RTT TECHNOLOGY TOPIC
February 2023

Optical C Band

Over the next eleven months (January to November 2023) we are making our way through the eleven chapters of our new book, 5G and Satellite RF and Optical Integration, highlighting industry announcements that consolidate the underlying narrative of an emerging market for 5G services from space coupled to increasing use of optical free space technology for inter satellite, inter constellation and earth to space/ space to earth links.
As a reminder,
Chapter 1 covers 5G radio spectrum including RF C Band, RF link budgets and active and passive device efficiency.
Topics addressed in the rest of the book include
Chapter 2 Optical C Band link budgets and active and passive device efficiency
Chapter 3 RF over Fiber- link budgets and network architectures
Chapter 4 Space RF Link Budgets
Chapter 5 Optical Inter Satellite Links (OISL)
Chapter 6 Deep Space and Near Space technologies
Chapter 7 Ground Station and Earth Station Hardware and Software
Chapter 8 Low Altitude Platforms
Chapter 9 High Altitude Platforms
Chapter 10 RF and Optical Technology Enablers
Chapter 11 Technology Economics of RF and Fiber for terrestrial and space networks.

For more information and to order go to
https://uk.artechhouse.com/5G-and-Satellite-RF-and-Optical-Integration-P2194.aspx
Hard and soft copies of the two previous books in the Series can be ordered here
https://uk.artechhouse.com/5G-and-Satellite-Spectrum-Standards-and-Scale-P1935.aspx
https://uk.artechhouse.com/5G-Spectrum-and-Standards-P1805.aspx

If you are interested in writing a book for Artech House or have research work you would like included in future 5G and 6G satellite RF and optical titles then email geoff@rttonline.com who will put you in touch with the Artech commissioning team.

We are also running a workshop on LEO, MEO, GSO, LEO, 5G, RF and optical integration in Prague 8th to 12th May 2023.

More information here
www.cei.se/continuing-education-institute/satellite-communications.html

Optical C Band (Chapter 2)

In last month's Technology Topic, 5G Radio Spectrum, we summarised some of the factors determining RF delivery cost in terrestrial and non-terrestrial networks. This month we look at the relative economics of optical transport both over fiber and in free space, a topic covered in detail in Chapter 2 of the new book.

The thesis is that the cost of connectivity over a radio network is increasing over time. The cost of connectivity over optical networks (fiber and free space) is decreasing over time. The underlying reasons are simple.

RF costs have increased over time due to the auction process. Increasing levels of interference (and related mandatory and rigorously enforced protection ratios) add to this cost base.

Optical band width has, to date at least, not been auctioned and there is a lot of bandwidth available Optical C band for example is a 4 THz pass band between 191 and 195 THz. This is the frequency band most commonly used in terrestrial and subsea fiber which means that optical active and passive devices, filters, mixers, amplifiers, splitters and laser sources, can be repurposed for free space systems, for example inter satellite optical links and optical ground stations. This includes components used in 5G optical backhaul.

More fundamentally, the high cost of terrestrial radio spectrum has meant that a large amount of engineering effort has gone into making 5G radio networks spectrally efficient. The cost of this spectral efficiency is power efficiency. This makes 5G waveforms generally more expensive in space (more power in space adds to launch cost and larger more vulnerable solar arrays which can easily degrade or abrade over the life span of the satellite).

5G RF modulated waveforms and other mechanisms used to improve spectral efficiency such as spatial diversity mean that 5G terrestrial radio networks are working close to the Shannon limit. By comparison, optical transport generally operates well short of the Shannon limit with many links still using on off keying or simple intensity modulation (the optical analog of AM). Even when coherent modulation is used there are still many ways in which spectral efficiency can be improved including narrow band (25 GHz) channel filtering and time and spatial domain multiplexing.

This means that an existing fiber link, for example a subsea cable can be simply upgraded by changing the modem at each end of the link. Free space optical links can also be far more power efficient than an equivalent RF link – optical transceivers consuming a few watts of power can support high throughput links between a LEO and GSO satellite thousands of kilometers apart, terminating in an on board optical fiber bus using standard fiber components (though possibly with some space qualification). In practical terms, 5G RF is getting close to its performance limit. 5G optical still has a huge amount of performance improvement potential.

Which brings us neatly back to next Month's Technology Topic, RF over Fiber.

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About RTT Technology Topics

RTT Technology Topics reflect areas of research that we are presently working on. We aim to introduce new terminology and new ideas to help inform present and future technology, engineering, market and business decisions.

The first technology topic (on GPRS design) was produced in August 1998. 25 years on there are over 270 technology topics **archived on the RTT web site.**

Do pass these Technology Topics and related links on to your colleagues, encourage them to join our **Subscriber List** and respond with comments.

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RTT, and **Niche Markets Asia** are presently working on research and forecasting projects in the mobile broadband, public safety radio, satellite and broadcasting industry and related copper, cable and fibre delivery options.

If you would like more information on this work then please contact **geoff@rttonline.com**
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