DIGITAL TERRESTRIAL TELEVISION

SESSION 6
DIGITAL TERRESTRIAL TELEVISION SYSTEMS

Policy and Regulation Initiative for Digital Africa (PRIDA)

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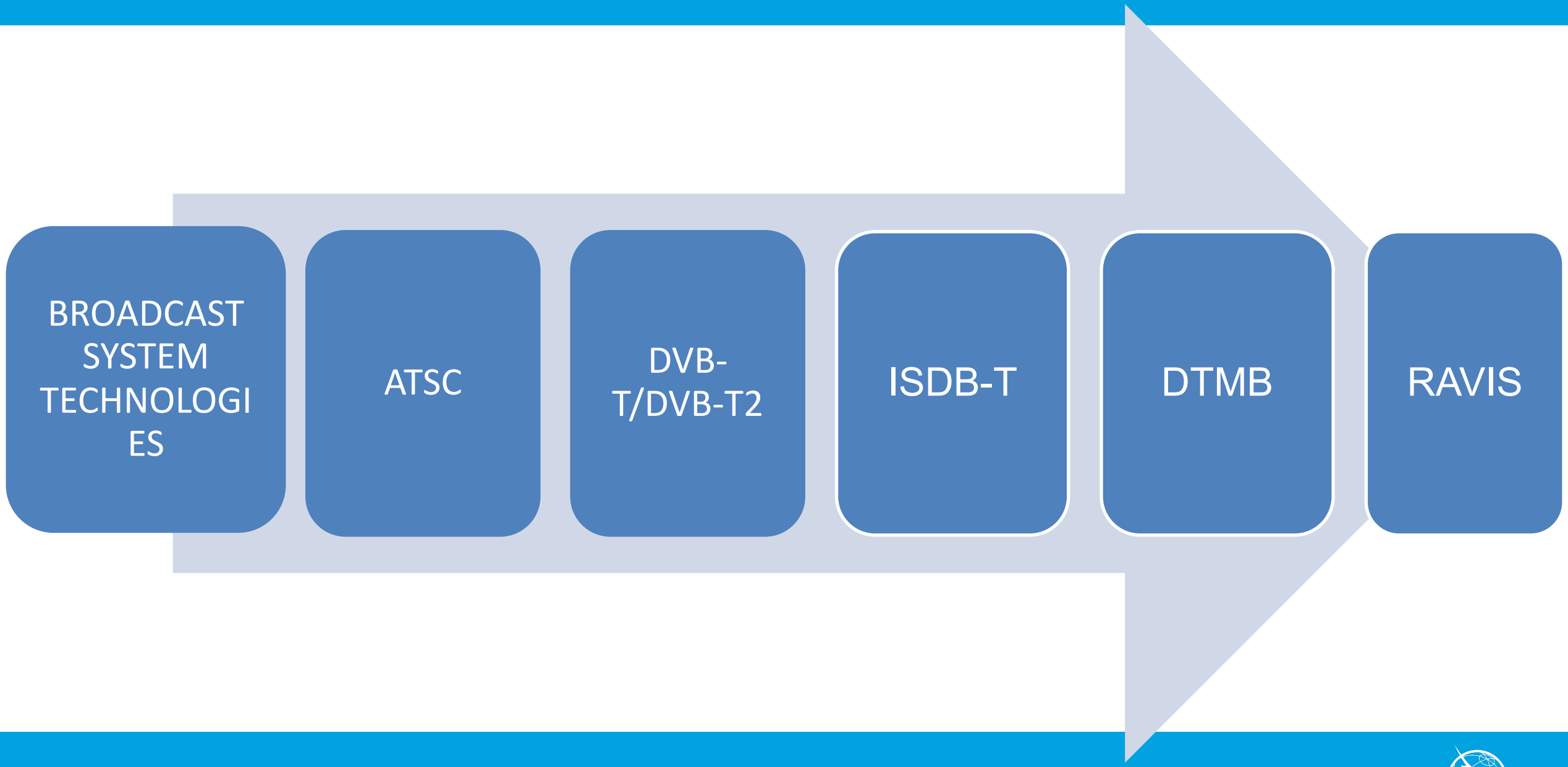
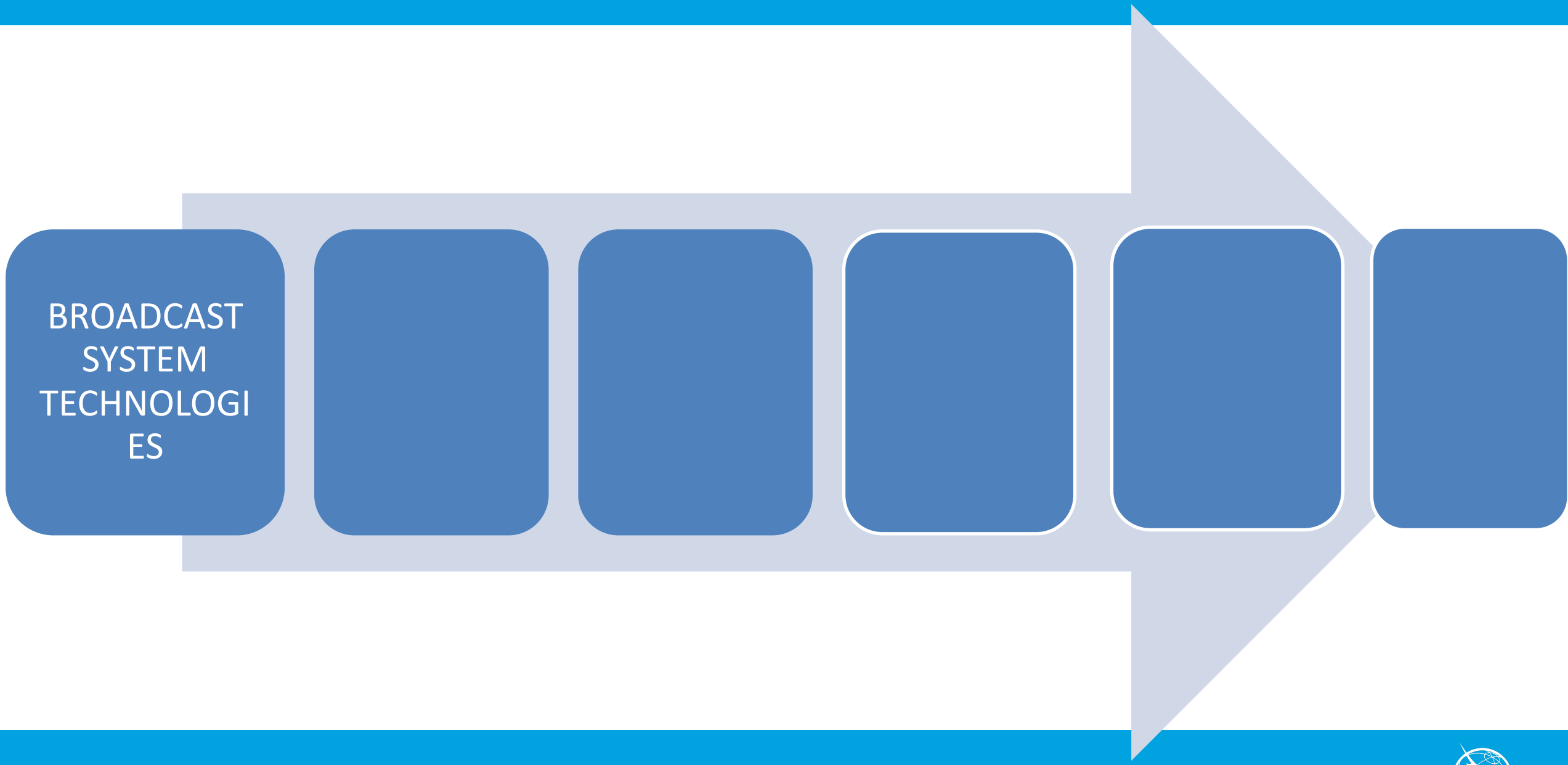
BRAZZAVILE (CONGO)
April 15th -19th, 2024

