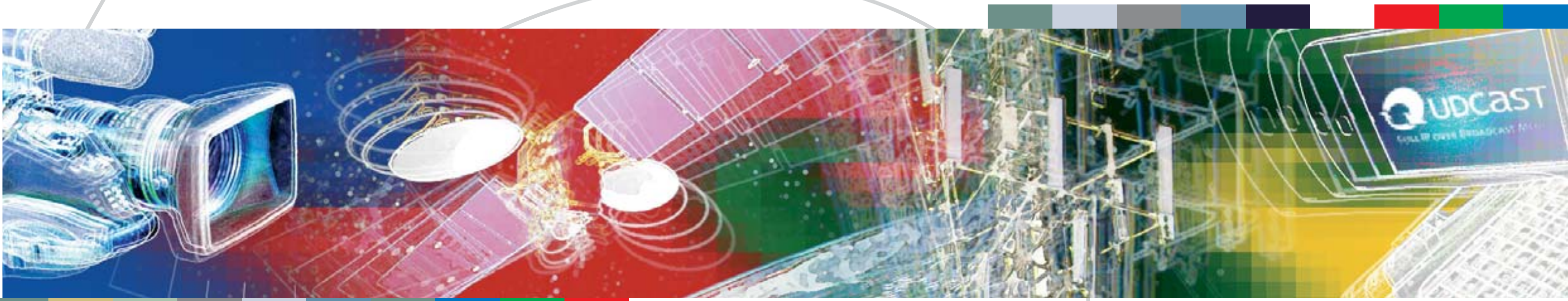
WHITE PAPER



MIP insertion in DVB-H networks

Abstract

This document describes the principles of the SFN (Single Frequency Networks) mechanism in DVB-H networks based on the usage of the Megaframe Initialization Packets. Both the traditional approach to the network architecture, as well as the innovative solution of UDcast are described. The UDcast's solution enables simplification of the network head-end by an integration of the MIP insertion function into a DVB-H IP Encapsulator.

UDCAST

IP • BROADCAST • WIRELESS

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1. INTRODUCTION TO MIP INSERTION

In todays Mobile TV broadcast Networks, SFN Transmission is a mandatory requirement due to the high number of required transmitters for a given Transmission Cell.

The size of the transmission cell is usually determined by international frequency planning and allotments. The most recent international Frequency Planning meeting was held in Geneva at the Regional Radiocommunication Conference in the year 2006, and is usually referred to as "GE06" frequency planning.

The GE06 Final Acts has been signed by 101 nations in Geneva, for the planning of the digital terrestrial broadcasting service and replacing parts of current agreements (ST61, GE89) In the frequency bands 174 - 230 MHz and 474 - 862 MHz.

The new GE06 agreement will regulate use of VHF and UHF band III,IV and V for decades, including mobile broadcasting under the DVB-T "spectrum mask".

Given the radio planning constraints, there are 2 options to obtain satisfactory coverage for Mobile reception within a Broadcasting Area:

1. Use different frequencies from the available GE06 frequency plan in order to have 1 Transmitter per used non-adjacent Frequency. This is called MFN (Multiple Frequency Network Architecture).

2. Use different Transmitters all operating at the same Frequency (Single Frequency Network Architecture).

While **option 1** (MFN) is technically easy since it does not require careful synchronization of the transmitters, it is uneconomical in terms of frequency usage, since it requires a minimum of 3 frequencies of the available allotment of GE06. Therefore MFN networks are totally unrealistic for Mobile TV network deploments, given the required higher transmitter density.

Therefore **option 2** (SFN) will be required for mobile TV networks, meaning the Transmitters will have to be carefully synchronized between each other in other not to interfere, but to help each others signal, creating the so-called SFN gain.
In order to achieve this careful synchronization, a central device has to insert a timing reference common to all transmitters. This is done by a device or function called the MIP inserter or also SFN adapter.

The MIP (Megaframe Initialization Packet) Inserter ensures homogeneous SFN network setup by making all transmitters in the network operate in a synchronized and simultaneous way.
The MIP insertion occurs once per megaframe, with a time interval dependent on the chosen guard interval. The MIP indicates the start of the transmission of the first packet in a mega-frame (Synchronization Time Stamp, STS). The time reference is usually an external 1 pulse per second signal, available from a GPS clock or other precise time source, combined with a 10 MHz reference clock input.

2. TRADITIONAL ARCHITECTURE

The MIP is usually inserted into the mega-frame by a dedicated appliance, called MIP Inserter (or SFN Adapter).

The Figure 1 shows the traditional architecture with an external MIP Inserter.

