DIGITAL TERRESTRIAL TELEVISION

SESSION 4
BROADCAST NETWORK PLANNING

Policy and Regulation Initiative for Digital Africa (PRIDA)

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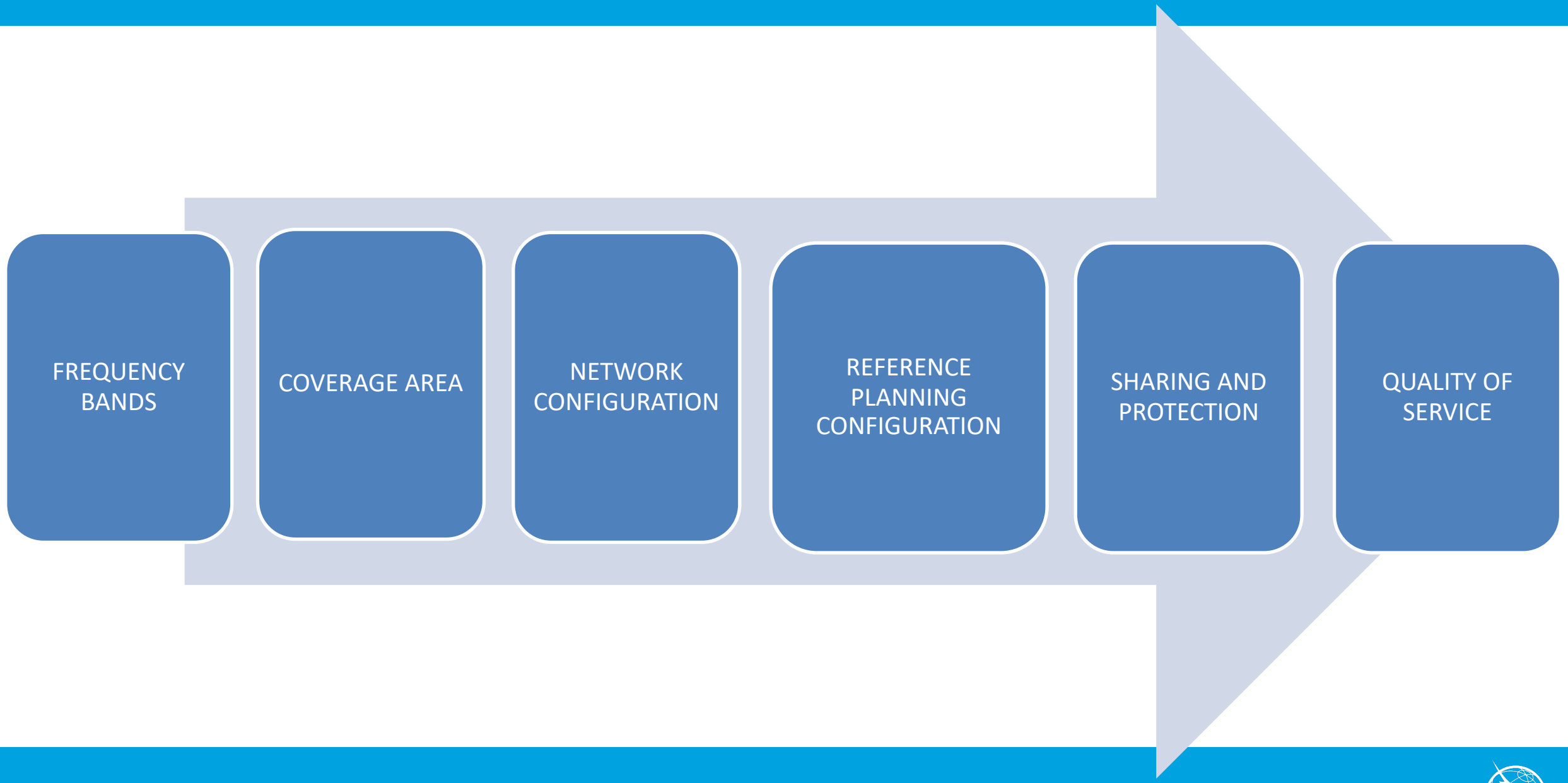
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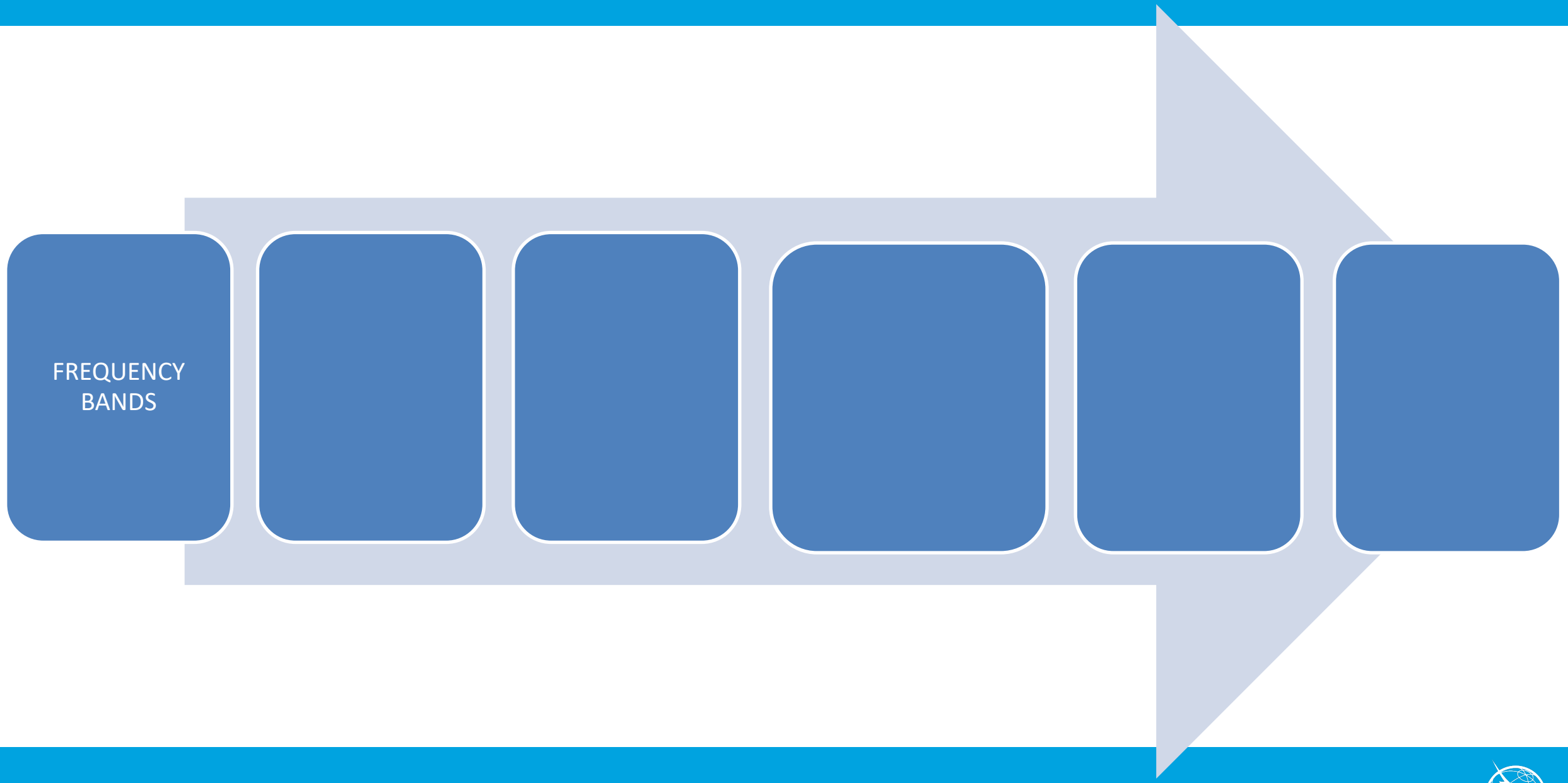

