DVB T/H Séminaire

Presented by:
Erwàn LECOMTE
Analyse de Signaux RF.
Agenda

- Introduction.
  - Historique.
  - Présentation générale des normes « Broadcast »
  - Définitions.

- Concepts de l’OFDM.

- DVB T / H.
  - Technologie.
  - Couche Physique.
  - La transmission MPEG.
  - Emetteur DVB.
  - Transmission hiérarchique.

- Les challenges de mesures en DVB-T et H.

- Solutions AGILENT

- Démo.
Agenda

➢ Introduction.
  ➢ Historique.
  ➢ Présentation générale des normes « Broadcast »
  ➢ Définitions.

➢ Concepts de l’OFDM.

➢ DVB T / H.
  ➢ Technologie.
  ➢ Couche Physique.
  ➢ La transmission MPEG.
  ➢ Emetteur DVB.
  ➢ Transmission hiérarchique.

➢ Les challenges de mesures en DVB-T et H.

➢ Solutions AGILENT

➢ Démo.
Digital Video Description

• Digital video delivers services via two infrastructures
  1. **Wireless**: digitized video via MPEG protocol + digital modulation for RF transport
  2. **Wired**: digitized video via MPEG protocol + internet transport

• Six primary delivery technologies
  1. **Cable TV**: DVB-C, J.83 Annex A/B/C
  2. **Satellite**: DVB-S, DVB-S2
  3. **Terrestrial Broadcast**: DVB-T, ISDB-T, ATSC, DTMB
  4. **Mobile TV** (digital TV broadcast directly to cell phone): DVB-H, MediaFLO, T/S-DMB
  5. **Telco TV & IPTV** (landline technologies): ADSL

• Various standards adopted by different countries/regions
## Digital Video Standards by Regions

<table>
<thead>
<tr>
<th></th>
<th>Mobile</th>
<th>Terrestrial</th>
<th>Satellite</th>
<th>Cable</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Europe Asia</strong></td>
<td>DVB-H, DAB, DVB-SH</td>
<td>DVB-T/T2</td>
<td>DVB-S/S2</td>
<td>DVB-C</td>
</tr>
<tr>
<td><strong>China</strong></td>
<td>T-MMB (CMMB and DAB)</td>
<td>DTMB</td>
<td>DVB-S/ABS-S</td>
<td>DVB-C</td>
</tr>
<tr>
<td><strong>Korea</strong></td>
<td>T/S-DMB</td>
<td>ATSC</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Japan</strong></td>
<td>ISDBT 1seg</td>
<td>ISDB-T</td>
<td>ISDB-S</td>
<td>J.83 Annex C</td>
</tr>
<tr>
<td><strong>U.S.</strong></td>
<td>MediaFLO</td>
<td>ATSC</td>
<td>Mixed (note)</td>
<td>J.83 Annex B</td>
</tr>
<tr>
<td>Tech</td>
<td>Regions</td>
<td>Channel coding</td>
<td>Mapping</td>
<td>Modulation</td>
</tr>
<tr>
<td>----------</td>
<td>------------------</td>
<td>----------------------------</td>
<td>--------------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>DVB-T/H</td>
<td>Europe</td>
<td>RS+convolutional coding</td>
<td>QPSK, 16QAM, 64QAM</td>
<td>OFDM (5MHz, 6MHz, 7MHz, 8MHz)</td>
</tr>
<tr>
<td>ISDB-T 1-Seg</td>
<td>Japan, Brazil</td>
<td>RS+convolutional coding</td>
<td>DQPSK, QPSK, 16QPSK, 64QPSK</td>
<td>OFDM (430kHz)</td>
</tr>
<tr>
<td>MediaFLO</td>
<td>US</td>
<td>RS+Turbo coding</td>
<td>QPSK, 16QPSK, 64QPSK, layered modulation</td>
<td>OFDM (6MHz)</td>
</tr>
<tr>
<td>CMMB</td>
<td>China</td>
<td>RS+LDPC</td>
<td>BPSK, QPSK, 16QPSK</td>
<td>OFDM (2/8 MHz)</td>
</tr>
<tr>
<td>TMMB</td>
<td>China</td>
<td>RS+convolutional coding</td>
<td>QPSK</td>
<td>OFDM (1.5MHz)</td>
</tr>
<tr>
<td>T-DMB</td>
<td>Korea</td>
<td>RS+convolutional coding</td>
<td>D-QPSK</td>
<td>OFDM (1.5MHz)</td>
</tr>
<tr>
<td>S-DMB</td>
<td>Korea</td>
<td>RS+convolutional coding</td>
<td>QPSK</td>
<td>CDM (25MHz)</td>
</tr>
<tr>
<td>DAB-IP</td>
<td>Europe</td>
<td>Convolutional coding</td>
<td>D-QPSK</td>
<td>OFDM (1.5MHz)</td>
</tr>
<tr>
<td>A-VSB</td>
<td>US</td>
<td>RS+Trellis coding &amp; Turbo coding</td>
<td>8/16 Level mapper</td>
<td>8/16-VSB</td>
</tr>
</tbody>
</table>
Layered Structure of Video System