CONTENT


BROADCAST SYSTEM TECHNOLOGIES
ATSC
DVB-T/DVB-T2
ISDB-T
DTMB
RAVIS

CONTENT



BROADCAST SYSTEM TECHNOLOGIES

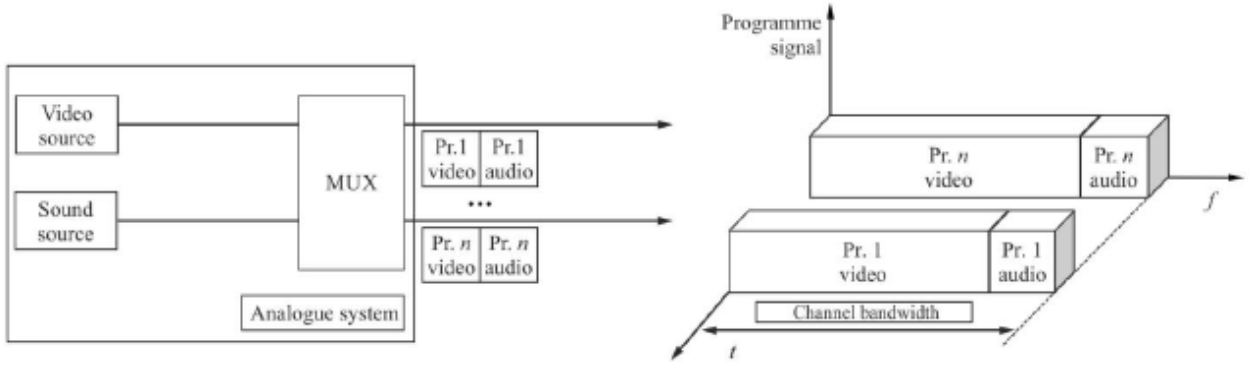
1) SERVICE MULTIPLEX AND TRANSPORT METHODS
2) SERVICE INFORMATION IN DIGITAL TV SYSTEMS
3) PROTOCOL STACK FOR DIGITAL TELEVISION BROADCASTING SYSTEM
4) DATA TRANSMISSION TECHNIQUES OVER DTTB SYSTEMS
5) TRANSPORT INTERFACES FOR DTTB SYSTEM
6) *DIVERSITY RECEPTION OF DTTB SYSTEMS*

BROADCAST SYSTEM TECHNOLOGIES – SERVICE MULTIPLEX AND TRANSPORT METHODS

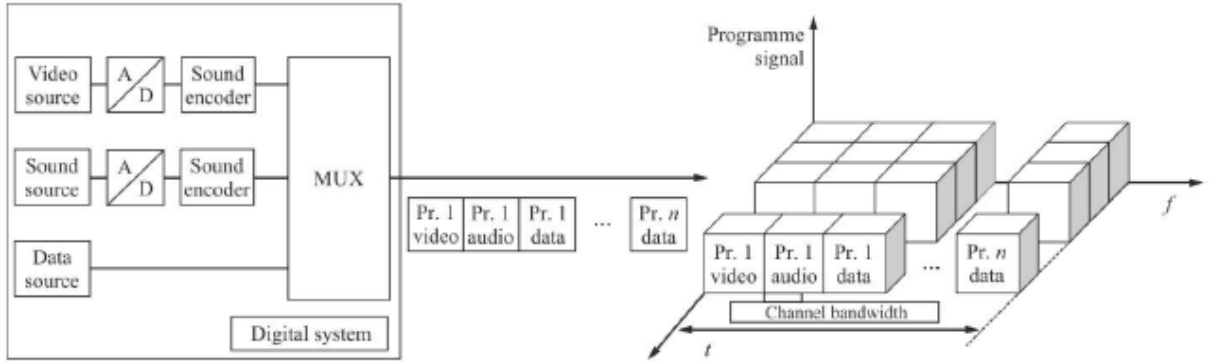
IN ANALOGUE BROADCASTING SYSTEMS, **VIDEO** AND **SOUND** FOR ANY PROGRAMME ARE **TRANSMITTED IN SEPARATE** WITH FREQUENCY CHANNELS, ON THE PRINCIPLE THAT ONE PROGRAMME SIGNAL OCCUPIES THE WHOLE CHANNEL BANDWIDTH

IN DIGITAL BROADCASTING SYSTEMS, **SIMULTANEOUS TRANSMISSION MODE** WITHIN **ONE FREQUENCY CHANNEL** IS USED TO DELIVER DATA STREAMS CONTAINING PACKETS GENERATED FROM AUDIO AND VIDEO INFORMATION FROM ONE OR MORE PROGRAMMES (PR. 1, … PR. N), AND ADDITIONAL DATA STREAMS, WITH VIRTUAL TIME AND FREQUENCY BANDWIDTH SEGMENTATION

Principle of multi-programme transmission in analogue broadcasting systems



Principle of multi-programme transmission in digital broadcasting systems



SERVICE MULTIPLEX METHODS

IN DTTB, ONE OR MORE **DIGITAL MULTIPLEXES** MAY **CARRY** A **NUMBER OF TELEVISION SERVICES**, EACH COMPRISED OF ***ONE OR MORE VIDEO COMPONENTS***, ***ONE OR MORE AUDIO COMPONENTS***, AND OPTIONALLY ***OTHER COMPONENTS SUCH AS ANCILLARY DATA***.

SERVICE MULTIPLEXING CAN BE IMPLEMENTED USING:

- STRUCTURED TRANSMISSION (FIXED ASSIGNED METHOD),
- PACKET TRANSFERRING (VARIABLE ASSIGNED METHOD), OR
- A COMBINATION OF BOTH.

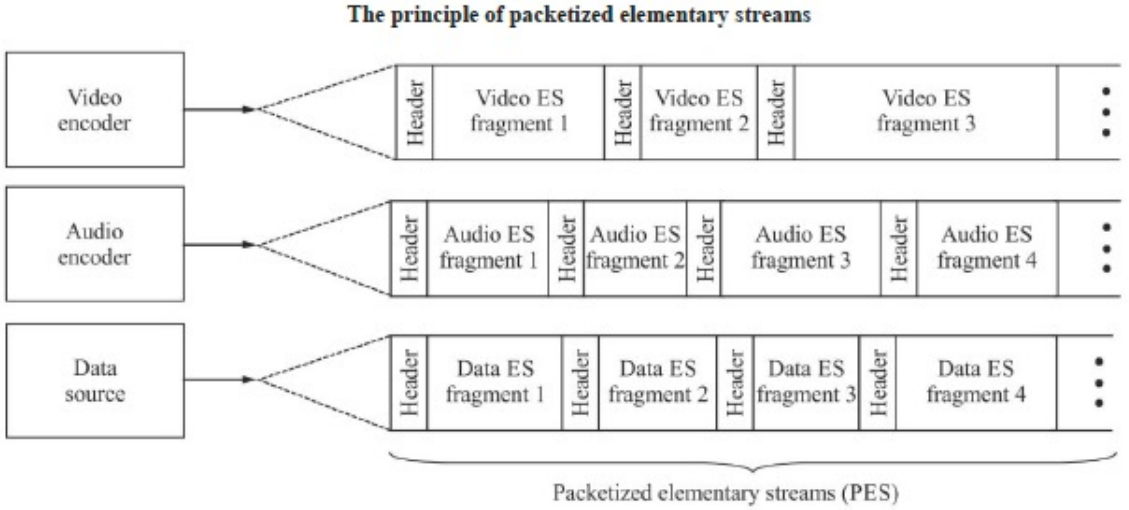
SUCH APPROACHES HAVE SIGNIFICANT ADVANTAGES FOR VARIOUS SERVICE IMPLEMENTATIONS.

SERVICE MULTIPLEX METHODS - FIXED AND VARIABLE LENGTH PACKET MULTIPLEXING

MULTIPLEXING APPROACH CAN BE THOUGHT OF AS A COMBINATION OF MULTIPLEXING AT TWO DIFFERENT LAYERS.

- IN THE FIRST LAYER (PROGRAMME LAYER), SINGLE PROGRAMME BIT STREAMS ARE FORMED BY MULTIPLEXING PACKETS FROM ONE OR MORE ELEMENTARY BIT STREAMS, AND
- IN THE SECOND LAYER (TRANSPORT LAYER), A NUMBER OF SINGLE PROGRAMME BIT STREAMS ARE COMBINED TO FORM ONE OR MORE TRANSPORT STREAM(S).

AT THE SOURCE ENCODER OUTPUT (VIDEO AND AUDIO ENCODERS) INFORMATION IS ORGANIZED AS SERIES OF A SEPARATED STREAMS, CALLED ELEMENTARY STREAMS (ES)



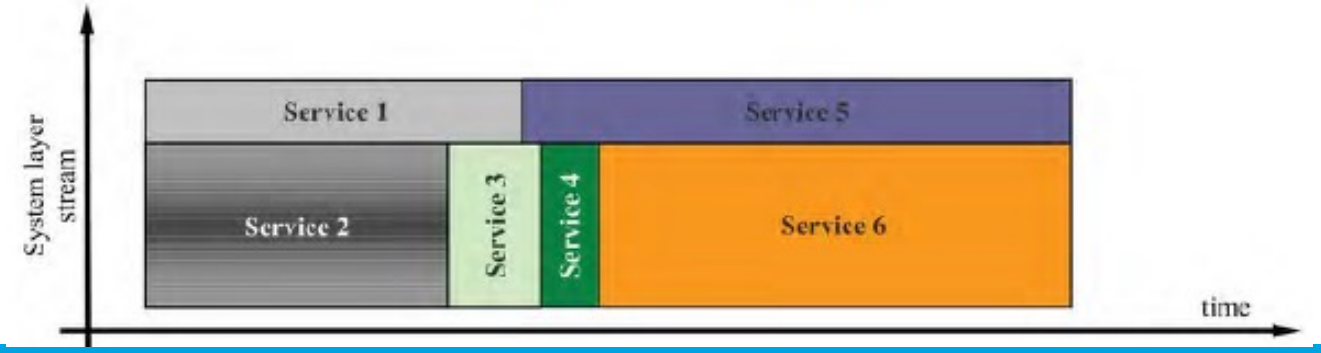
SERVICE MULTIPLEX METHODS - STATISTICAL MULTIPLEXING

AUDIOVISUAL INFORMATION COMPRESSION CODECS WITH VARIABLE BIT-RATE (VBR) CODING HAVE WIDESPREAD USE. IN SUCH CODEC COMPRESSION, AN ALGORITHM IS USED TO **ALLOCATE A CERTAIN DATA CAPACITY** FOR PICTURE SCENES THAT ARE CRITICAL TO COMPRESSION QUALITY. OTHERWISE, FEWER BITS ARE USED.

