Data Tunnelling: digital transmission compression technique

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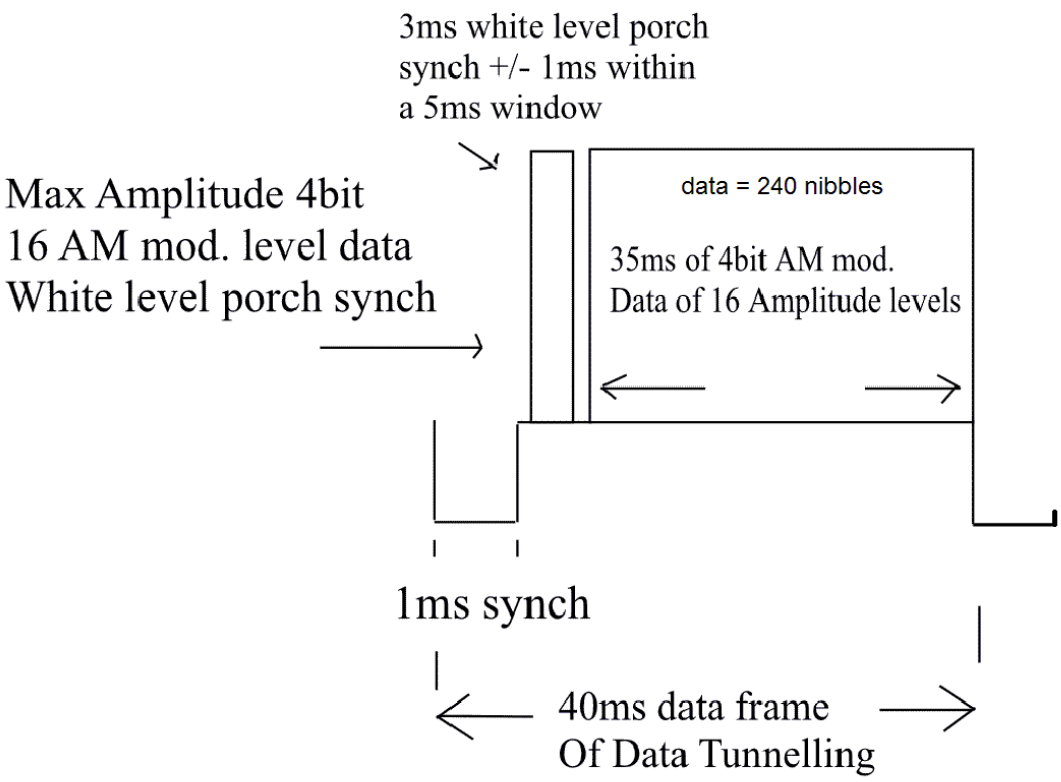

"I" and "Q" RF carrier signalling transmission of Data Tunnelling.

The above diagram illustrates a data frame timing diagram of the “Data Tunnelling” digital transmission compression technique.

The principle is based on the QPSK carrier system, but with a few tweaks added to the original principle.

The first alteration is the use of a peak amplitude porch, similar to a white level porch from analogue television. The porch is used to provide a signal reference voltage for the analogue to digital conversion process of the data package on the synch framing system. The white level porch provides the ADC reference voltage by using a “sample and hold circuit”, capturing the signal pulse amplitude.

The idea and method behind the white level porch signal pulse is to overcome signal fading within the received data signal carrier. As the signal fades so would the white level porch pulse, but the reference voltage for the ADC would also vary in sympathy as the received RF signal, thus keep the signal conversion accuracy afloat.

The negative 1ms synch pulse is to illustrate to the decoding signal modem the start of the 39ms data frame. The first 4ms contains the white level synch is followed by the 35ms data block. The data block is this example consists of 240 nibbles, which equates to 240 ½bytes or 4bits. The data is encoded as amplitude modulated data signal as $2^{\wedge 4}$ = 16, therefore a full 4bits would equate to a signal voltage of 16, which may equate in sympathy as a 1·6Volts at full amplitude, data of “F hex”.

The above image illustrates one carrier out of two, using an “I” and “Q” carrier format. By combining both signal carriers, an 8 bit or one byte data sequence would follow from the two 4bit nibbles, one set of 4bit nibble from each carrier of the “I” and “Q” combined signals.

To aid the error correction of the modem, an addition technique may be to use an 8bit ADC device. The 256 levels of an 8bit ADC convertor, divided into 16levels would give an area of margin on the 8bit Adc for the 4bit nibble, creating an additional hardware error correction in the overall "I and Q" ADC decoding.