<table>
<thead>
<tr>
<th>Application: Audio/video/Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport Stream</td>
</tr>
<tr>
<td>Radio Layer</td>
</tr>
</tbody>
</table>

MPEG-2, MPEG-4, H.264, AVS, AAC, …

MPEG-2 TS

DVB-T/H/C/S, ATSC, ISDB-T, DTMB, J.83…

Example: DVB-H protocol stack implementation
MPEG Definitions (Motion Picture Experts Group)

**MPEG-1**: Initial video and audio compression standard. Later used as the standard for **Video CD**, and includes the popular Layer 3 (**MP3**) audio compression format.

**MPEG-2**: Transport, video and audio standards for broadcast-quality television. Used for over-the-air digital television **ATSC**, **DVB** and **ISDB**, digital satellite TV services like **Dish Network**, digital **cable television** signals, **SVCD**, and with slight modifications, as the **.VOB** (Video OBject) files that carry the images on **DVDs**.

**MPEG-3**: Originally designed for **HDTV**, but abandoned when it was realized that MPEG-2 (with extensions) was sufficient for HDTV. (not to be confused with **MP3**, which is MPEG-1 Layer 3.)

**MPEG-4**: Expands MPEG-1 to support video/audio "objects", 3D content, low bitrate encoding and support for **Digital Rights Management**. Several new (newer than MPEG-2 Video) higher efficiency video standards are included (an alternative to MPEG-2 Video), notably:

- **MPEG-4 Part 2** (or Advanced Simple Profile for motion compensation) and
- **MPEG-4 Part 10** (or Advanced Video Coding or **H.264**). MPEG-4 Part 10 may be used on **HD DVD** and **Blu-ray** discs, along with **VC-1** and MPEG-2.

**MPEG-7**: Standard for the content description of multimedia signals. “Bits that describe the other bits”. Will be used with other above MPEG standards. EG: for use in a digital library.
MPEG2

- Used in DVB-C, DVB-S and DVB-T/H
- Compression of Standard Definition TV from 270Mbit/s to less than 5Mbit/s
- High Definition TV in MPEG2 is less than 15Mbits/s
- Sound is from 200 to 400kbit/s
- MPEG2 services are encoded and multiplexed to be the MPEG2 transport stream
DVB-T/H – Brief History & Status

• DVB started in 1993
  – European Broadcasting Union (EBU)
  – European Telecommunications Standards Institute (ETSI)

• DVB-T: Terrestrial
  – Most advanced and flexible digital terrestrial transmission system available today
  – COFDM where each sub-carrier may have QPSK or QAM modulation
  – Used in Europe and Asia for broadcasting MPEG-2 coded TV signals
  – Not used in US, Japan, & Korea (they have unique standards)

• DVB-H: Handheld
  – Based on DVB-T (backwards compatible)
  – New features to support handheld and mobile TV reception
    • Battery saving
    • Mobility with high data rates
    • Impulse noise tolerance
    • Increased general robustness
    • Support for seamless handover
Agenda

- **Introduction.**
  - Historique.
  - Présentation générale des normes « Broadcast »
  - Définitions.