THIS LEADS TO THE POSSIBILITY OF **BIT-RATE VARIATION AT THE AUDIO OR VIDEO ENCODER** OUTPUT DEPENDING ON THE NATURE OF THE SCENE OR THE SOUND SEQUENCE BEING PROCESSED, OR **DEPENDING ON REQUIREMENTS OF THE PARTICULAR PROGRAMME.**

PADDING INFORMATION IS ADDED TO THE DATA. UNDER SUCH CONDITIONS, HOWEVER, THE EFFICIENCY OF SPECTRUM USE DECREASES

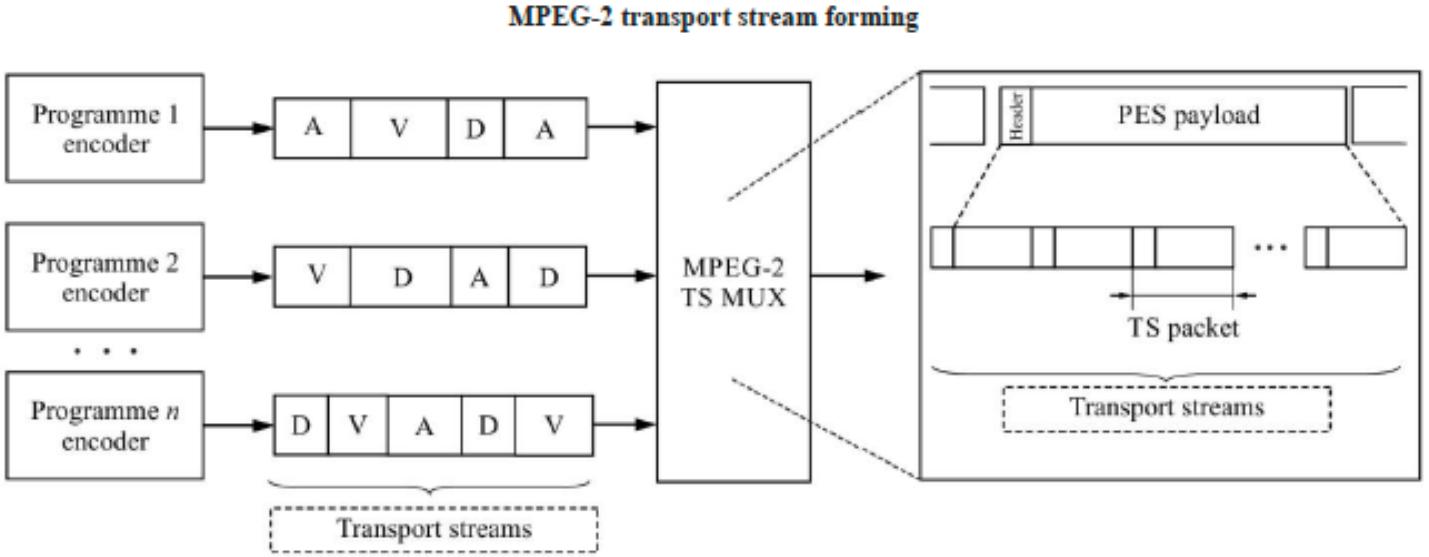
Example of statistical multiplexing



SERVICE TRANSPORT METHOD

THE SECOND LAYER OF MULTIPLEXING IS MULTIPLEXING PROGRAMME STREAMS TO FORM A SINGLE STREAM, WHICH IS CALLED A TRANSPORT STREAM (TS) OR AN IP STREAM.

PACKETIZED **PROGRAMME STREAMS (PS)**, CONTAINING INFORMATION ABOUT **VIDEO (V), AUDIO (A) OR DATA (D)**, FORMED ON THE PREVIOUS SYSTEM LEVEL, ARE PROVIDED TO A TRANSPORT STREAM MULTIPLEXER, WHERE PS VARIABLE LENGTH PACKET MAPPING INTO PACKETIZED TRANSPORT STREAM FORMAT WITH FIXED PACKET LENGTH IS PERFORMED.



BROADCAST SYSTEM TECHNOLOGIES – SERVICE MULTIPLEX AND TRANSPORT METHODS

RECOMMENDATION ITU-R BT.1209-1

RECOMMENDATION ITU-R BT.1299

RECOMMENDATION ITU-R BT.1437

RECOMMENDATION ITU-R BT.1869

INFORMATION INSERTED MAY BE CLASSIFIED IN TWO SUB-GROUPS: SERVICE INFORMATION, SPECIFIC TO **PROGRAMMES (PSI)**, ANDINFORMATION BEING INSERTED AT **SYSTEM LEVEL (SI)**.

a) PSI CONSISTS OF 6 TABLES

NETWORK INFORMATION TABLE (NIT)	DEFINES DTTB NETWORK PARAMETERS SUCH AS CARRIER FREQUENCY, CHANNEL BANDWIDTH, CHANNEL ENCODING PARAMETERS, ETC. AND REFERENCES THE NETWORK PID, WHICH CARRIES DATA WHOSE DEFINITION AND STRUCTURE IS DEFINED IN PARTICULAR DIGITAL BROADCASTING SYSTEM.
PROGRAMME ASSOCIATION TABLE (PAT)	PROVIDE THE CORRESPONDENCE BETWEEN A PROGRAMME NUMBER AND THE PACKET IDENTIFIER (PID) VALUE OF THE TS PACKETS THAT CARRY THE PROGRAMME INFORMATION.
PROGRAMME MAP TABLE (PMT)	SPECIFY THE TYPES OF ELEMENTARY COMPONENTS THAT MAKE UP THE SERVICE AND THE PID IN THE TS THAT CARRIES THEM
CONDITIONAL ACCESS TABLE (CAT)	SUPPORT THE NEEDS OF ACCESS CONTROL, THE CAT ASSOCIATES ONE OR MORE PRIVATE ENTITLEMENT MANAGEMENT MESSAGE STREAMS EACH WITH A UNIQUE PID VALUE
TRANSPORT STREAM DESCRIPTION TABLE (TSDT)	TCONTAIN DATA THAT MAY INDICATE THE METHOD FOR INCLUDING PRIVATE DATA IN THE TS, OR TO CARRY DESCRIPTORS WHOSE SCOPE INCLUDES ALL SERVICES CARRIED IN THE TS
IPMP CONTROL INFORMATION TABLE (ICIT)	USED FOR INTELLECTUAL PROPERTY MANAGEMENT AND PROTECTION BASED ON DIGITAL RIGHTS MANAGEMENT (DRM) STANDARDS

SERVICE INFORMATION (SI): SERVICE (OR SYSTEM) INFORMATION (SI) ALLOWS FOR IDENTIFICATION/SELECTION OF SERVICES OR EVENTS FOR THE USER IN THE SYSTEM TS AND MAY ALSO PROVIDE INFORMATION ON SERVICES CARRIED BY DIFFERENT MULTIPLEXES AND EVEN OTHER NETWORKS.

SI DATA COMPLEMENTS PSI TABLES SPECIFIED BY PROVIDING DATA TO AID AUTOMATIC TUNING OF RECEIVERS, AND INFORMATION INTENDED FOR DISPLAY TO THE USER.

PRINCIPLES

OSI MODEL WAS CHOSEN AS BASELINE SYSTEM MODEL WITH A DIVISION OF SIGNAL PROCESSING INTO SEVEN LAYERS: PHYSICAL, LINK, NETWORK, TRANSPORT, SESSION, PRESENTATION AND APPLICATION LAYERS.

AT EACH OF THE LAYERS, CERTAIN FUNCTIONS ON THE BROADCAST SERVICE DATA ARE PERFORMED. FOR EACH SYSTEM, A PROTOCOL STACK, WHICH PROVIDES THESE FUNCTIONS, HAS BEEN DEFINED.

EACH OF THE PROTOCOLS IS AN INTERFACE TO THE ADJACENT LAYERS, AND DEFINES THE ORDER AND PRINCIPLES FOR THE CONVERSION OF DATA FOR TRANSFER TO THE UPPER AND LOWER LAYERS OF THE PROTOCOL STACK.