Referring to the timing diagram, the 240 nibbles are sent a transmitted at a rate of 25 times per second.

Equates to 240 nibbles * 25 repeat frame rate * 2 ("I and Q" carriers) = 12000bits of overall data per second.

The data burst rate then over a 35ms frame time period equates to 13,714bits/sec bandwidth.

However the twin "I and Q" carriers equate to a parallel data bus of 8bits, hence the serial data link rate equate to:

12,000 * 8 = 96,000bits, or 96Kbits/sec.

However the RF bandwidth in this case is equal to the parallel data rate, in the form of the "I and Q" signal.

The base bandwidth is half the data rate, hence 6,000Hz but effectively over a 35ms frame period equates to 6,857Hz. The RF bandwidth is twice this at 13,714Hz between the first data null points on the RF spectrum plot.

If we change the parameters to using a data block of 1024 nibbles over 25 frame repeat rates per second, then this equates to a data through put of 25,600bits/sec at a burst data rate of 29·257Kbits/sec. A BBC Basic mathematical model has been written to calculate the signal parameters, shown below:

```
Number of nibbles (4bits) per I/Q carrier = 1024 Nibbles
data_block_time = 35ms        synch_clamp_time = 5ms        frame_time_length = 40ms
repeat rate of data frame per second = 25 Hz
nibble data_baud_rate_for_block = 29257.1429 = Nibbles/sec
AF base_band_bw = 14628.5714 Hz
AM carrier RF_bw = 29257.1429 Hz
overall data nibble baud rate per carrier = 25600 nibbles/sec
overall transmission I and Q byte baud rate = 50 Kbytes/sec
overall transmission I and Q bit baud rate = 400 KBits/sec
```

However I have found a technical reference from the Adobe website for "FLV" video files. Two studies based on this website calculator have been completed. The technical data speeds required have been modelled within the data tunnelling CAD program. The results for TV media free-view are listed first. The second is a video phone application for mobile radio video communications.

http://www.adobe.com/jp/devnet/flash/apps/flv_bitrate_calculator.html

Mobile Radio Video communications

For mobile radio video communications, a smaller pixel size has been modelled, a video format of 480 * 360 pixels.

```
http://www.adobe.com/jp/devnet/flash/apps/flv_bitrate_calculator.html
aspect ratio 4:3, width 480 pixels, height 360 pixel, frame rate 24Hz
motion average, video codec avc-H.264
audio = AAC, sampling rate 11.025KHz, Stereo mono, quality = medium
encoding method = 2 pass VBR
contents mixed,  sound track = mixed, flash player 9.0, 11+
flash player video file = http

total FLV bit rate = 393Kbps, recommended connection speed 472Kbps


Number of nibbles (4bits) per I/Q carrier = 1072 Nibbles

data_block_time = 40ms       synch_clamp_time = 2ms        frame_time_length = 42ms

repeat rate of data frame per second = 23.8095238 Hz

nibble data_baud_rate_for_block = 26800 = Nibbles/sec

AF base_band_bw = 14070 Hz

AM carrier RF_bw = 28140 Hz

overall data nibble baud rate per carrier = 25523.8095 nibbles/sec

overall transmission I and Q byte baud rate = 49.8511905 Kbytes/sec

overall transmission I and Q bit baud rate = 398.809524 KBits/sec
```

Ideas such as real time police relay video to headquarters from either on beat patrol around the neighbourhood, or from police car video in real time to headquarters, could be perhaps useful. Situation decisions reports can make by HQ guidance given relative to the real time online video requirement reports.

Using mobile video communications may also by useful for air traffic control; the air-line pilot then able to see the air traffic controller so would also the air-line pilot. Perhaps also a video relay from inside the aircraft cockpit for security concerns of a “hi-jacking” would perhaps be useful.

Looking further afield, the use of mobile radio video to give military orders so one can see their commanding officer may be perhaps also useful. From this situation strategic video of the battle field relayed in real-time over a mobile radio channel could be handy.

As the mobile video RF bandwidth could be as low as 30KHz between the first data null points on the frequency spectrum, the use of the data tunnelling for HF frequency use may be possible. In this regard, propagation distances of not just tens, but hundreds or even thousands of miles could be to hand.