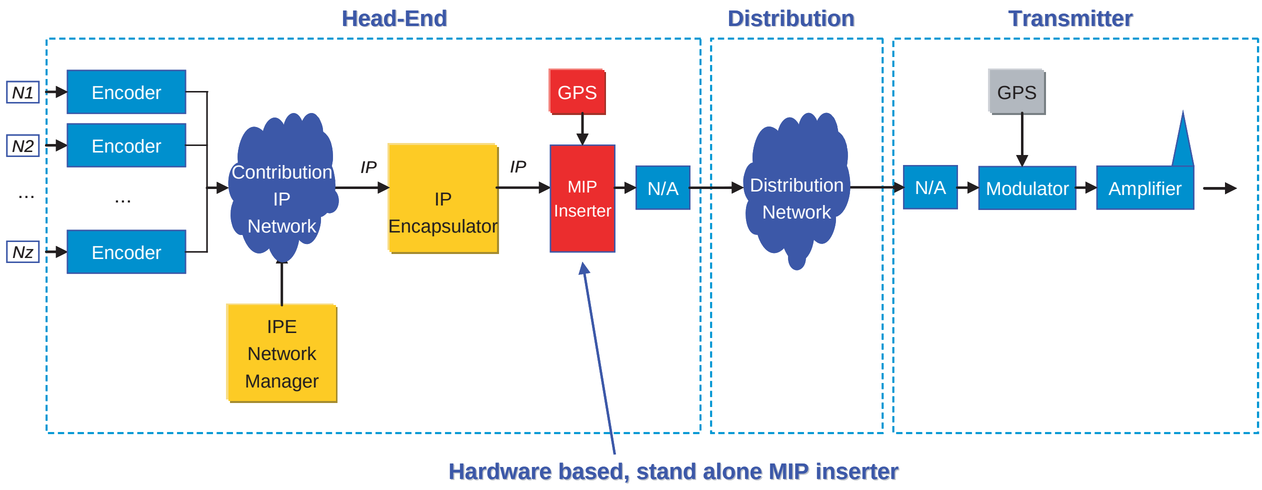

Figure 1 - Traditional architecture with MIP in separate device

The traditional approach can enable any DVB-H network to work in the SFN mode, however it requires installation of additional MIP insertion component in the head-end, along with its direct connectivity to the GPS time reference. The stand-alone MIP Inserter requires dedicated management and might become a single point of failure for the entire network. Moreover access to an GPS antenna may not be easy in some spaces.

3. INTEGRATED MIP INSERTION

The latest DVB-H IP Encapsulation technology enables for the first time integration of the MIP Insertion function directly into the IP Encapsulator. This solution reduces the number of components in the head-end, simplifies the management and increases reliability of the entire system.

The MIP insertion function is available as a pure software option, and benefits from all the centralized management tools, redundancy features and existing NTP (network time protocol) facilities already put in place for the IP Encapsulator.