Generalized protocol stack for broadcast system

<table>
<tr><td>Television services</td><td>Data services</td><td>Multimedia A/V services</td><td>IP-based services</td></tr>
<tr><td>Video and audio</td><td>Data and control</td><td>Video and audio</td><td>Data</td></tr>
<tr><td>MPEG-2 PES</td><td>MPEG-2 Section</td><td colspan="2">IP or other signalization protocol</td></tr>
<tr><td colspan="2">MPEG-2 TS</td><td colspan="2">GSE-based BB or other system stream</td></tr>
<tr><td colspan="4">Transmission layer (terrestrial television and multimedia broadcastirg air interfaces, such as DVB-T, ATSC, ISDB-T FLO, T-DMB)</td></tr>
<tr><td colspan="4">Physical layer (terrestrial channel)</td></tr>
</table>

REPORT ITU-R BT.1223

RECOMMENDATION ITU-R BT.1434

FOR PROVIDING INTEROPERABILITY WITH OTHER TELECOMMUNICATION SYSTEMS, DATA BROADCASTING SYSTEMS' ARCHITECTURE SHOULD BE BASED ON THE LAYERED APPROACH OF THE ISO OPEN SYSTEMS INTERCONNECTION (OSI) OF BASIC REFERENCE

ISO OSI basic reference model in the broadcasting context

Layer	Principle function	Classification
7 Application	Use of information at application level	Service information protocol Content delivery protocol
6 Presentation	Conversion and presentation of information	
5 Session	Selection of and access to information	
4 Transport	Identification of group of data	
3 Network	Identification of logical channel	Data broadcasting system
2 Data link	Linkage with logical transmission unit	
1 Physical	Physical transmission	Terrestrial broadcasting system

Report ITU-R BT.956

Report ITU-R BT.1210

Recommendation ITU-R BT.807

Recommendation ITU-R BT.1225

BROADCAST SYSTEM TECHNOLOGIES – TRANSPORT INTERFACES FOR DTTB SYSTEM

AN INTERFACE IS DEFINED AS A UNIDIRECTIONAL OR BIDIRECTIONAL CONNECTION BETWEEN ONE OR MORE FUNCTIONAL EQUIPMENT BLOCKS OF THE SAME OR DIFFERENT TYPES.

SUCH CONNECTIONS MAY BE CONSIDERED AT EITHER PHYSICAL OR LOGICAL LEVEL.

INTERFACE REALIZATION IS LEFT TO MANUFACTURERS.

INTERFACES MAY BE CLASSIFIED OVER FOLLOWING MAIN CATEGORIES:

1. BY APPLICATION SPHERE: PROFESSIONAL, SEMI-PROFESSIONAL AND NON-PROFESSIONAL INTERFACES;
2. BY PHYSICAL TRANSMISSION METHOD: SERIAL OR PARALLEL;
3. BY CHANNEL TRANSMISSION METHOD: SYNCHRONOUS OR ASYNCHRONOUS.
4. BY DIRECTIVITY: UNIDIRECTIONAL OR BIDIRECTIONAL INTERFACES.

CONSIDERING THAT DURING THE DELIVERY OF AUDIOVISUAL INFORMATION AND/OR DATA TO THE USER, OR DURING DISTRIBUTION BETWEEN SEPARATE PARTS OF BROADCASTING CHAIN, DIFFERENT TELECOMMUNICATION/BROADCASTING OR ANY OTHER TYPE OF NETWORKS MAY BE USED, A SET OF INTERFACES, THAT MAY BE USED IN DIFFERENT COMBINATIONS IN A DIGITAL TELEVISION BROADCASTING NETWORK, HAVE BEEN DEFINED.

Recommendation ITU-R BT.1436

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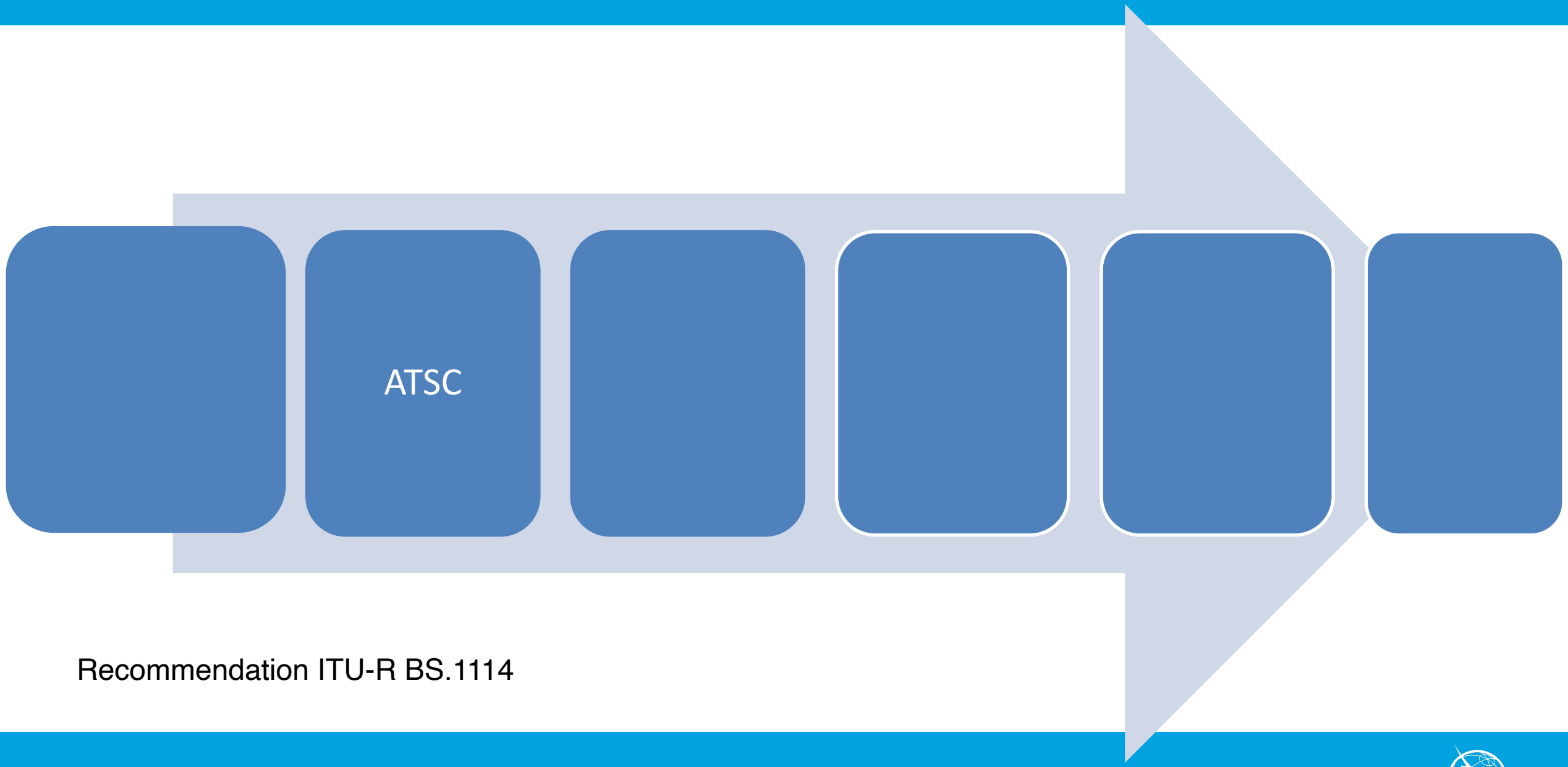

Recommendation ITU-R BS.1114

ADVANCED TELEVISION SYSTEMS COMMITTEE - ATSC

ATSC STANDARDS DESCRIBE A SYSTEM DESIGNED TO TRANSMIT **HIGH QUALITY VIDEO AND AUDIO AND ANCILLARY DATA OVER A SINGLE 6 MHz CHANNEL**.

ALTHOUGH ATSC TRANSMISSION SUBSYSTEMS ARE DESIGNED SPECIFICALLY FOR TERRESTRIAL AND CABLE APPLICATIONS, OBJECTIVE IS THAT THE VIDEO, AUDIO, AND SERVICE MULTIPLEX/TRANSPORT SUBSYSTEMS CAN BE USEFUL IN OTHER APPLICATIONS.

FOR DELIVERY OF DTV CONTENT TO MOBILE OR PORTABLE DEVICES, ATSC USES THE MOBILE/HANDHELD (M/H) EXTENSION THAT IS ALSO CALLED ATSC M/H.

