuss other ways Telesat can improve the efficiency and performance of your satellite network.