



Return Channel Terrestrial

A Wireless Return Channel system in the VHF/UHF Bands for Interactive Terrestrial TV incorporating Multiple Access OFDM.

Why DVB-RCT? And what is it?

It is now widely projected that revenues from TV commerce will exceed revenues from e-commerce in the home by 2008. T-commerce clearly requires a Return Path from the home back to the Digital TV Service Provider.

The current scenario of UHF/VHF bands shows a very congested spectrum in several countries that is a real problem for the introduction of new services.

DVB-RCT is THE response that offers a wireless interaction channel for Interactive Digital Terrestrial Television, even in the congested UHF/VHF bands:

- ✓ DVB-RCT is very spectrum efficient, low cost, powerful and flexible Multiple Access OFDM system
- ✓ DVB-RCT can serve large cells, up to 65kms radius, providing a typical bitrate capacity of several kilobits per second, for each TV viewer, even at the edge of the

coverage area. Typically, these large cells closely match the downstream coverage area of the Digital Television broadcast signal.

- ✓ DVB-RCT can handle very large peaks in traffic, as it has been specifically designed to process up to 20,000 short interactions per second in Tele-polling Mode, this in each sector of each cell.
- ✓ DVB-RCT can be employed with smaller cells, to constitute denser networks of up to 3.5km radius cells, providing to the user a bitrate capacity of up to several Megabits per second.
- ✓ DVB-RCT does not require access to spectrum on a primary basis, the system has been designed to use any gaps or under-utilised spectrum anywhere in Bands III, IV and V without interfering with the primary analogue and digital broadcasting services.
- ✓ DVB-RCT is able to serve portable devices; bringing interactivity everywhere the Terrestrial Digital broadcast signal is receivable
- ✓ DVB-RCT can be used around the world, which uses the different DVB-T system: 6, 7 or 8 MHz channels
- ✓ DVB-RCT does not require more than 0,5W rms power transmission from the User Terminal or Set Top Box to the base station.

DVB-RCT: a very Robust and Flexible Return Channel solution for DVB-T!

From a pure technical point of view, DVB-RCT is built around the most promising technologies for digital transmission and information theory; in addition to the uncontested benefits of first generation OFDM technology for broadband portable and mobile services, Multiple Access OFDM included in the DVB-RCT specification provides the following characteristics:

- ✓ Turbo Codes or Concatenated Codes
- ✓ Time Interleaving
- ✓ Band Segmentation (from 1 MHz slot up)
- ✓ Dynamically Assigned Adaptive Modulation
- ✓ Power Ranging to reduce interference

Turbo or Concatenated Coding

DVB-RCT is an extremely robust system. Turbo Coding or Concatenated Coding, which is employed, gives a further reduction in the required C/N ratio of 1.5dB. As a result, some Modulation Modes of DVB-RCT require a C/N of only 4dB!

Time Interleaving

Time Interleaving gives at least an additional 5dB improvement against the Impulsive Interference (the actual figure depends on the repetition rate of the interference). This ensures that the coverage area of the Multiple Access OFDM signals can be designed to closely match the service area of Digital Terrestrial Television broadcast, thus reducing the need for new installations.

Band Segmentation

Band Segmentation greatly eases the problem of access to spectrum: any 1MHz segment of spectrum can be used. This is particularly important as long as analogue terrestrial transmissions continue.