1) **ARCHITECTURE MODEL**
2) **KEY TECHNOLOGIES**
3) **PHYSICAL LAYER**
4) **TRANSPORT LAYER**

ADVANCED TELEVISION SYSTEMS COMMITTEE (ATSC) - TRANSPORT LAYER

Key characteristics of ATSC system

Characteristics	ATSC
Reception modes: – Fixed – Portable – Portable handheld – Mobile	 + + + +
Channel bandwidth	a) 6 MHz; b) 7 MHz; c) 8 MHz
Net data rates	Depending on modulation and code rate: a) 4.23-19.39 Mbit/s b) 4.72-21.62 Mbit/s c) 5.99-27.48 Mbit/s
Spectrum efficiency (bit/s/Hz)	0.55-1.48
Single frequency networks	
Broadcasting types: – sound – multimedia – TV	 + +
Transmission data/service types	Video, audio, data
Frequency bands	VHF, UHF
Used bandwidth	At –3 dB: a) 5.38 MHz; b) 6.00 MHz; c) 7.00 MHz
Number of segments	1
Number of subcarriers per segment	1
Subcarrier spacing	–
Active symbol duration	a) 92.9 ns; b) 83.3 ns; c) 71.4 ns
Guard interval duration/ ratio	–
Frame duration	a) 48.4 ms; b) 43.4 ms; a) 37.2 ms
Time/ frequency synchronization	Segment sync, pilot carrier; Frame sync
Modulation methods	8-VSB
Inner FEC	2/3 trellis, concatenated 1/2 or 1/4 trellis
Inner interleaving	Independently encoded streams interleaved in time: a) 12; b) 24; c) 28
Outer FEC	RS (207,187, T = 10), concatenated RS (184,164, T = 10)
Outer interleaving	52 segment convolutional byte interleaved, concatenated 46 segment byte interleaved
Data randomization/ energy dispersal	16 bit PRBS
Hierarchical transmission	–
Transmission parameter signalling	Mode symbols in frame sync

Derivation by the figure of merit method ATSC 6 MHz system

Planning parameter[1]	Low VHF 54-88 MHz	High VHF 174-216 MHz	UHF 470-806 MHz
Frequency (MHz)	69	194	615
C/N (dB)	19.5[2]	19.5[2]	19.5[2]
k (dB)	–228.6	–228.6	–228.6
B (dB(Hz)) (6 MHz)	67.8	67.8	67.8
G_{1m^2} (dB)	–1.8	7.3	17.2
G_D (dB)	6	8	10
G_I (dB)	8.2	10.2	12.2
Transmission line loss (dB) α_{line}	1.1	1.9	3.3
Antenna 300/75 balun loss (dB) α_{balun}	0.5	0.5	0.5
Receiver noise figure (dB)	5	5	10
T_{rx}(K)	627.1	627.1	2 610
T_{line}(K)	65.0	102.9	154.4
LNA noise figure (dB)	5	5	5
LNA gain (dB)	20	20	20
T_{LNA} (dB)	627.1	627.1	627.1
T_{balun} (K)	31.6	31.6	31.6
T_a (K)	9 972.1	569.1	Negligible
$T_a\alpha_{balun}$ (K)	8 885.1	507.1	Negligible
$T_{line}/\alpha G$ (K)	0.8	1.6	3.3
$T_{rx}/\alpha G$ (K)	8.1	9.7	55.8
T_e (K)	9 552.6	1 176.8	717.8
10 log(T_e)(dB(K))	39.8	30.7	28.6
G_A (dB)	7.7	9.7	11.7
E_{rx}(dB(μV/m))[2], [3] (TBC)	35	33	39

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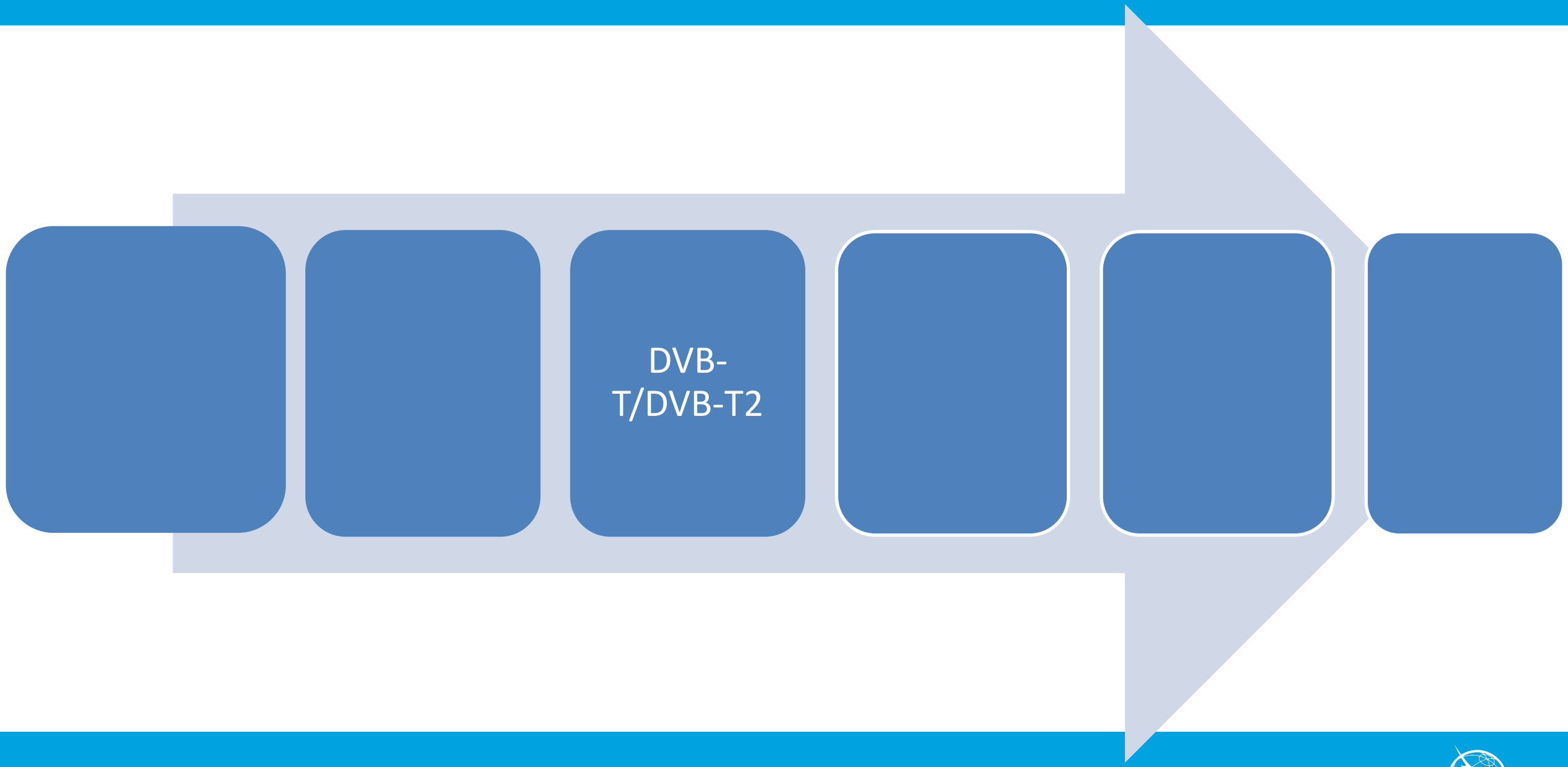

DIGITAL VIDEO BROADCASTING – T/T2 (DVB-T/T2) (http://www.dvb.org)

DVB-T/DVB-T2 SYSTEMS ARE DEFINED AS FUNCTIONAL BLOCKS WHICH PERFORM THE ADAPTATION OF BASEBAND TV SIGNALS FROM THE OUTPUT OF THE TRANSPORT MULTIPLEXER, TO THE TERRESTRIAL CHANNEL CHARACTERISTICS.

FOR TRANSMISSION OF TELEVISION BROADCASTING SIGNALS, CHANNEL BANDWIDTHS OF 1.7 MHz AND 7 MHz AND USED IN THE FREQUENCY BAND 174-230 MHz, AND 8 MHz CHANNEL BANDWIDTH ARE USED IN THE BAND 470-862 MHz.

DUE TO UNIVERSALLY-SUPPORTED INPUT FORMATS, HIGH FLEXIBILITY IN SELECTION OF PARAMETERS TO GIVE THE TRADE-OFF BETWEEN CHANNEL CAPACITY AND RECEIVER INPUT SIGNAL POWER, POSSIBILITY OF ROBUST FUNCTIONING IN DIFFERENT BROADCASTING NETWORK TYPES (MULTI-FREQUENCY OR SINGLE-FREQUENCY NETWORKS) AND RECEIVING CONDITIONS (FIXED, PORTABLE OR MOBILE RECEPTION), DVB-T AND DVB-T2 SYSTEMS ARE USED AS MAIN STANDARDS FOR DIGITAL TERRESTRIAL TELEVISION BROADCASTING IN MANY COUNTRIES.

