

# Digital TV and Mobile TV Backhauling with Point-to-Point Microwave in Unlicensed Bands

**Point-to-Point microwave links that operate in unlicensed bands present a reliable, robust and at the same time extremely cost effective solution for digital TV and mobile TV distribution.**

## Point-to-Point Microwave in Unlicensed Bands

Point-to-Point microwave links operating in various licensed bands have for many years been an attractive alternative to wired networks in situations where difficult terrain or lack of access make cable runs expensive or impractical. Point-to-Point microwave, however, does have its drawbacks: the high frequencies it operates in translate to high hardware cost, and the per-link license fee it entails is often a significant operational cost element.

Over the last two decades, special frequency bands have been set aside globally at 2.4 and around 5 GHz for operation without a license. These have proved to be of tremendous benefit to users, with the most important application by far being of course wireless LANs. As a result, a wide range of technologies have been developed to enable high-speed, efficient and trouble-free operation in these bands. These technologies have later been further developed and enhanced to implement high-speed, point-to-point links that operate over the same frequencies. These unlicensed links offer a high-speed, efficient and robust alternative to traditional point-to-point microwave, at much lower capital and operational costs.

RADWIN's ([www.radwin.com](http://www.radwin.com)) RADWIN 2000 is a prime example of a state-of-the-art point-to-point microwave link for unlicensed-band operation:



*RADWIN 2000 Microwave Link for Unlicensed Bands*

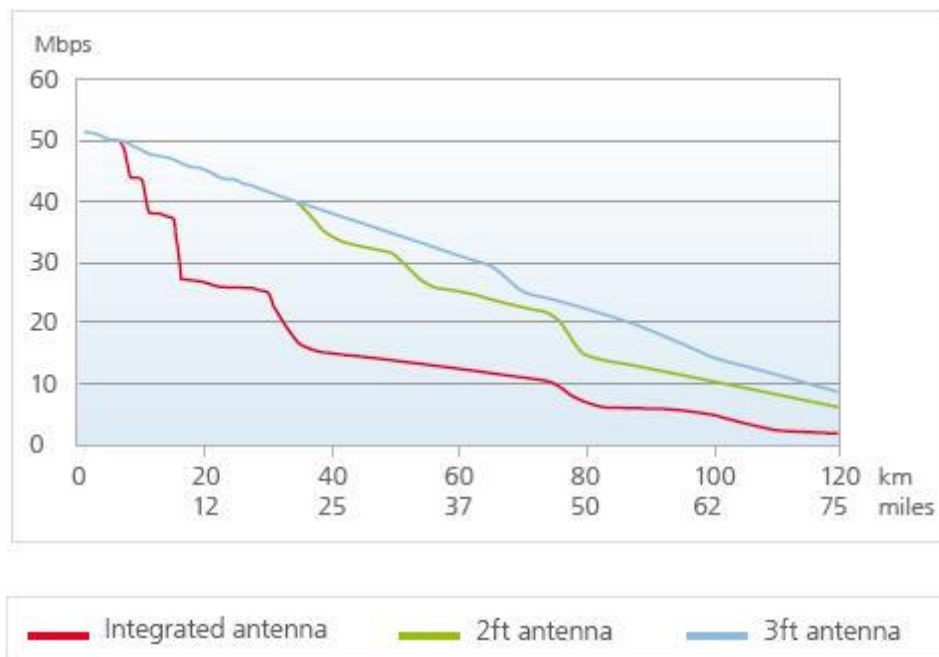
Each of the two endpoints of a link consists of an indoor unit and an outdoor unit, connected by a Category 5E twisted-pair cable run. The indoor unit presents the link interfaces to the user and implements most signal conversion and processing functions, while the outdoor unit



performs RF signal receive and transmit amplification. The outdoor unit pictured above includes an integrated antenna for a complete link endpoint. Alternatively, an electronics-only version of the outdoor unit can be joined to a stand-alone 2-foot or 3-foot antenna for extended range operation.

RADWIN 2000 can carry TDM services, presenting multiple E1/T1 user ports, or act as an Ethernet bridge for packet services.

The maximum full-duplex throughput of a RADWIN 2000 link is a function of distance and antenna type. The following charts the maximum available speed as a function of distance for various antenna options:



*RADWIN 2000 Range vs. Throughput*

## IP Backhauling for Digital TV and Mobile TV Networks

Digital TV content distribution, or backhauling, has traditionally been done over TDM circuits but is rapidly migrating to packet services. With these, it is usually carried over IP using the Pro-MPEG standard:

Per Pro-MPEG, the MPEG multiplex is partitioned into consecutive groups of up to seven MPEG packets. Each such group is encapsulated in an IP packet, and the resulting IP packets are carried over a unidirectional RTP stream. The Code of Practice 3 (CoP 3) part of Pro-MPEG may optionally be used to introduce error correction coding into the stream: the transmitter generates and sends out redundant packets, which enable the receiver to fully reconstruct the stream in the presence of packet loss.

As an alternative to Pro-MPEG, RTP is sometimes replaced by UDP as the encapsulating method for MPEG over IP.