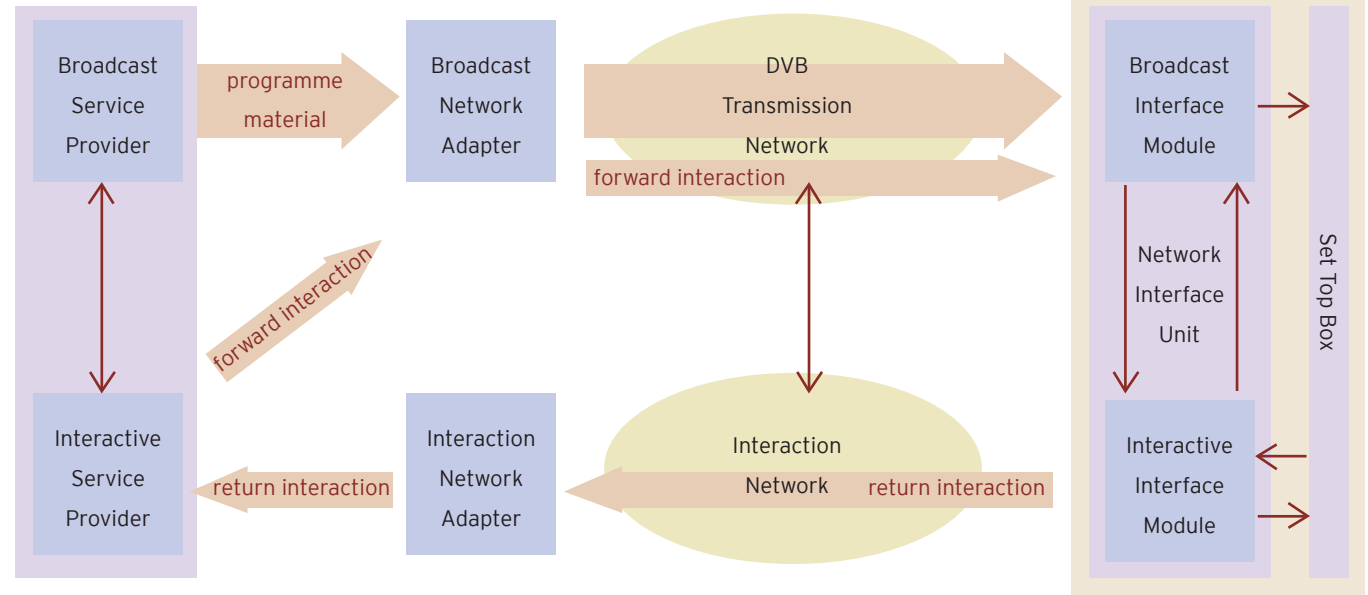
The spectrum signature of analogue TV is dominated by energy near the vision carrier. For example, if Channel 50 is used in Coverage Area A then DVB-RCT can use Channel 50 in the adjacent Coverage Area B at 2 MHz above the Vision Carrier, where the interfering energy is 30dB+ down relative to the vision carrier.

A key commercial advantage of Band Segmentation is that different Interactive TV Service Providers can be assigned their own 1MHz of spectrum and can thereby remain independent of one another.

Dynamically Assignable Adaptive Modulation (DAAM)

DVB-RCT supports within the same cell the simultaneous use of different types of modulation from 4QAM (1/2 rate) to 64 QAM (3/4 rate). This feature called "Dynamically Assignable Adaptive Modulation" enables the Service Provider to control the level of interference from a given cell into neighbouring co-channel cells while, at the same time making maximum use of the allocated spectrum.

This can be achieved by assigning the most robust form of modulation (e.g. 4QAM 1/2 rate) to users near the outer boundary of the cell allowing these users to use the minimum possible amount of power to transmit back to the Base Station. Conversely, users nearer to the center of the cell can be assigned less robust modulation, at the



expense of more power, to transmit back to the Base Station. Even these users, close to the center of a cell, will use more power to enjoy higher data throughput, as they are further away from other cells, they will cause less interference into the other co-channel cells.

Power Ranging

DVB-RCT uses a power ranging system, similar to that used in Cellular phones, to ensure that the lowest power is used by the Interactive Terminals at all times. This is also consistent with the need for spectrum efficiency.

Spectrum efficiency

The new features highlighted in Section 5 above ensure that DVB-RCT is highly spectrum efficient - a feature that will become more and more important over the next 5-10 years. DVB-RCT can rightly be seen as a 2nd Generation OFDM system.