- **Concepts de l’OFDM.**

- **DVB T / H.**
  - Technologie.
  - Couche Physique.
  - La transmission MPEG.
  - Emetteur DVB.
  - Transmission hiérarchique.

- **Les challenges de mesures en DVB-T et H.**

- **Solutions AGILENT**

- **Démo.**
From Single Carrier Modulation (SCM) to Frequency Division Multiplexing (FDM)

A single high-rate information stream modulated on a single carrier is too sensitive to multipath,

IDEA: divide it in multiple lower-rate information streams!
OFDM: Orthogonal Carriers

- Closely spaced carriers overlap
- Nulls in each carrier’s spectrum land at the center of all other carriers for Zero Inter-Carrier Interference
OFDM – Basic Concepts

bits → map onto constellation → load complex values into frequency bins

carrier number: -26 -25 -24 .. -3 -2 -1 0 +1 +2 +3 .. 4 5 6

1011 → \(0.29 + j0.85\)

do inverse FFT to create time waveform → transmit as 1 symbol

repeat
Dealing With Multipath

Transmitter

Receiver

Tu

Delay Spread
A Guard Interval is inserted before Transmission

\[ T_g = 0.8 \text{ usec} \quad T_u = 3.2 \text{ usec} \]

The guard interval is often referred to as a “cyclic extension”. 
Dealing With Multipath Two Paths/Transmitters

Region where Symbol Interferes Only With Itself

Region of ISI

Tu Tg
# Comparing COFDM Systems

<table>
<thead>
<tr>
<th></th>
<th><strong>DVB-T</strong></th>
<th><strong>DAB</strong></th>
<th><strong>802.11A</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BW</strong></td>
<td>8 MHz</td>
<td>1.5 MHz</td>
<td>18 MHz</td>
</tr>
<tr>
<td><strong>Carriers</strong></td>
<td>1705</td>
<td>1536</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>6817</td>
<td>384</td>
<td>4 (sync)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>192</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>768</td>
<td></td>
</tr>
<tr>
<td><strong>Carrier Spacing</strong></td>
<td>4.464 kHz</td>
<td>1 kHz</td>
<td>312.5 kHz</td>
</tr>
<tr>
<td></td>
<td>1.116 kHz</td>
<td>4 kHz</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>8 kHz</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 kHz</td>
<td></td>
</tr>
<tr>
<td><strong>Pilot/Sync Mod.</strong></td>
<td>BPSK</td>
<td>QPSK</td>
<td>BPSK</td>
</tr>
<tr>
<td><strong>Data Modulation</strong></td>
<td>QPSK</td>
<td>DQPSK</td>
<td>BPSK, QPSK,</td>
</tr>
<tr>
<td></td>
<td>16 QAM</td>
<td></td>
<td>16 QAM</td>
</tr>
<tr>
<td></td>
<td>64 QAM</td>
<td></td>
<td>64 QAM</td>
</tr>
</tbody>
</table>
## Comparing COFDM Systems

