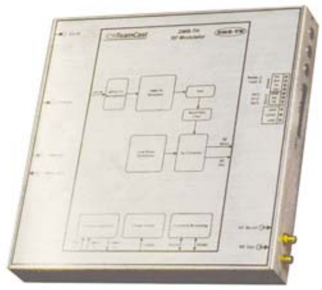
TeamCast

Rennes, May, 2nd - 2007

Get China ready for Single Frequency Network!
(using the Chinese DMB-T terrestrial DTV standard)

TEAMCAST is surfing the technologic wave of DMB-T: having been the first company to exhibit (at IBC-2006) a modulator generating a real-time DMB-T signal to a prototype decoder. TEAMCAST and their Chinese partner DIGITAL HORIZON demonstrated at CCBN a DMB-T Single Frequency Network in full operation. Two new released products were used: the MIP-1000 (MIP-Inserter) and the MCN-2000 (Modulator) both supporting MFN and SFN operating modes. Additionally, the GFX-1000 product - a versatile Repeater/Gap-filler engine - is available for DMB-T network extension.



The DMB-T Modulator

The magic of SFN

The Chinese digital terrestrial TV broadcast standard, issued last August 2006 and referenced as GB20600-2006, embraces both a single-carrier vestigial sideband mode (VSB) and a multi-carrier Time Domain Synchronous OFDM mode (TDS-OFDM). The multi-carrier transmitted signal conveys a series of hierarchical frames. Instead of the cyclic prefix used in other standards (the so-called “Guard Interval”), in TDS-OFDM a Frame Header precedes each data-frame body to convey a PN sequence. This “Guard Interval” eases the demodulator channel estimation and synchronization especially when receiving multi-paths signals, but it also provides the means to deploy Single Frequency Networks (SFN)! As shown in the Figure 1 in the case of 8 MHz channel bandwidths, three operating modes have been defined with three different frame header durations. The longer is this “Guard Interval”, the larger the distance between transmitters can be, but the smaller is the useful bit rate.

Channel Bandwidth	**8 MHz**	**8 MHz**	**8 MHz**
Frame Header Mode	FH-Mode 1	FH-Mode 2	FH-Mode 3
Guard Interval Equivalence	1/9	1/6	1/4
Data Frame Duration	500 µs	500 µs	500 µs
Frame Header Duration	55.56 µs	78.7 µs	125 µs
Maximum TX distance	**17 km**	**24 km**	**38 km**

Fig.1: Frame Header modes in the Chinese DTV standard

During the last decade, the efficiency of SFN has been proven in the field and especially appreciated in terrestrial Digital TV deployment (both DVB-T and DVB-H). SFN fulfils multiple broadcasters’ objectives: extending digital network coverage, improving ONAIR signal robustness to enable portable reception, re-enforcing existing service penetration by filling “coverage holes”, etc. One key advantages of SFN is to achieve the same service coverage with significant smaller radiated power as compared with a single high power MFN transmitter!

TEAMCAST’s expertise takes the benefit of more than 15 years’ experience in OFDM technology and terrestrial DTV network roll-out. Pointing out that the broadcasters are expecting a high level of performances for SFN modulators, TEAMCAST Product Line Manager Eric PINSON said: “Close relationships with broadcasters during SFN network implementations has provided TEAMCAST with unique practical feed-back and knowledge. The very latest state-of-the-art technological features are available now in TEAMCAST's DMB-T modules!"

Spectrum analyzer usage limits

Installing and tuning a SFN network is not something trivial. To operate in SFN, each of the transmitters must fulfill the SFN "golden rules": to transmit the same bit, at the same time and on the same frequency. In laboratory environments, SFN operation is easily obtained with synchronized modulators: by adjusting the modulator's static delay (i.e. the absolute time offset that can be added to adjust the SFN time alignment). The correct SFN alignment of the network equipments can be checked and the relationship between the time domain and the frequency domain can be highlighted. For instance, the channel spectrums shown in Figures 2 & 3 have been respectively measured for a time shift of 1µs and 5µs.

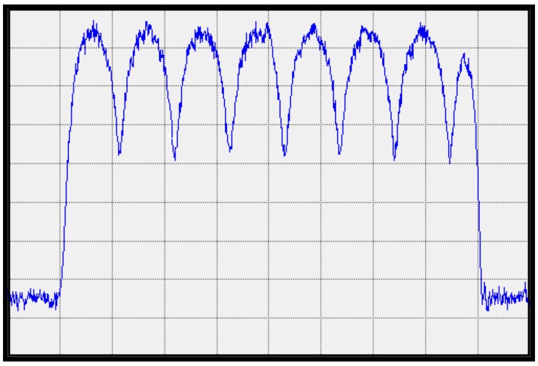


Fig.2: In labs SFN spectrum with ΔT=1µs

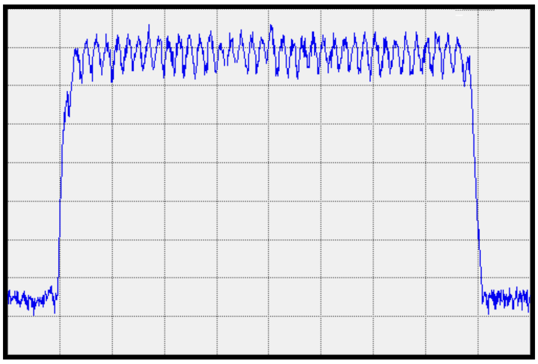


Fig.3: In labs SFN spectrum with ΔT=5µs

These plots show the in-band frequency "echoes" or "bounces" that depend on the time alignment shift between the two transmitted signals. Accordingly, fine tuning of the SFN drives is used to reduce the bounces by aligning the RF signals. The bounces period, which is directly derived from the time shift, becomes less and less measurable because the number of bounces increases with the time shift. In practice, the spectrum analysis becomes useless for SFN signal alignment for a time shift greater than 5µs! Moreover, on-field signal spectrum measurements are quite unstable and noisy as additional signal impairments can occur such as signal fading due to natural echoes, as shown in Figure 4. Therefore, another measurement is needed on the field to allow fine tuning of SFN synchronization in practice…