1) **ARCHITECTURE MODEL**
2) **KEY TECHNOLOGIES**
3) **PHYSICAL LAYER**
4) **TRANSPORT LAYER**

DIGITAL VIDEO BROADCASTING – T/T2 (DVB-T/T2) (http://www.dvb.org) – PERFORMANCE

Key characteristics of DVB-T2 and DVB-T2 Lite systems

Characteristics	DVB-T2
Reception modes: – Fixed – Portable – Portable handheld – Mobile	 + + + +
Net data rates	7.5-50.5 Mbit/s
Spectrum efficiency (bit/s/Hz)	0.98-6.50
Single frequency networks	Supported
Broadcasting types: – sound – multimedia – TV	 + +
Transmission data/service types	Video, audio, data
Frequency bands	VHF, UHF
Channel bandwidth	a) 1.7 MHz b) 5 MHz c) 6 MHz d) 7 MHz e) 8 MHz f) 10 MHz 1
Used bandwidth (Note 2)	a) 1.52 MHz b) 4.75 MHz c) 5.71 MHz d) 6.66 MHz e) 7.61 MHz f) 9.51 MHz 1,2
Number of segments	Configurable
Number of subcarriers per segment (Note 2)	853 (1k mode) 1 705 (2k mode) 3 409 (4k mode) 6 817 (8k mode) 13 633 (16k mode) 27 265 (32k mode) 2, 3
Subcarrier spacing (Note 2)	a) 1 802 Hz (1k mode) 901 Hz (2k mode) 450 Hz (4k mode) 225 Hz (8k mode) 113 Hz (16k mode) 56 Hz (32k mode) b) 5 580 Hz (1k mode) 2 790 Hz (2k mode) 1 395 Hz (4k mode) 698 Hz (8k mode) 349 Hz (16k mode) 174 Hz (32k mode) c) 6 696 Hz (1k mode) 3 348 Hz (2k mode), 1 674 Hz (4k mode) 837 Hz (8k mode) 419 Hz (16k mode) 209 Hz (32k mode) d) 7 812 Hz (1k mode) 3 906 Hz (2k mode) 1 953 Hz (4k mode) 977 Hz (8k mode) 488 Hz (16k mode) 244 Hz (32k mode) e) 8 929 Hz (1k mode) 4 464 Hz (2k mode) 2 232 Hz (4k mode) 1 116 Hz (8k mode) 558 Hz (16k mode) 279 Hz (32k mode) f) 11 161 Hz (1k mode) 5 580 Hz (2k mode) 2 790 Hz (4k mode) 1 395 Hz (8k mode) 698 Hz (16k mode) 349 Hz (32k mode) 1,3

Characteristics	DVB-T2
Active symbol duration (Note 2)	a) 554.99 µs (1k), 1 109.98 µs (2k), 2 219.97 µs (4k), 4 439.94 µs (8k) 8 879.87 µs (16k) 17 759.75 µs (32k) b) 179.2 µs (1k), 358.4 µs (2k), 716.8 µs (4k), 1 433.6 µs (8k), 2 867.2 µs (16k), 5 734.4 µs (32k) c) 149.3 µs (1k), 298.67 µs (2k), 597.33 µs (4k), 1 194.67 µs (8k), 2 389.33 µs (16k), 4 778.67 µs (32k) d) 128 µs (1k), 256 µs (2k), 512 µs (4k), 1 024 µs (8k), 2 048 µs (16k), 4 096 µs (32k) e) 112 µs (1k), 224 µs (2k), 448 µs (4k), 896 µs (8k), 1 792 µs (16k), 3 584 µs (32k) f) 89.6 µs (1k), 179.2 µs (2k), 358.4 µs (4k), 716.8 µs (8k), 1 433.6 µs (16k), 2 867.2 µs (32k) 1,3
Guard interval duration/ ratio	1/128, 1/32, 1/16, 19/256, 1/8, 19/128, 1/4
T2-Frame duration	Flexible with possibility of changing on frame-by-frame basis. Max 250 ms
Time/ frequency synchronization	P1 symbol/Guard interval/Pilot carriers
Modulation methods	QPSK, 16-QAM, 64-QAM, 256-QAM with or without constellation rotation specific for each physical layer pipe
Inner FEC	LDPC code with code rates 1/3, 2/5, 1/2, 3/5, 2/3, 3/4
Inner interleaving	Cell, time and frequency interleaving
Outer FEC	BCH (16 200, x, t), there x – depends on LDPC code rate. Error correction capability t = 12 errors
Outer interleaving	Bit (parity and column twist) interleaving
Data randomization/ energy dispersal	16 bit PRBS
Hierarchical transmission	–
Transmission parameter signalling	Preamble symbol P1

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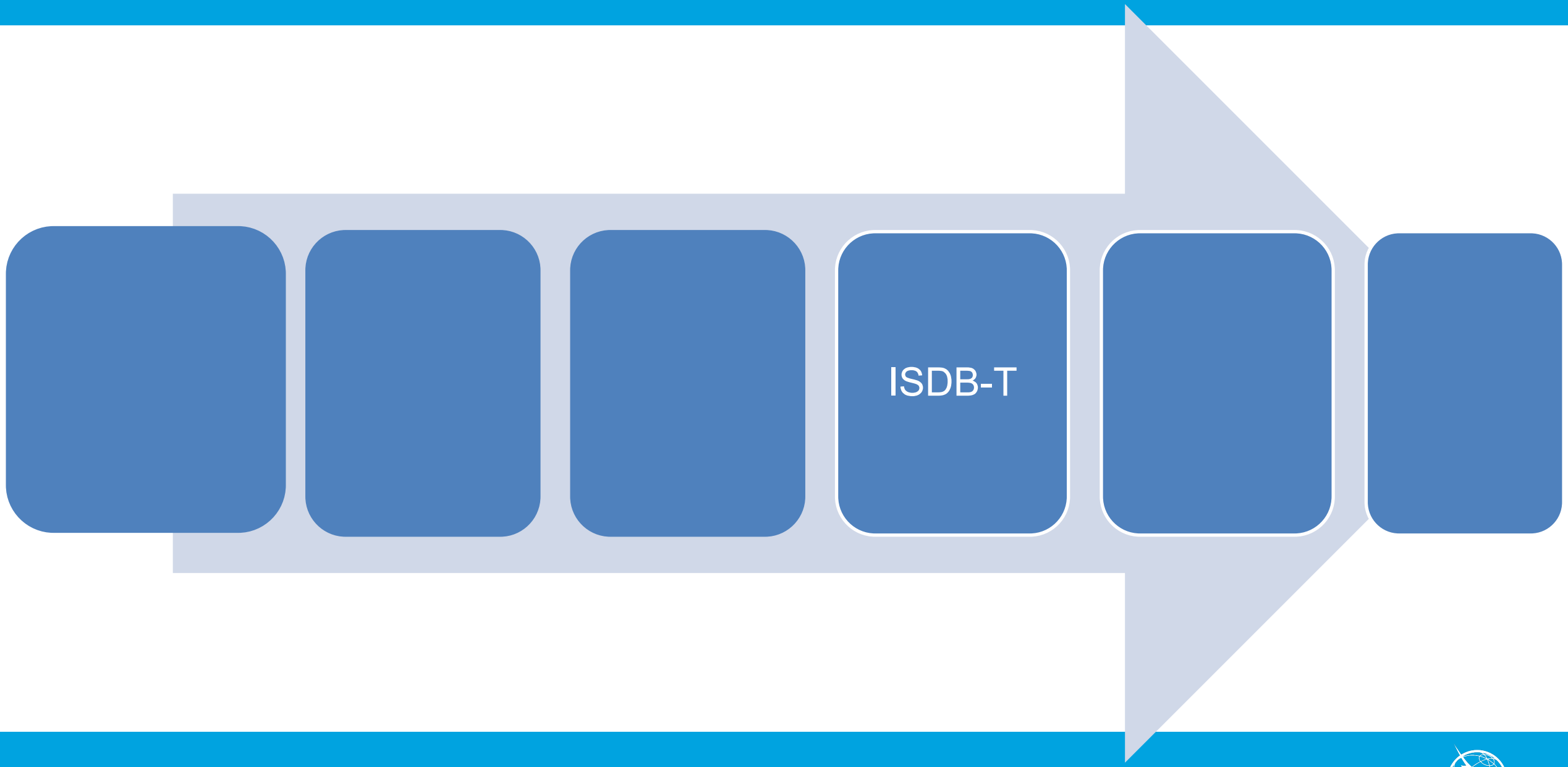
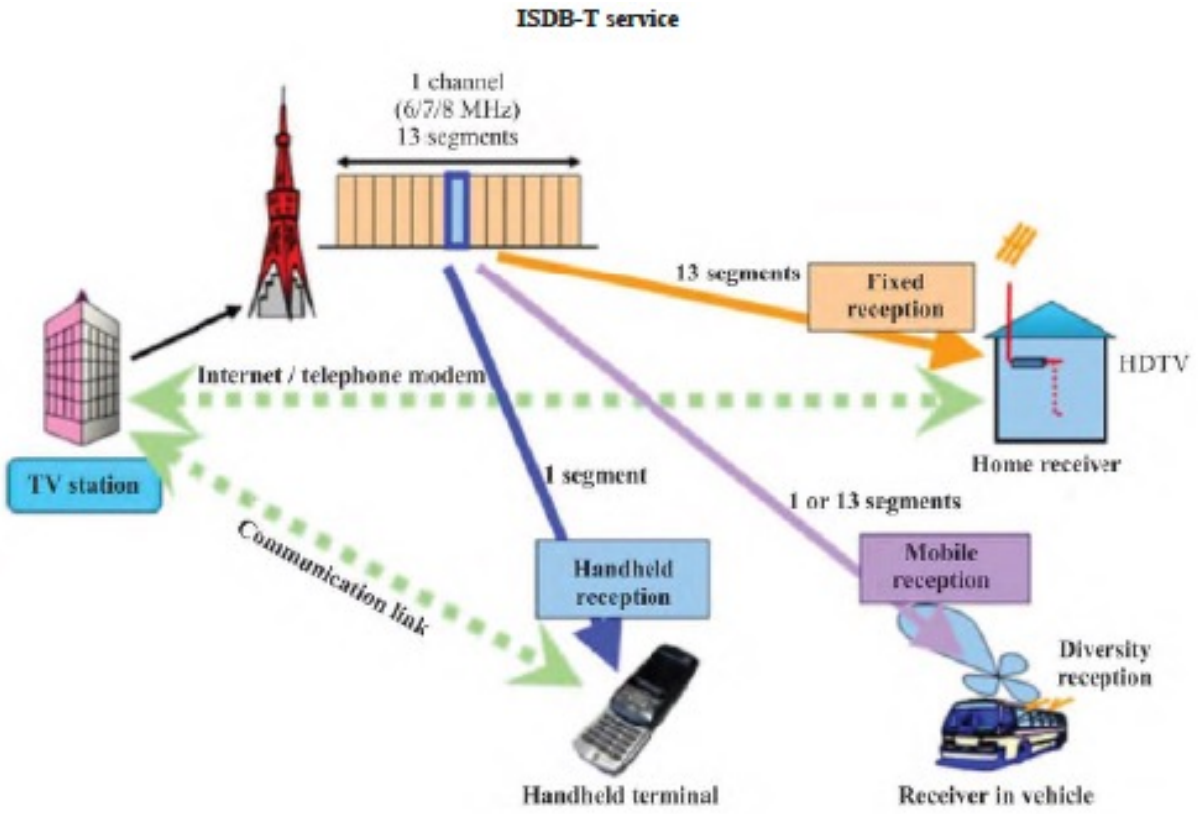