<table>
<thead>
<tr>
<th></th>
<th>DVB-T</th>
<th>DAB</th>
<th>802.11A</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Max Guard Interval</strong></td>
<td>56 usec (2k)</td>
<td>246 usec</td>
<td>0.8 usec</td>
</tr>
<tr>
<td>(max delay spread)</td>
<td>224 usec (8k)</td>
<td>62 usec</td>
<td></td>
</tr>
<tr>
<td></td>
<td>31 usec</td>
<td>31 usec</td>
<td></td>
</tr>
<tr>
<td></td>
<td>123 usec</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Equalizer</strong></td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Pulse Shape</strong></td>
<td>Rect</td>
<td>Rect</td>
<td>Raised Cosine</td>
</tr>
<tr>
<td><strong>Pilot/Sync</strong></td>
<td>Continuous and Scattered Pilots</td>
<td>Null and Phase Ref. symbols</td>
<td>Short and Long Training Symbols</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>Yes, but not used</td>
<td>Yes, but not used</td>
</tr>
<tr>
<td><strong>Carrier at TX frequency</strong></td>
<td>Yes</td>
<td>Yes, but not used</td>
<td>Yes, but not used</td>
</tr>
</tbody>
</table>
Agenda

- Introduction.
  - Historique.
  - Présentation générale des normes « Broadcast »
  - Définitions.

- Concepts de l’OFDM.

- DVB T / H.
  - Technologie.
  - Couche Physique.
  - La transmission MPEG.
  - Emetteur DVB.
  - Transmission hiérarchique.

- Les challenges de mesures en DVB-T et H.

- Solutions AGILENT

- Démo.
DVB-T – Key Technologies

- Hierarchical coding
  - Outer code (Reed-Solomon)
  - Inner code (convolutional)
  - Interleaving
    - Outer Byte-wise
    - Inner bit-wise and symbol interleaving
- OFDM Modulation
  - 2K mode – doppler tolerant for short distances
  - 8K mode – longer symbols to minimize ISI over long distances
  - Mapping: QPSK, QAM: 16, 64
- Frame Structure
  - scattered pilot cells
  - continual pilot carriers and TPS (Transmission Parameters Signaling)
- Hierarchical transmission
  - HP/LP bit stream, $\alpha = 2, 4$
DVB-H – Key Technologies

- Time-slicing for power saving in the Rx
- MPE-FEC for additional robustness and mobility
- 4k mode for mobility and network design flexibility
- In-depth inner interleaving
- Additional minor changes, e.g. signaling
- Supports DVB-T frequencies
  - 6, 7 or 8 MHz BW
  - Also a new 5 MHz channel (L band, USA)
DVB-H and Time-Slicing in MPEG-2 Transport Streams.

Time slicing is applied to the MPEG-2 stream to reduce the on time for mobile receivers. If a stream contains 10 services and the user is watching one channel, then the Rx power saving is 90% over DVB-T.

IP encapsulated services are transmitted as data bursts in time slots. Each burst may contain up to 2 Mbps of data (including parity bits). There are 64 parity bits for each 191 data bits, protected by further RS codes in a method called “Multiprotocol Encapsulation Forward Error Correction” or MPE-FEC. We report MPE-FER, or forward error rate.

Each burst carries “Delta-t” information, telling the receiver when to expect the next burst for the service. Timing jitter is measured by DVB-H test equipment to report differences between expected arrival time and real arrival time of bursts. Missing bursts result in poor service quality at the user equipment.
DVB T/H physical layer

Up to 8 MHz bandwidth

COFDM

- DVB-T uses 2K, 8K carriers (2K mainly in UK, 8K rest of Europe)
- DVB-H uses also 4K carriers

Supported the following modulation scheme:

- QPSK
- 16 QAM
- 64 QAM

Up to 8MHz BW
OFDM Frame Structure

• Each frame consists of 68 OFDM symbols
• Four frames constitute one super-frame
• Each symbol is composed of two parts: useful part and guard interval (1/4, 1/8, 1/16, 1/32). Guard interval avoids ISI between symbols. The choice of the guard interval depends on the maximum transmission distance.
DVB-T Carrier Types