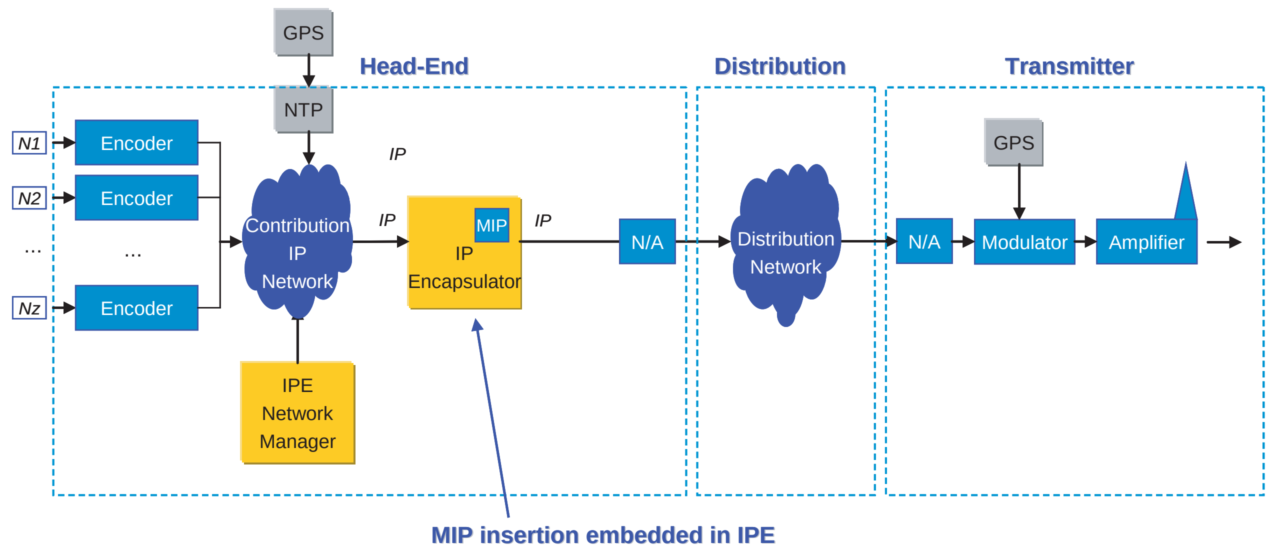

Figure 2 - New architecture: MIP insertion in IPE

The MIP insertion is generated based on the NTP (Network Time Protocol) information which the IP Encapsulator is synchronized onto. The precision of this MIP insertion is the same or better as an external SFN adapter. The values for the MIP time signaling (STS offset and Pointer) are calculated mathematically using patented technology.
The time supplied by the NTP server should be precise up to +/- 10 milliseconds. The IP network jitter between the NTP server and IPE-10 will have to be taken into account when determining the max SFN delay. Very good NTP time sources are GPS receivers that also generate 1PPS/10MHz and have a built-in NTP server.

4. TRANSMITTER MANAGEMENT

The DVB standard enables to use Megaframe Initialization Packet (MIP) to configure the entire transmitter networks directly from the head-end. An IP Encapsulator that feeds one or several transmitters can configure them automatically via the MIP parameters.

The MIPs can be used to provide parameters such as modulation, code rate, constellation, etc. A complex distribution network made up of several transmitters can be configured directly and quickly from a single point.

Typically, in order to slightly modify the area covered by a transmitter, the operator can modify the power thanks to 'Power dB' field. All these fields will be addressed to the transmitter thanks to specific 'function' (Cell ID, frequency offset, time offset, transmit power, private data) as defined in ETSI TS 101 191 "DVB mega-frame for Single Frequency Network (SFN) synchronization).

The following parameters can be configured with a Megaframe Initialisation Packet.

- **Identifier**: Transmitter identifier to address individual or groups of transmitters.
- **Cell ID**: Cell identifier linked to the transmitter.
- **Frequency offset**: The deliberate frequency offset to the centre frequency of the RF channel in use.
- **Time offset**: The deliberate offset in time of the transmitted signal, relative to the reference transmission time.
- **Private data**: The private data to send to the transmitter via the MIP. They can be used for proprietary functions.
- **Power dB**: The power of the transmitter defined as the ERP (Effective Radiation Power).

Usage example:
MIPs are dedicated packets used to configure remotely transmitters of a distribution network.
In the following case, MIPs indicate to the transmitters that the constellation must be set to 16 QAM.
Morevover thanks to specific fields in the MIP, transmitters can be addressed individually. For example, power dB has been used to increase the area covered by the transmitter 2. This has been done thanks to a 'function' addressed to this transmitter (Tx identifier #2).

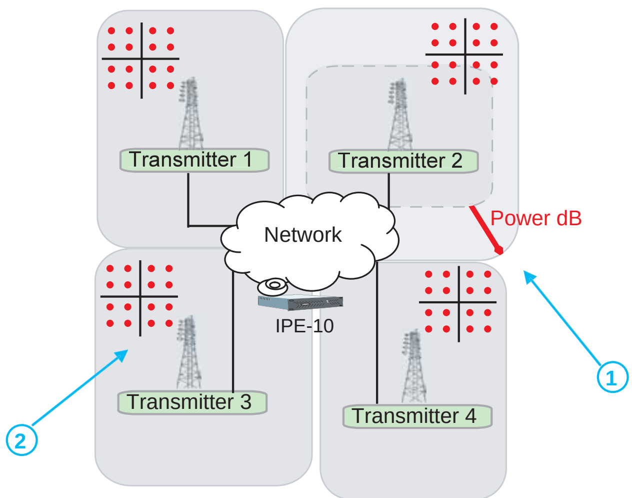

Figure 3 - MIP insertion

(1) - When functions are used, transmitter configuration can be changed individually in addition to common frequency parameters.
(2) - When a transmitter belongs to a cell, it will use common frequency parameters (here 16 QAM constellation for example).

5. CONCLUSIONS

The IP Encapsulator with MIP insertion feature provides the following benefits to the broadcasters:

1. Replaces the external hardware-based MIP inserter, saving the precious space, reducing costs and simplifying installation.
2. Takes benefits of the central and unified management for IPE, iSplicers and MIP via IPE Manager - reduces the management costs and human error factor. Ensures coherence of NIT, Cell ID, and RF configuration parameters.

Additionally, the embeded MIP insertion removes the GPS as a single point of failure from the head-end and entire system, since the NTP based solution offers possibility of redundancy. There might be no need for any specific GPS dedicated for MIP insertion, if an accurate NTP server is already in place. The MIP features benefits also from the hardware redundancy options installed with the IP Encapsualtors.