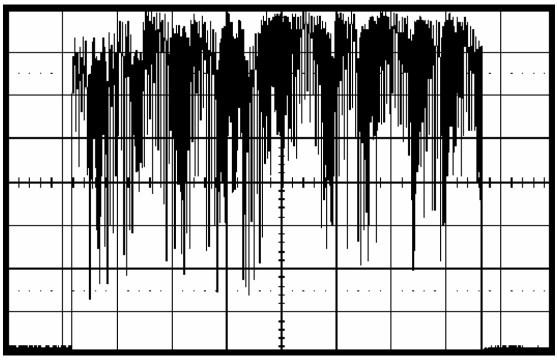


Fig.4: In-field SFN spectrum

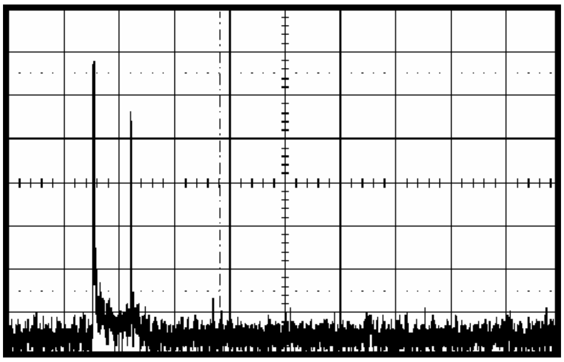


Fig.5: SFN Channel Impulse Response

Essential CIR monitoring

In real implementations, SFN network tuning is a tricky process. Multiple experiences have demonstrated to TEAMCAST the necessity to use Channel Impulse Response (CIR) monitoring to adjust on-field the SFN synchronization. Figure 5 shows a typical CIR display, here with a SFN formed from two transmitter sites.
Similarly to all OFDM based technologies, DMB-T SFN network installation will require CIR monitoring facilities. As the DMB-T technology is very new & innovative, tests and the availability of measurements equipment for DMB-T solutions is very limited, while, at the same time, the Chinese market demands are growing very strongly and it is seen already that SFN DMB-T trials are happening.

For these reasons, TEAMCAST has designed and implemented an innovative DMB-T test mode within its DMB-T modulator. This test mode has two objectives:

1- To authorize the usage of standard monitoring tools, especially to monitor the CIR
2- To ease the DMB-T SFN network installation and tuning in the field

"By enabling this test mode on each transmitter site the technician in charge of the SFN network installation can use a DVB-T monitoring unit to monitor the CIR in the field. The availability of the "Channel Impulse Response" makes it easier and faster to align the received signals when adjusting the static delays at each transmission site. Once this adjustment process has performed, the operational DMB-T mode can be enabled" explained Eric PINSON.
Note that the differences between the DMB-T and the DVB-T data and framing (in particularly the guard interval format and TPS data) have no impact on the methodology to tune SFN transmitters. In both standards, the SFN tuning aims at adjusting signal propagation delays that mainly depend on the transmitter site characteristics (location, ERP power, antenna diagram and height, etc.) and on the receiving conditions. Therefore the test mode implemented by TEAMCAST is fully applicable to DMB-T SFN network tuning, as soon as the generated signal output from the modulator has similar characteristics.

MIP Control: when optional fields become mandatory!

A typical DMB-T network consists of a Network Operating Center (NOC), plus a distribution telecom network that conveys the MPEG-TS stream from the NOC to the transmitter sites using Radio links with PDH or SDH transmission. At the NOC, a digital head-end is installed using video encoders and a multiplexer. The MIP Inserter is connected to the multiplexer output to perform the bit rate adjustment and to time stamp the multiplex. Then the signal is distributed via the telecom network to each of the DMB-T transmitters, operating in SFN mode.
Practically, there two main parameters to be adjusted during SFN tuning: transmitter power and time offset delay. In the old days of SFN installations, a technician at each transmitter site received directions via telephone and then adjusted the static delay or muted the transmitter. This was very time consuming, unreliable and difficult to organize.
Today, thanks to the MIP packet control data, it is possible to remotely control such commands from a unique and single site: the power control (tx_power_function) and the static delay (tx_time_offset_function) adjustment commands are parts of the optional fields defined in the MIP packet used by TEAMCAST.

TEAMCAST has implemented within both the MIP inserter and the DMB-T modulator product range basic controls using the MIP packet fields to ease the SFN tuning process. This is one of the strengths of the global OEM solution provided by TEAMCAST for DMB-T. Beyond such implementation innovations, TEAMCAST products additionally implement an advanced management process that detects and handles any loss of the critical synchronization signals (1 PPS and 10 MHz).

“With our local Chinese partner DIGITAL HORIZON, we are ready to support Chinese broadcasters, by providing high performance technologies and by sharing our practical experience of deploying SFN networks”, said Eric PINSON.

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