- Continual Pilots: BPSK, a given carrier always transmits the same symbol
- Data Carriers: 1512 (2k) or 6048 (8k) carriers modulated in QPSK, 16QAM or 64QAM
- Scattered Pilots: Scattered pilots are BPSK
- TPS: Transmit system information on BPSK carriers, lower power than pilots
TPS (Transmission Parameter Signaling)

- Each TPS block contains 68 bits
  - 1 initialization bit;
  - 16 synchronization bits
  - 37 information bits (channel coding, modulation, guard interval…)
  - 12 redundancy bits for error protection
- Modulation: DBPSK
- Transmitted over 68 consecutive OFDM symbols (a frame), every TPS carrier in the same symbol conveys the same differentially encoded information bit.
DVB-T Carrier Assignments

- Continuous or Scattered Pilot
- TPS Symbols BPSK
- Data Symbols (e.g., 64 QAM)

Carrier # 0 1 2 3 4 5 6 7 8 9 ....
DVB-T: Spectrogram of Scattered and Continuous Pilots Only

Tu + Tg
DVB-T useful bit rate

- Ranges from 3.73Mbit/s to 31.67Mbit/s according to the following parameters:
  - The bandwidth: 6, 7 or 8MHz
  - The modulation: QPSK, 16QAM or 64QAM
  - The code rate: \( \frac{1}{2} \), \( \frac{2}{3} \), \( \frac{3}{4} \), \( \frac{5}{6} \) or \( \frac{7}{8} \)
  - The guard interval: \( \frac{1}{4} \), \( \frac{1}{8} \), \( \frac{1}{16} \) or \( \frac{1}{32} \)
  - The implemented DVB-T networks have often a useful bitrate of 22Mbit/s (up to 6 TV channels on one frequency channel).
  - The bitrate in Germany is around 15Mbit/s due to a 16QAM modulation and a more robust transmission.
**DVB-H**

**DVB-H data stream path**

- IP data → MPEG source coding → MPE → MPE FEC → Time slicing → TS multiplexer → TS → Modulator → RF

- **DVB-H designed to address issues for **Handheld** reception**
  - Power consumption (battery life)
  - Mobility with high data rates, single antenna reception, SFN
  - Impulse noise tolerance
  - Increased general signal robustness
  - Support for seamless handover

- **DVB-H same as DVB-T with the addition of:**
  - Time-slicing for power saving
  - 4k mode for mobility and network design flexibility
  - In-depth inner interleaving
  - MPE-FEC for additional robustness and mobility

---

Based on DVB-T

**fully backwards compatible**
DVB-H

- DVB-H is introduced to broadcast common information on mobile phones
- Associated with 2.5G or 3G, DVB-H enables to relieve the cellular network from the load of common services
- DVB-H technology will be part of cellular mobile phones. The market is different from the TV decoder market
DVB-T/H - Block Diagram

**Transmitter**

- MPEG-2 TS MUX Adaption & Energy Dispersal
- Outer (Reed-Solomon) Encoder
- Outer Interleaver
- Inner (Viterbi) Convolution Encoder
- Baseband Shaping
- Modulator
- Up Convert
- RF

**Receiver**

- Tuner
- Demod
- Channel Equalizer
- Inner Viterbi Decoder
- Outer De-Interleaver
- Outer (Reed-Solomon Decoder)
- De-Scramble
- RF
Hierarchical Modulation

- Two separate data streams are modulated onto a single DVB-T stream
  - “High priority” stream (HP)
  - “Low priority” stream (LP)

- Receiver with good reception condition can receive both HP and LP stream
- Typically LP is of higher bitrate (e.g. used for HD)
Hierarchical modulation

Two most significant bits (MSB) would be used for robust mobile service while the remaining six bits would contain, for example, a HDTV service. The first two MSBs correspond to a QPSK service embedded in the 64QAM one.
Hierarchical channel coding: Simulcast 2 MPEG transport streams with one signal.
Agenda

- Introduction.
  - Historique.
  - Présentation générale des normes « Broadcast »
  - Définitions.

- Concepts de l’OFDM.