FREQUENCY BANDS

FOLLOWING THREE FREQUENCY BANDS THAT ARE ALLOCATED TO THE BROADCASTING SERVICE AND USED FOR BROADCAST TELEVISION:

- BAND III: FREQUENCY RANGE 174-230 MHz IN REGION 1, 174-216 MHz IN REGION 2, AND 174-223 MHz IN REGION 3.

  IN REGION 3, THERE ARE CO-PRIMARY ALLOCATIONS TO THE FIXED AND THE MOBILE SERVICE. IN REGION 1, THIS BAND IS ALSO USED FOR DIGITAL AUDIO BROADCASTING.

- BAND IV: FREQUENCY RANGE 470-582 MHz.

- BAND V: FREQUENCY RANGE 582-862 MHz (REGION 1), 582-890 MHz (REGIONS 2 AND 3).

FREQUENCY BANDS - EVOLUTION

- WRC-07: 790-862 MHz ALLOCATE TO MOBILE SERVICE IN REGION 1.
- WRC-12: FREQUENCY RANGE 470-582 MHz.
- WRC-15: 694-790 MHz ALLOCATE TO MOBILE SERVICE IN REGION 1
- WRC-23: 614-694 MHz ALLOCATE TO MOBILE IN CERTAINS ADMINISTRATIONS OF REGION 1