TV media standard definition free-view

With a Freeview standard definition picture, the data tunnelling modem reduces the transmission bandwidth to within 100KHz. Each TV station could be 150KHz apart, using a 50KHz guard band space between each TV station. Over an original analogue 8MHzTV channel space, by using data tunnelling, some 50 TV stations could be placed of fitted into the original 8MHz channel space allocation.

```
http://www.adobe.com/jp/devnet/flash/apps/flv_bitrate_calculator.html
aspect ratio 16:9, width 900 pixels, height 506 pixel, frame rate 24Hz
motion average, video codec avc-H.264
audio = AAC, sampling rate 22.050KHz, Stereo sound, quality = medium
encoding method = 2 pass VBR
contents mixed,  sound track = mixed, flash player 9.0 - 11.5+
flash player video file = http

total FLV bit rate = 1349Kbps, recommended connection speed 1619Kbps


Number of nibbles (4bits) per I/Q carrier = 3800 Nibbles

data_block_time = 40ms       synch_clamp_time = 2ms        frame_time_length = 42ms

repeat rate of data frame per second = 23.8095238 Hz

nibble data_baud_rate_for_block = 95000 = Nibbles/sec

AF base_band_bw = 49.875 KHz

AM carrier RF_bw = 99.7500001 KHz

overall data nibble baud rate per carrier = 90476.1905 nibbles/sec

overall transmission I and Q byte baud rate = 176.71131 Kbytes/sec

overall transmission I and Q bit baud rate = 1413.69048 KBits/sec
```

The “Carmel transmitter at Cross Hands” transmits four TV multiplexers, but by implementing data tunnelling at 150 KHz channel spacing, up to as many as 200 TV stations could flow out from the Carmel transmitter. One thought that comes to mind, the “Band Two FM” allocation, by using data tunnelling, an additional digital broadcast signal of ”video with stereo sound” for in-car, coach travel, aircraft inflight or home entertainment could be included on “Band Two FM” band plan.

TV media HD free-view

HD free-view is a pixel range of 1920 * 1080 for the display TV picture. Using data tunnelling method, the RF bandwidth is within the 500KHz range.

```
http://www.adobe.com/jp/devnet/flash/apps/flv_bitrate_calculator.html
aspect ratio 16:9, width 1920 pixels, height 1080 pixel, frame rate 24Hz
motion average, video codec avc-H.264
audio = AAC, sampling rate 22.050KHz, Stereo sound, quality = medium
encoding method = 2 pass VBR
contents mixed,  sound track = mixed, flash player 9.0 - 11.5+
flash player video file = http

total FLV bit rate = 6080Kbps, recommended connection speed 7296Kbps


Number of nibbles (4bits) per I/Q carrier = 16500 Nibbles

data_block_time = 40ms       synch_clamp_time = 2ms        frame_time_length = 42ms

repeat rate of data frame per second = 23.8095238 Hz

nibble data_baud_rate_for_block = 412500 = Nibbles/sec

AF base_band_bw = 216.5625 KHz

AM carrier RF_bw = 433.125 KHz

overall data nibble baud rate per carrier = 392857.143 nibbles/sec

overall transmission I and Q byte baud rate = 767.299107 Kbytes/sec

overall transmission I and Q bit baud rate = 6138.39286 KBits/sec
```

TV media 4K free-view

Ultra HD or 4K TV free-view is a pixel range of 3840 * 2160 for the display TV picture. Using data tunnelling method, the RF bandwidth is within the 2MHz range.

```
http://www.adobe.com/jp/devnet/flash/apps/flv_bitrate_calculator.html
aspect ratio 16:9, width 3840 pixels, height 2160 pixel, frame rate 24Hz
motion average, video codec avc-H.264
audio = AAC, sampling rate 22.050KHz, Stereo sound, quality = medium
encoding method = 2 pass VBR
contents mixed,  sound track = mixed, flash player 9.0 - 11.5+
flash player video file = http

total FLV bit rate = 24177Kbps, recommended connection speed 29012Kbps


Number of nibbles (4bits) per I/Q carrier = 68500 Nibbles

data_block_time = 40ms       synch_clamp_time = 2ms        frame_time_length = 42ms

repeat rate of data frame per second = 23.8095238 Hz

nibble data_baud_rate_for_block = 1712500 = Nibbles/sec

AF base_band_bw = 899.062501 KHz

AM carrier RF_bw = 1798.125 KHz

overall data nibble baud rate per carrier = 1630952.38 nibbles/sec

overall transmission I and Q byte baud rate = 3185.45387 Kbytes/sec

overall transmission I and Q bit baud rate = 25483.631 KBits/sec
```

TV media 8K free-view

Unfortunately for 8K TV (7680 * 4320 pixels), the calculation specifications used for the “Flv” file, seems to produce figures that I am not quite sure how to interpret for the data tunnelling model.

http://www.adobe.com/jp/devnet/flash/apps/flv_bitrate_calculator.html