When traffic-engineering an IP link for Digital TV or mobile TV distribution, the following considerations need to be taken into account:

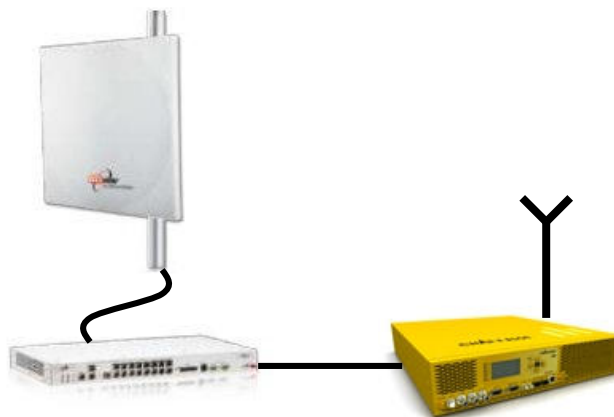
**Bit rate:** A TV backhaul stream will typically be Constant Bit Rate (CBR) in a Single Frequency Network (SFN) and moderately Variable Bit Rate (VBR) in a Multi-Frequency Network (MFN). While it is fairly tolerant to delay and jitter (see below), the necessary capacity for the stream needs to be available over any averaging interval that is longer than a few tens of milliseconds. Specifically, bandwidth sharing with volume applications such as FTP is not desirable unless proper bandwidth management mechanisms are in place: otherwise, the FTP stream might occasionally crowd out RTP for a period that is long enough to cause underflow of the TV transmitter's input buffer.

**Delay and jitter:** TV backhauling is fairly tolerant to delay and jitter. While video encoding and decoding are real-time in nature, the fact that the service is unidirectional means network delay is not critical and buffering can be employed to combat jitter. For MFNs, Channelot 100 includes a deep buffer that can accommodate jitter of hundreds of milliseconds. In SFNs, transmitters in general and Channelot 100 in particular need to include a worst-case delay plus peak jitter buffer of 1 second.

**Packet loss:** TV backhauling is sensitive to packet loss: the loss of a packet is likely to be noticeable to the viewer as a momentary distortion in the picture or soundtrack. In an SFN, furthermore, the loss of a packet will cause misalignment of the mega-frame, resulting in an even longer loss of the video signal. Therefore, of the main traffic engineering metrics, packet loss is the most sensitive parameter.

## Unlicensed Point-to-Point Microwave for TV Network Backhauling

A Channelot 100 transmitter can be gluelessly combined with a RADWIN 2000 microwave link to form a complete digital TV or mobile TV distribution plus transmission solution:



*A Digital TV or Mobile TV site implemented using a Channelot 100 transmitter and a RADWIN 2000 microwave link*

In this application, RADWIN 2000 is operated in native Ethernet mode, and its LAN output port is directly connected to the Data IP input of the Channelot 100 transmitter. The transmitter is configured to perform Pro-MPEG (or UDP) de-capsulation and – if chosen –



Pro-MPEG CoP 3 error correction decoding, thus recreating the digital TV or mobile TV multiplex for broadcast over the transmitter's service area.

Several unique features of Channelot 100 and RADWIN 2000 combine to handle the traffic engineering challenges involved in using IP links for TV backhauling:

Channelot 100 implements a deep input buffer that can accommodate up to 1 second of incoming traffic. This input buffer provides very high tolerance to network delay and jitter.

Several mechanisms implemented by RADWIN 2000 and Channelot 100 provide, between them, protection against the potential loss of IP packets over the unlicensed-band wireless link:

- RADWIN 2000 implements Automatic Channel Selection (ACS), a mechanism by which the two endpoints of the link autonomously select for operation the frequency channel within the license-free band which suffers the least interference. From then on, the level of interference on the selected channel is continuously monitored and once it is deemed unacceptable the system automatically performs channel re-selection in order to improve transmission conditions.
- RADWIN 2000 implements an Automatic Repeat Request (ARQ) protocol across the link. With ARQ, the receiving endpoint uses packet sequence numbering to detect missing packets, for which it then requests re-transmission. The receiver then uses a queuing mechanism to guarantee in-order deliver of normally received and re-transmitted packets. The end result is an error-free service at the expense of a small additional delay, which is easily handled by the input buffer of Channelot 100.
- Channelot 100 can be configured to perform packet-level error correction decoding according to the Pro-MPEG CoP 3 standard. With CoP 3, the head-end computes and sends out redundant IP packets that serve as an error correcting code for the TV payload carrying packets. Channelot 100 combines both packet types to reconstruct any missing payload packets. CoP 3 can be used in any one of a number of configurations that trade traffic overhead against error correcting capability: as an example, an overhead of 10% will provide error protection against a packet loss rate of close to 10%.

Between them, the mechanisms described above combine to provide a high-quality and robust TV backhaul solution even in a challenging interference environment.

## Conclusions

The combination of Channelot 100 and RADWIN 2000 offers the TV network implementer a distribution plus transmission solution that brings extremely cost-effective yet high-quality distribution together with a low-footprint, low-cost yet highly-functional transmission site implementation, for an extremely compelling overall proposition.