INTEGRATED SERVICES DIGITAL BROADCASTING – TERRESTRIAL (ISDB-T)

THE ISDB-T SYSTEM IS DESIGNED TO PROVIDE RELIABLE HIGH-QUALITY VIDEO, SOUND, AND DATA BROADCASTING NOT ONLY FOR FIXED RECEIVERS BUT ALSO FOR MOBILE RECEIVERS).

THE SYSTEM HAS A WIDE VARIETY OF TRANSMISSION PARAMETERS FOR CHOOSING THE CARRIER MODULATION SCHEME, THE CODING RATE OF THE INNER ERROR-CORRECTING CODE, THE LENGTH OF TIME INTERLEAVING, ETC.



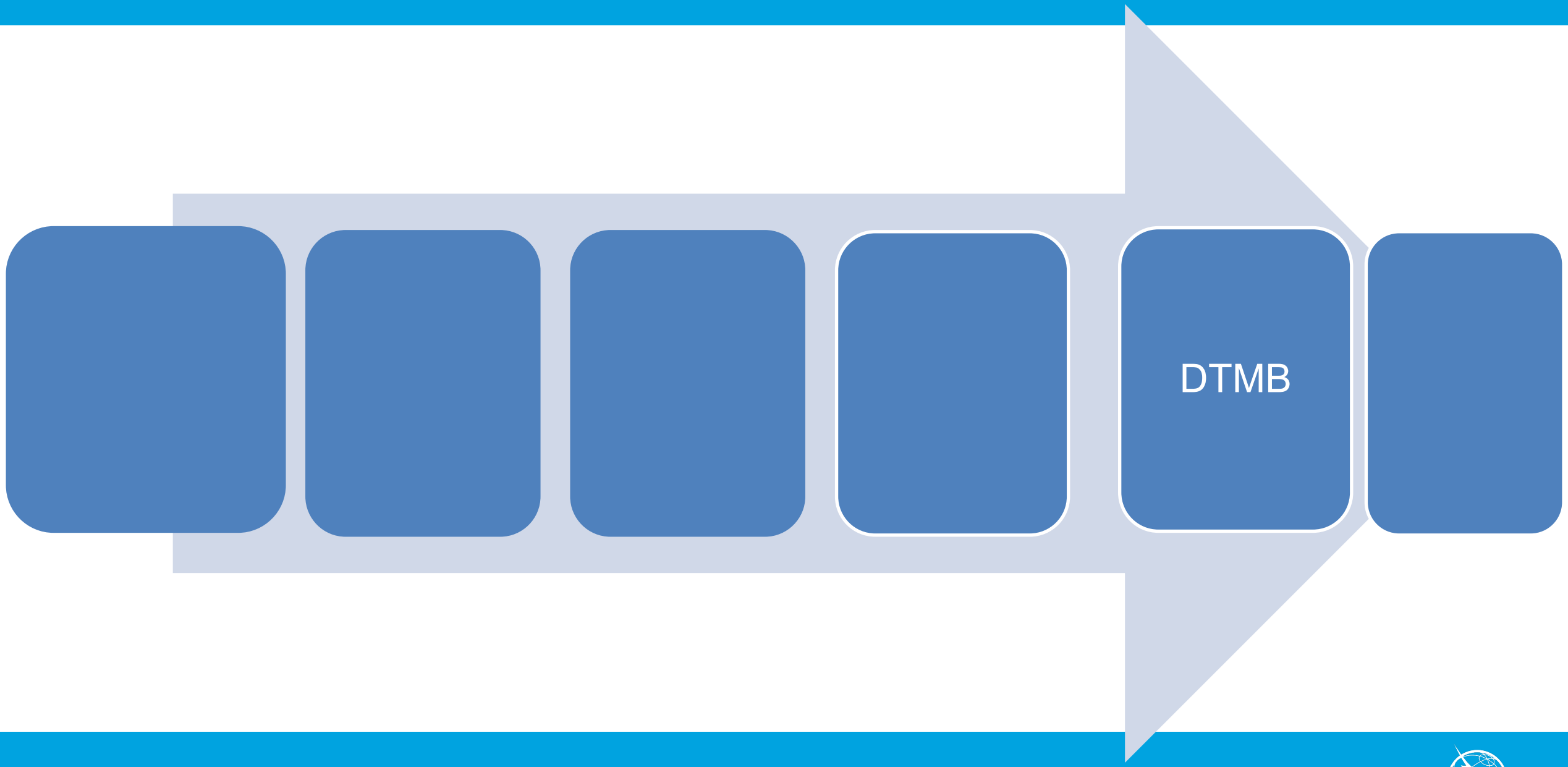
INTEGRATED SERVICES DIGITAL BROADCASTING – TERRESTRIAL (ISDB-T)

Key characteristics of ISDB system

Characteristics	ISDB-T family
Reception modes: – Fixed – Portable – Portable handheld – Mobile	 + + + +
Net data rates	n × a) 0.281 to 1.787 Mbit/s b) 0.328 to 2.085 Mbit/s c) 0.374 to 2.383 Mbit/s
Spectrum efficiency (bit/s/Hz)	0.66-4.17
Single frequency networks	Supported
Broadcasting types: – sound – multimedia – TV	 + + +
Transmission data/service types	Video, audio, data
Frequency bands	VHF, UHF
Channel bandwidth	1/14 × n of a) 6 MHz b) 7 MHz c) 8 MHz n ≥ 1 [1]
Used bandwidth	Subcarrier spacing + 1/14 × n × a) 6 MHz b) 7 MHz c) 8 MHz n ≥ 1 [1]
Number of segments	n ≥ 1 [1]
Number of subcarriers per segment	108 (Mode 1) 216 (Mode 2) 432 (Mode 3)
Subcarrier spacing	a) 3.968 kHz (Mode 1) [2], 1.984 kHz (Mode 2), 0.992 kHz (Mode 3) b) 4.629 kHz (Mode 1), 2.314 kHz (Mode 2), 1.157 kHz (Mode 3) c) 5.291 kHz (Mode 1), 2.645 kHz (Mode 2), 1.322 kHz (Mode 3)
Active symbol duration	a) 252 µs (Mode 1) [2], 504 µs (Mode 2), 1 008 µs (Mode 3) b) 216 µs (Mode 1), 432 µs (Mode 2), 864 µs (Mode 3) c) 189 µs (Mode 1), 378 µs (Mode 2), 756 µs (Mode 3)
Guard interval duration/ ratio	1/32, 1/16, 1/8, 1/4
Frame duration	204 OFDM symbols
Time/ frequency synchronization	Pilot carriers
Modulation methods	DQPSK, QPSK, 16-QAM, 64-QAM
Inner FEC	Convolution code, Mother rate 1/2 with 64 states. Puncturing to rate 2/3, 3/4, 5/6, 7/8

Characteristics	ISDB-T family
Inner interleaving	Frequency interleaving: Intra and inter segments interleaving Time interleaving: Symbol-wise convolutional interleaving 0, 380, 760, 1 520, 3 040 symbols (Mode 1)[2] 0, 190, 380, 760, 1 520 symbols (Mode 2) 0, 95, 190, 380, 760 symbols (Mode 3)
Outer FEC	RS (204, 188, T = 8)
Outer interleaving	Byte-wise convolutional interleaving, I = 12
Data randomization/ energy dispersal	PRBS
Hierarchical transmission	+
Transmission parameter signalling	TMCC pilot carriers

CONTENT



DIGITAL TELEVISION TERRESTRIAL MULTIMEDIA BROADCASTING (DTMB)

DTMB SYSTEM HAS A WIDE VARIETY OF TRANSMISSION PARAMETERS SUCH AS THE COMBINATION OF THE CONSTELLATION MODE, GUARD INTERVAL DURATION, INNER CHANNEL CODE, ETC.