- DVB T / H.
  - Technologie.
  - Couche Physique.
  - La transmission MPEG.
  - Emetteur DVB.
  - Transmission hiérarchique.

- Les challenges de mesures en DVB-T et H.

- Solutions AGILENT

- Démo.
Digital Video Typical Transmission System

Transmitter
- Analog Video
- MPEG Encoding
- Modulation I/Q
- RF Signal Gen

Transmission Channel
- RF Signal Down
- Demodulation
- MPEG Stream
- Video Display

Receiver
- RF Gen.
- I/Q Modulation
- MPEG Streaming

Analysis
- RF Analysis
- Modulation Analysis
- MPEG Analysis
- Video Analysis

Video Sig Gen
Equipements utilisés pour ce Séminaire.

- **MXA**
- **MXG**
- **X-application: N6153A**
- **Signal Studio: N7623B**
Agilent Spectrum Analysis Portfolio

- **PSA**
  - Market Leading Performance
  - 3 Hz to 50 GHz

- **MXA**
  - Super Mid Performance
  - 20 Hz to 26 GHz

- **EXA**
  - World’s “Soon To Be” Most Popular
  - Economy class
  - 9KHz to 26 GHz

- **CSA**
  - Low cost portable
  - 100 kHz to 6 GHz

- **N9340B**
  - Basic performance, Handheld
  - 100 kHz to 6 GHz

- **N9320B**
  - Basic performance, Benchtop
  - 100 Hz to 26 GHz

- **ESA**
  - World’s Most Popular
  - 100 Hz to 26 GHz

- **N9340**
  - Basic performance, Handheld
  - New

89600 VSA Software
- World’s best analysis & troubleshooting
A Portfolio of Signal Generators

**Analog**

**UP TO 40 GHz**

- RF mid-performance
  - **N5181/3A MXG**
    - New price/performance point, fast switching

**Mid performance**

- RF mid-performance
  - **N5182A MXG**
    - New price/performance point, fast switching, best ACPR

**High performance**

- **Best close-in phase noise**
- **High power, low phase noise**
- **Real-time BBG, BERT, digital I/Q**
- **Agilent INNOVATION first vector modulation at MW**

**Vector**

- **High performance**
- **Analog**
- **Vector**
Signal Studio software for MXG

**Cellular Communications**
- 3GPP W-CDMA with HSUPA/HSDPA
- 3GPP2 cdma2000/1xEV-DO
- GSM/EDGE
- TD-SCDMA LCR

**Digital Video Broadcasting**
- DVB T/H/S/S2/C
- ISDB-T
- DTMB

**Wireless Connectivity**
- 802.16 OFDMA (Mobile WiMAX)
- 802.16-2004 (Fixed WiMAX)
- 802.11a/b/g/j/n/p WLAN
Measurement Summary for N6153A

1. Power measurements:
   - Channel Power (Shoulder Attenuation, Spectrum Mask with adjacent analog TV)
   - Spectrum Emission Mask
   - ACP, CCDF, Spurious Emissions
   - Monitoring Spectrum, I/Q Waveform

2. Modulation accuracy measurements:
   - Constellation
   - TPS decoding
   - MER/EVM
   - Frequency Error, Mag Error, Phase Error
   - Quadrature Error, Amplitude Imbalance, Carrier Suppression, Phase Jitter
   - Pre-Viterbi/Pre-RS/Post-RS BER
   - Channel Frequency Response
   - Channel Impulse Response
DVB-T/H Applications and Examples

1. Channel Power

– Channel Power can measure and report the integrated power in a defined bandwidth and power spectral density (PSD) displayed in dBm/Hz or dBm/MHz
– Channel Frequency can be configured either by Center Frequency or by Channel Table and Channel Number
– Channel Bandwidth can be chosen from 5/6/7/8 MHz
DVB-T/H Applications and Examples

