



RTT TECHNOLOGY TOPIC March 2023

RF over Fiber

This is your last chance to book on to our five day Continuing Education Institute workshop on LEO, MEO and GSO integration in Prague on the 8th to 12th May at the early bird discount rate of €3215 (Early bird price valid up to March 8th). The workshop provides an intensive insight into the technology enablers driving the 'New Space' communications revolution including 5G and 6G and RF and optical integration. We do hope you can join us. Book via the link below;
www.cei.se/continuing-education-institute/satellite-communications.html



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 and 6G 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.

RF over Fiber (Chapter 3)

In last month's (February) Technology Topic, Optical C Band we looked at the relative economics of optical transport both over fiber and in free space. This Month (March 2023) we summarise the evolving technology economics of RF over Fiber, covered in detail in Chapter 3 of [5G and Satellite RF and Optical Integration](#).

Any analog RF carrier with multiple channels carrying multiple users can be intensity modulated on to optical fiber provided there is sufficient linearity and dynamic range to preserve the original modulated data imposed on the frequency and or phase and or amplitude of the carrier.

Satellite radio systems generally use simple amplitude phase shift keying (APSK) modulated on to 125 MHz carrier bandwidths (uplink) or 250 MHz carrier bandwidths (downlink) increasing to 500 MHz at Ka band (and between one and two GHz at V Band). Satellite TV broadcast is typically configured within 250 MHz channels divided into 40 MHz sub channels each supporting a 36 MHz transponder. Each 36 MHz transponder can support 15 HDTV channels.

RF over Fiber is used to move these satellite TV signals from ground station antennas back into a nice dry hut for demodulation and onward transmission to domestic and commercial subscribers over hybrid fiber and copper (coax) transmission lines. The signals do not have to be demodulated in the hut and could carry on unmolested until their final destination, the television screen in your home cinema room for example. The advantage in early demodulation is that the data stream can be packetized and addressed and routed which is how IP TV arrives in your living room. The disadvantage is that any routing node will introduce delay and delay variability.

An analog signal or digital signal on a carrier that has not been demodulated will travel happily to an end destination but a router will not know what to do with the signal. Optical routers and optical switches could potentially address this issue. The alternative is to dedicate one or more wavelengths to an RF overlay. RF over Fiber is capable of moving signals between satellite ground stations over distances of tens or potentially hundreds of kilometers. It is also used in 5G enhanced Mobile Broadband (**eMBB**), Ultra Reliable Low Latency Communication (**URLLC**), In Band Access Backhaul (**IAB**) and Network Vendor Inter-Operability Testing (**NV-IOT**).

It is going to be a while before we have optical everywhere but the bandwidth limitations of copper, losses at higher frequencies, higher power consumption and high maintenance costs relative to optical fiber all add to the economic argument in favour of the photon. Once fiber is in place it is tempting to put RF signals down such a convenient optical pipe. Whether these RF signals are dominantly digital is open to debate. The potential for achieving lower latency, less jitter (latency variability) and lower energy and maintenance costs means analog has an interesting future.

Almost all communication networks use a mix of guided (cable and fiber) and unguided (free space RF and optical) transport carrying digital and or analog signals. The relative economics of these transport technology options change over time and determine the underlying financial sustainability of telecommunication systems. Our next two Technology Topics cover Space RF link budgets (April) and Space Optical Link Budgets (May).

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 280 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.

Contact RTT

[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

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