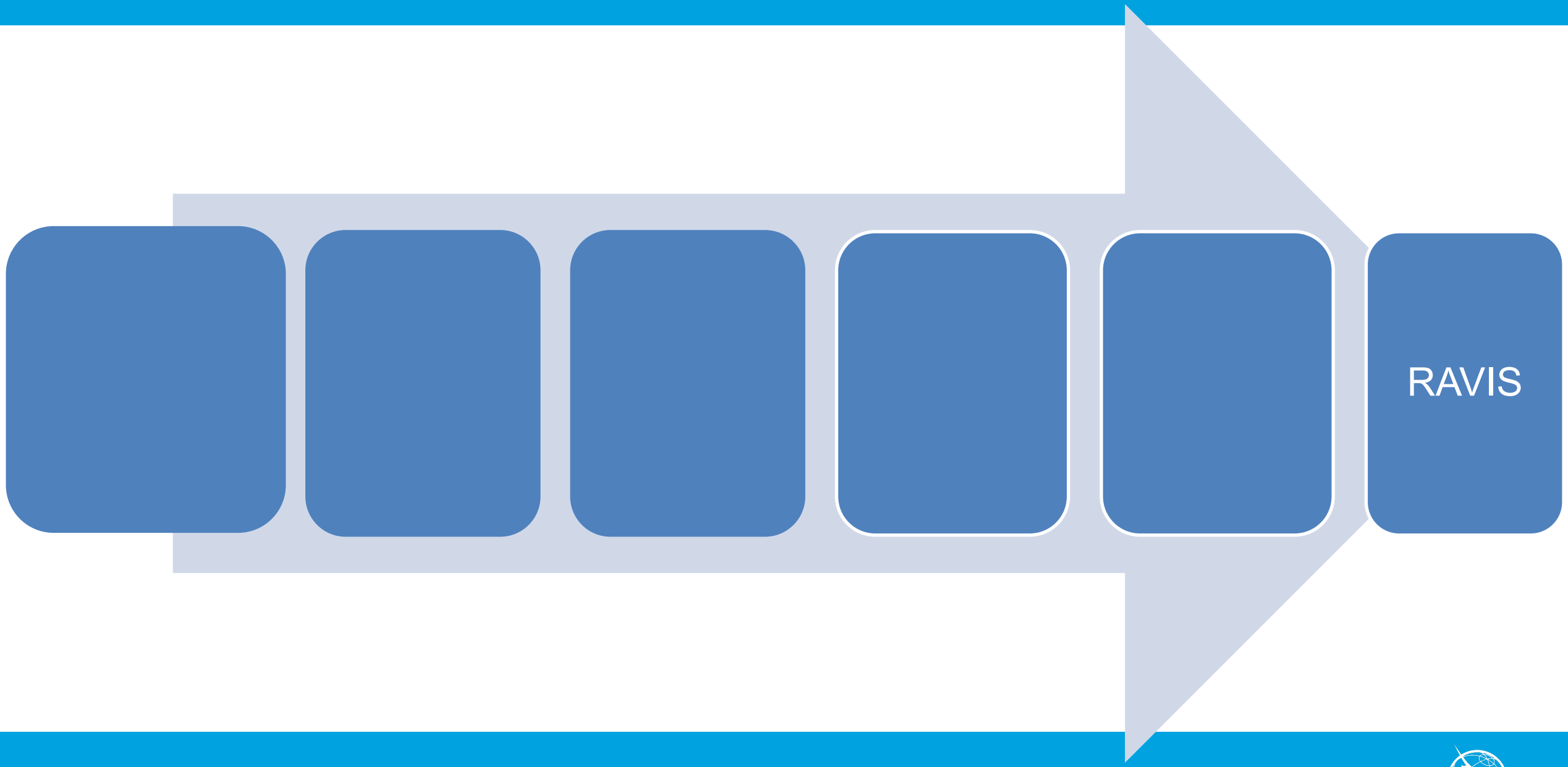
DTMB STANDARD CAN SUPPORT FIXED OR MOBILE AS WELL AS INDOOR/OUTDOOR RECEPTION FOR HIGH DEFINITION TV (HDTV), STANDARD DEFINITION TV (SDTV), OR MULTIMEDIA DATA BROADCASTING SERVICES. DTMB CAN ALSO SUPPORT BANDWIDTH OF 6 MHz, 7 MHz AND 8 MHz

Key characteristics of T-DMB/ AT-DMB systems

Characteristics	T-DMB, AT-DMB
Reception modes: – Fixed – Portable – Portable handheld – Mobile	 + + + +
Net data rates	T-DMB: 0.576 to 1.728 Mbit/s AT-DMB: 0.864 to 2.304 Mbit/s at BPSK over DQPSK AT-DMB: 1.152 to 2.88 Mbit/s at QPSK over DQPSK
Spectrum efficiency (bit/s/Hz)	T-DMB: 0.38-1.13 AT-DMB: 0.56-1.88
Single frequency networks	Supported
Broadcasting types: – sound – multimedia – TV	 + + +
Transmission data/service types	Video, audio, data
Frequency bands	VHF, UHF
Channel bandwidth	1.712 MHz
Used bandwidth	1.536 MHz
Number of segments	1
Number of subcarriers per segment	192; 384; 768; 1 536

Characteristics	T-DMB, AT-DMB
Subcarrier spacing	a) 8 kHz b) 4 kHz c) 2 kHz d) 1 kHz
Active symbol duration	a) 156 µs b) 312 µs c) 623 µs d) 1 246 µs
Guard interval duration/ ratio	a) 31 µs b) 62 µs c) 123 µs d) 246 µs
Frame duration	96 ms; 48 ms; 24 ms
Time/ frequency synchronization	Null symbol and centre frequency and phase reference symbol
Modulation methods	T-DMB: DQPSK AT-DMB: DQPSK; BPSK over DQPSK; QPSK over DQPSK
Inner FEC	T-DMB: Convolution code (1/4 to 3/4) AT-DMB: Convolution code + Turbo code (1/4 to 1/2)
Inner interleaving	Time interleaving and frequency interleaving
Outer FEC	RS (204, 188, T=8) code for video service and scalable video service
Outer interleaving	Convolutional interleaving for video service and scalable video service
Data randomization/ energy dispersal	16 bit PRBS
Hierarchical transmission	–
Transmission parameter signalling	Phase reference symbol

CONTENT



REAL-TIME AUDIO-VISUAL INFORMATION SYSTEM (RAVIS)

RAVIS SYSTEM IS DESIGNED FOR HIGH QUALITY MULTI-PROGRAMME SOUND, VIDEO WITH SEVERAL SOUND ACCOMPANIMENT CHANNELS AND OTHER DATA (BOTH RELATED AND UNRELATED TO SOUND AND VIDEO PROGRAMMES) BROADCASTING SERVICES.

SERVICES SHOULD BE PROVIDED IN VARIOUS CONDITIONS, INCLUDING DRIVING IN DENSE CITY ENVIRONMENT, IN WOODY AND MOUNTAINOUS TERRAIN, IN WATER AREAS; I.E. A RELIABLE RECEPTION MUST BE PROVIDED IN MOTION, IN THE ABSENCE OF DIRECT LINE OF SIGHT OF THE TRANSMITTER ANTENNAS AND MULTIPATH SIGNAL PROPAGATION.

Key characteristics of RAVIS system

Characteristics	RAVIS
Reception modes: – Fixed – Portable – Portable handheld – Mobile	 + + + +
Net data rates	Depending on modulation and code rate for different channel bandwidth: a) 100 kHz-75-341 kbit/s b) 200 kHz-155-703 kbit/s c) 250 kHz-196-888 kbit/s
Spectrum efficiency (bit/s/Hz)	0.77-3.64

Characteristics	RAVIS
Single frequency networks	Supported
Broadcasting types: – sound – multimedia – TV	 + +
Transmission data/service types	Video, audio, still pictures, presentations, traffic data, etc.
Frequency bands	VHF bands I, II
Channel bandwidth	a) 100 kHz b) 200 kHz c) 250 kHz
Used bandwidth	a) 96.0 kHz b) 185.6 kHz c) 246.2 kHz
Number of segments	1
Number of subcarriers per segment	a) 215 b) 439 c) 553
Subcarrier spacing	4000/9 Hz
Active symbol duration	2.25 ms
Guard interval duration/ ratio	1/8
Frame duration	103.78125 ms (41 OFDM symbols)
Time/ frequency synchronization	Guard interval/ Pilot carriers
Modulation methods	QPSK, 16-QAM, 64-QAM
Inner FEC	LDPC code with approximate code rates 1/2, 2/3, 3/4
Inner interleaving	Bit, cell, time and frequency interleaving
Outer FEC	BCH (n, k, t); n, k depend on channel bandwidth, LDPC code rate; error correction capability t = 10 errors (for main service channel)
Outer interleaving	–
Data randomization/ energy dispersal	16 bit PRBS
Hierarchical transmission	–
Transmission parameter signalling	4 subcarriers per OFDM symbol, 41 bits per OFDM frame

MERCI !!!