Carrier spacing, burst structures

To provide a shared wireless return channel for Terrestrial distribution system, the DVB-RCT standard makes use of a dedicated radio frequency channel and organises it to allow concurrent access from many individual Interactive Terminals, using TDMA/OFDMA techniques.

The method used to organise the DVB-RCT channel is inspired by the DVB-T standard: a partition of the whole radio frequency return channel is performed in both time & frequency domains. Accordingly, the DVB-RCT RF channel provides a grid of time-frequency slots, which are distributed to the individual User terminals.

DVB-RCT has 3 Carrier Spacings (CS) and 3 Burst (slot) Structures (BS1, BS2, BS3) which cover a wide range of deployment scenarios from non-dense, very large broadcasting type cells to very dense networks of small cells.

	Size	Duration
CS1	~1 kHz	~1000 ms
CS2	~2 kHz	~500 ms
CS3	~4 kHz	~250 ms

Carrier spacing and symbol duration

Burst Structures offer various methods to map the user data among the time-frequency slots. In BS1 all the RF power is applied to a single carrier, in BS2 the power is shared across 4 carriers and in BS3 the power is shared across 29 carriers. Whatever the spread of user data amongst the frequency carriers (ie: whatever the Burst Structure used), a fixed number of bytes must be transferred in any given transmission slot. This results in the various duration of the Burst Structure transmission: BS1 being 29 times longer and BS2 being 4 times longer than BS3.

These features allow a trade-off between transmission time duration and occupied bandwidth.

Cost of DVB-RCT

The overall system costs are made up of User Terminal Costs and Base Station Costs. There is also, of course, the cost of the backhaul-linking network from the Base Stations to Service Provider's main hub - although this will normally be in place for existing broadcasting networks. The reason that DVB-RCT is so cost effective is that a single low cost receive system at the Base Station can process up to 20,000 short interactions per second.

For instance, in the 2k mode, 59 interactions from different subscribers can be processed at a rate up to 600 every second!

DVB-RCT can be deployed for a small fraction of the cost of any competing system - for example PSTN, XDSL, GSM or UMTS.

DVB-T and DVB-RCT networks can be designed to provide totally 'wire-free' services in the home.

This results in enormous savings to the Service Provider - as it is not necessary to send a technician or antenna erector to each subscriber's home before the service can be initiated.

For further information...

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PHYSICAL PARAMETERS

Downstream Channel (DS)	OFDM, ETS 300 744 (DVB-T) compliant
Return Interaction Channel	Multiple Access OFDM (MA-OFDM)
Forward Interaction Channel (US)	Embedded in DS, compliant with ETS 300 744 (DVB-T)
OFDM Carrier set	1024 (1K), 2048 (2K)
OFDM Carrier spacing (CS)	~1K, ~2K, ~4K
Transmission modes	6 modes (as combination of 3 CS and 2 Carrier set)
Carrier shaping	Nyquist, Rectangular
Guard Interval	⊕, 1/8, 1/16, 1/32 (for Rectangular shaping only)
Transmission Frames	TF1, TF2
Data randomization	PRBS with polynomial: 1+X14+x15
Modulation	QPSK, 16QAM, 64QAM
Encoding rates	⊕, ⊕
Useful data payload per burst	18, 27, 36, 54, 81 bytes (1 burst = 144 modul. Symbols)
Channel codes	Turbo or concatenated (Reed-Solomon + Convol.)
Interleaving	Random Interleaver - PRBS with polynomial: 1+X3+x10
Burst Structures	BS1, BS2, BS3
Frequency hopping	for BS1 only (optional)
Medium Acces Schemes	MAS1, MAS2, MAS3 (as combinations of BS and TF)
Net Bit rate /carrier (range)	0.6 Kbit/s - 15 Kbit/s (depending on the mode)
Maximum carrier / user	
Service range	Up to 65 km (cell radius)
Channelisation	6, 7, 8 MHz channels are supported

PROTOCOLS

Medium Access Control	Specs mostly derived from EN 300 800
Access options	Fixed rate access, Contention access , Reservation access
Security	Supported (derived from EN 300 800)