2. Channel Power - Shoulder Attenuation and Spectrum Mask

– Channel Power has two other View/Display: Shoulder Attenuation and Spectrum Mask

– Shoulder Attenuation is measured to check the linearity of an OFDM signal w/o reference to spectrum mask which is defined in DVB-T/H test specification

– Spectrum Mask View is to check the spectrum emission mask in the case of Analog TV signal in adjacent channel
DVB-T/H Applications and Examples

3. SEM – Spectrum Emission Mask

– SEM is a key measurement linking amplifier linearity and other performance characteristics

– Limit Type supports Manual, Non-Critical and Critical (The last two type are defined in DVB-T/H standard.)

– PASS/FAIL indicator is convenient for R&D, Mfg and Performance Test customers
DVB-T/H Applications and Examples

4. ACP – Adjacent channel power

• Adjacent channels could be analog TV channel or digital channels (like DVB-T/H channel with adj DVB-T channels)

• Examples with one DVB-T channel with two PAL adj channels:
6. Modulation Analysis

- Modulation Analysis measurement is the most important one in DVB-T/H measurement application.

- It includes the measurement of MER (Modulation Error Ratio), which is an indicator of noise, interferences or distortions on signal and is a figure of merit widely used in broadcasting industry similar to the EVM in wireless industry.

- Modulation Analysis measurement is helpful and necessary to meet DVB-T/H defined test specification and ensure proper operations of the transmitters.

- This measurement provides the flexibility of RF input or Analog IQ input (only available in MXA)

- A good DVB-T transmitter should have MER > 35 dB.
Modulation Accuracy Analysis

Modulation Error

Basic Concept:

Ideal point

Ideal Signal
at decision time

Measuring point

Measured Signal
at decision time

Measured signal is never equal to ideal signal, due to noise, transmitter impairments, propagation phenomena,...
**I/Q Modulation Analysis**

**Broadcast Industry**

\[
MER = 10 \times \log_{10}\left(\frac{\sum_{j=1}^{N} (I_j^2 + Q_j^2)}{\sum_{j=1}^{N} (\delta I_j^2 + \delta Q_j^2)}\right) \text{dB}
\]

\[
EVM_{\text{RMS}} = \sqrt{\frac{1}{N} \sum_{j=1}^{N} (\delta I_j^2 + \delta Q_j^2)} \times 100\%
\]

Where \( I \) and \( Q \) are the ideal co-ordinates, \( \delta I \) and \( \delta Q \) are the errors in the received data points. \( S_{\text{max}} \) is the magnitude of the vector to the outermost state of the constellation.

**Wireless Industry**

\[
EVM = \frac{\text{RMS}(E)}{\text{RMS}(R')} \times 100\%
\]

(here, EVM is relative and expressed in %)

\[
E = Z' - R'
\]

where:

- \( Z' \) - the varied signal under test
- \( R' \) - the varied reference signal

**MER (dB) in broadcast industry is actually same as EVM (%) in wireless industry, except whether to include I/Q offset or not**
Modulation Accuracy – Meas Setup Parameters

1. User friendly feature “Auto Detect”
2. Demod symbols can be customized to balance between speed and accuracy
3. Switch “Decoding” On to get the TPS Decoding and BER results
4. Flexible advanced modulation settings are beneficial for customers to trouble-shoot DVB-T/H products development
Modulation Accuracy Measurement

1. Use can specify the measured subcarriers range from the 0 to 1704 (2K mode)

2. MER vs. Subcarriers can show the MER result at each subcarrier

3. More detailed modulation analysis results can be shown in the I/Q Error view like AI/QE/SNR/CS/Phase Jitter etc
Modulation Accuracy Measurement

- Channel Frequency Response view includes three traces:
  - Amplitude vs. subcarriers
  - Phase vs. subcarriers
  - Group Delay vs. subcarriers

- Channel Impulse Response can be shown for multi-path measurement.
Modulation Accuracy Measurement