6. ORDER INFORMATION

Any UDcast DVB-H IP Encapsulator can be outfitted with the MIP insertion feature starting with version 4.2. It is possible to order the IPE-10 with the MIP insertion Option already factory installed.

Part Numbers:

HH-IPE10MIP	IPE-10 with factory installed MIP insertion function (replaces stand-alone MIP inserter/SFN adapter). HH-IPEMANMIP is mandatory to use this feature.
HS-OPTIPEMIP	Post-install MIP insertion function for HH-IPE10 (replaces stand-alone MIP inserter/SFN adapter). Requires version 4.2 or higher, HH-IPEMANMIP is mandatory to use this feature.
HH-IPEMANMIP-L*	IPE-Manager with factory installed MIP insertion option
HS-OPTMANMIP	Post-install MIP insertion management for HH-IPEMANAGER-L* to manage HH-IPE10MIP. Requires version 4.2 or higher.

ABBREVATIONS

DVB	Digital Video Broadcasting
DVB-H	Digital Video Broadcasting - Handheld
GPS	Global Positioning System
IPE	IP Encapsulator
MFN	Multi Frequency Network
MIP	Mega-frame Initialization Packet
NTP	Network Time Protocol
pps	pulse per second
SFN	Single Frequency Network
TS	Transport Stream
TX	Transmitter

7. Q&A ON MIP INSERTION FUNCTIONALITY IN THE IPE-10

Q: How is the MIP insertion generated on the IPE-10?
A: MIP insertion is generated from the NTP (Network Time Protocol) information which the IPE-10 is synchronized onto.

Q: How precise is the MIP insertion compared to an external SFN Adapter/MIP inserter?
A: The precision is the same or better as an external SFN adapter. The values for the MIP time signaling (STS offset and Pointer) are calculated mathematically using patented technology. The time supplied by the NTP server should be precise up to +/- 10 milliseconds. The IP network jitter between the NTP server and IPE-10 will have to be taken into account when determining the max SFN delay.

Q: How can an IPE-10 guarantee a precise ASI output bitrate required for SFN operation?
A: The IPE-10 ASI output bitrate is precisely controlled by a feedback mechanism, where the ASI output bits are counted and compared with the number of bits that should have been sent in a certain time window. From this comparison, the ASI output bitrate is very smoothly corrected.

Q: Is there a particular NTP time source that is recommended for use with IPE-10?
A: Any NTP time source synchronized to UTC (Universal Time Coordinated) can be used, but in order to mitigate the IP network jitter, it is recommended to have the NTP server as few router hops as possible from the IPE-10. Very good NTP time sources are GPS receivers that also generate 1PPS/10MHz and have a built-in NTP server.

Q: What happens if the NTP time source looses its synchronization?
A: Exactly the same than when using an SFN adapter. The time drift is then only dependent of the drift of the NTP time source. The more precise the NTP time source is, the more precise the MIP insertion will be on the IPE-10. The behavior is the same when the NTP server regains its synchronization. For the IPE-10, everything is fine since the NTP time source is active and reachable.

Q: What happens if the IPE-10 looses connectivity with the NTP time server?
A: The IPE-10 generating the MIP has synchronized its internal clock on the NTP time source and the maximum time drift when NTP time source is lost is about 0.3 ppm, meaning a maximum time drift of less than 1ms per hour. This means the IPE-10 can run for a few hours without connectivity to its NTP time server.

Q: What happens when the IPE-10 regains connectivity with the NTP time source?
A: When the IPE-10 resynchronizes with the NTP time, the possible time difference that accumulated during the NTP absence will be slowly corrected to converge gracefully towards the NTP time, meaning that the downstream SFN modulators will continue to operate normally.

Q: Since NTP needs to converge for a certain time, what is this convergence time on the IPE-10?
A: When the IPE-10 leave the UDcast factory, their NTP clock drifts are individually precalibrated on the specific hardware they are being shipped. In the rare event that this drift information is not present (field reinstall for example), the drift will take not more than a few hours to converge to its usual precision.

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ABOUT UDCAST

UDcast is the leader in the DVB-H IP Encapsulation providing its IP Encapsulators, as wells Mobile TV network transmission (DVB-H iSplicer) and monitoring equipments to 70% of global DVB-H deployments and trials. The solutions of UDcast are deployed in the countries like USA, Finland, France, UK, Spain, Italy, Germany, Netherlands, China, Hong Kong, Singapore, Taiwan, Philippines, Indonesia, Malaysia, Vietnam, India, Australia, and South Africa. The equipments and technologies of UDcast are selected by Nokia, Motorola, Alcatel-Lucent, Harris and other global Mobile TV integrators as part of their commercial solutions. UDcast has been at the forefront of DVB-H development from the very beginning, and was involved in the standardization process through ETSI, as well as in the development and standardisations of protocols enabling satellite IP communication.

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