- TPS means **Transmission Parameter Signaling**
- TPS carriers are used for the purpose of signaling parameters related to the transmission scheme, i.e. channel coding and modulation.
**Modulation Accuracy Measurement – BER Definition**

- **BER before Viterbi decoder** - To give an indication of the un-coded performance
- **BER before RS decoder** - This is the primary parameter which describes the quality of the digital transmission link
- **BER after RS decoder** - To gain information about the pattern with which bit errors occur

There are two methods to calculate BER related results. One is “In Service” (using data packet) and the other is “Out of Service” (using Null TS packet).

Different BER results are calculated by different measurements.
- BER Before Viterbi: “In Service” measurement.
- BER Before RS: “In Service” and “Out of Service” measurements.
- BER After RS: Only available for “Out of Service” measurement.
Modulation Accuracy Measurement

• Pre-Viterbi/Pre-RS BER results can be calculated when turning on the “Decoding” switch

• Post-RS BER result can be only shown for “NullPacket” payload

• All of the available modulation analysis results will be shown in the “Result Metrics” view.
## Agilent Digital Video Solutions - Format Coverage

<table>
<thead>
<tr>
<th>Region</th>
<th>Format</th>
<th>Source Solutions</th>
<th>Analyzer Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>HW boxes</strong></td>
<td><strong>Software (perp. license)</strong></td>
</tr>
<tr>
<td><strong>Europe / Asia</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>DVB-C</td>
<td>PSG/ESG/MXG</td>
<td>N7623B-QFP</td>
</tr>
<tr>
<td></td>
<td>DVB-T/H</td>
<td>PSG/ESG/MXG</td>
<td>N7623B-QFP</td>
</tr>
<tr>
<td></td>
<td>DVB-S</td>
<td>PSG/ESG/MXG</td>
<td>N7623B-VFP</td>
</tr>
<tr>
<td></td>
<td>DVB-S2</td>
<td>PSG/ESG/MXG</td>
<td>N7623B WFP</td>
</tr>
<tr>
<td></td>
<td>DVB-SH</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>US</strong></td>
<td>ATSC</td>
<td>PSG/ESG/MXG</td>
<td>N7623B-UFP</td>
</tr>
<tr>
<td></td>
<td>J.83 Annex B</td>
<td>PSG/ESG/MXG</td>
<td>N7623B-XFP</td>
</tr>
<tr>
<td></td>
<td>MediaFLO</td>
<td>PSG/ESG/MXG</td>
<td>Qualcomm waveform</td>
</tr>
<tr>
<td><strong>Japan</strong></td>
<td>ISDB-T</td>
<td>PSG/ESG/MXG</td>
<td>N7623B-RFP</td>
</tr>
<tr>
<td></td>
<td>ISDB-T 1/3-seg</td>
<td>PSG/ESG/MXG</td>
<td>N7623B-RFP</td>
</tr>
<tr>
<td></td>
<td>J.83 Annex C</td>
<td>PSG/ESG/MXG</td>
<td>N7623B-UFP</td>
</tr>
<tr>
<td><strong>China</strong></td>
<td>DTMB</td>
<td>PSG/ESG/MXG</td>
<td>N7623B-SFP</td>
</tr>
<tr>
<td></td>
<td>CMMB</td>
<td>PSG/ESG/MXG</td>
<td>N7623B-YFP</td>
</tr>
<tr>
<td><strong>Korea</strong></td>
<td>T-DMB</td>
<td>ESG/MXG</td>
<td>N7616B-QFP</td>
</tr>
<tr>
<td></td>
<td>S-DMB</td>
<td>ESG</td>
<td>E4438C #407</td>
</tr>
</tbody>
</table>

- Solution not available yet from Agilent – please let us know your needs
Q&A
Feedbacks?
Questions?
Besoin d’une visite?
Evaluation?
Prêt?

Erwan_lecomte@agilent.com