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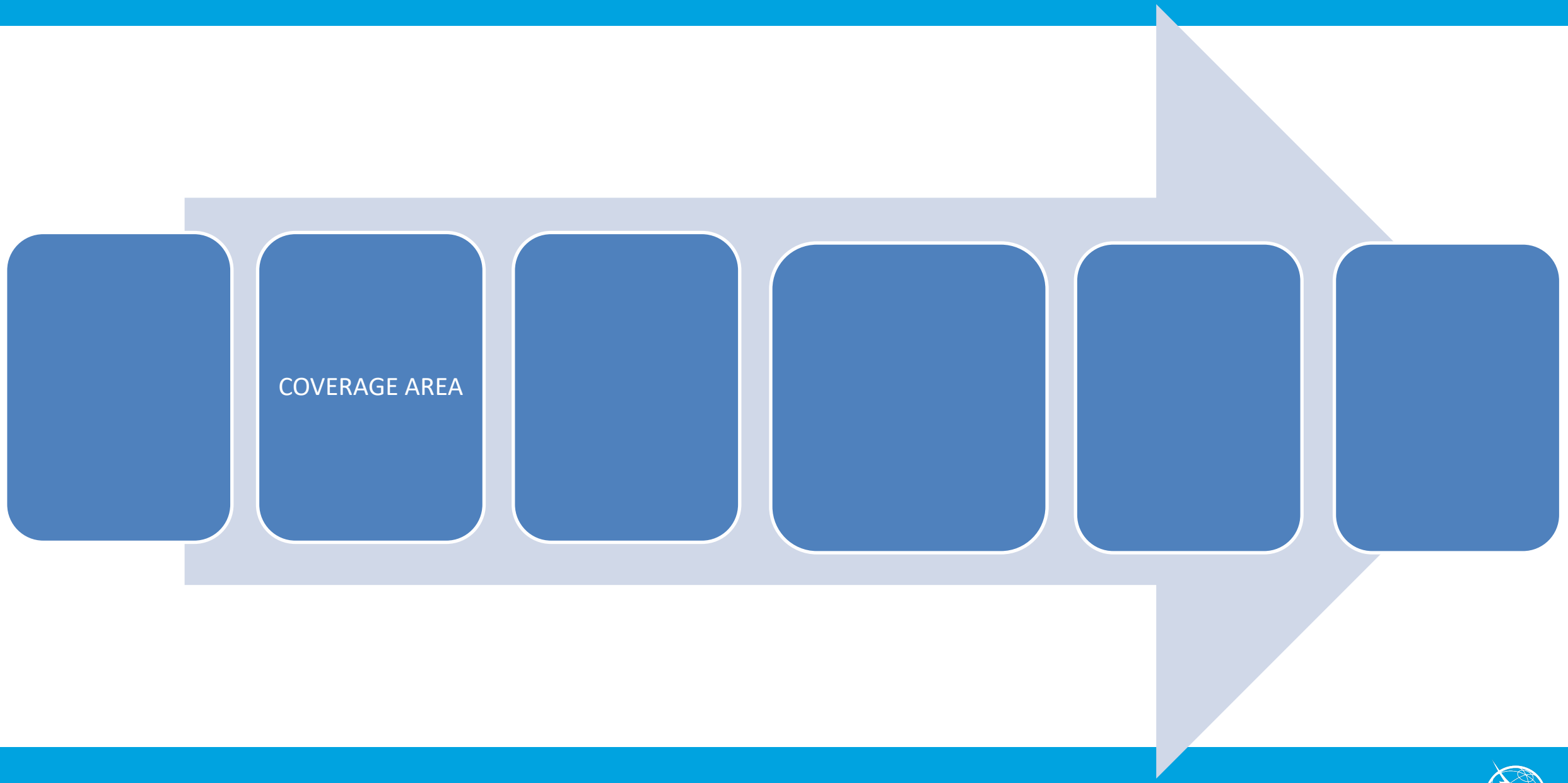

COVERAGE AREA

COVERAGE AREA OF A BROADCASTING STATION, OR A GROUP OF BROADCASTING STATIONS, IS AREA WITHIN WHICH THE WANTED FIELD STRENGTH IS EQUAL TO OR EXCEEDS THE USABLE FIELD STRENGTH DEFINED FOR SPECIFIED RECEPTION CONDITIONS AND FOR AN ENVISAGED PERCENTAGE OF COVERED RECEIVING LOCATIONS.

1) LEVEL 1: RECEIVING LOCATION – THE SMALLEST UNIT IS A RECEIVING LOCATION; OPTIMAL RECEIVING CONDITIONS WILL BE FOUND BY MOVING THE ANTENNA UP TO 0.5 M IN ANY DIRECTION. A RECEIVING LOCATION IS REGARDED AS BEING COVERED IF THE LEVEL OF THE WANTED SIGNAL IS HIGH ENOUGH TO OVERCOME NOISE AND INTERFERENCE FOR GIVEN PERCENTAGE OF THE TIME.

2) LEVEL 2: SMALL AREA COVERAGE – THE SECOND LEVEL IS A “SMALL AREA” (TYPICALLY 100 M BY 100 M). IN THIS SMALL AREA THE PERCENTAGE OF COVERED RECEIVING LOCATIONS IS INDICATED.

3) LEVEL 3: COVERAGE AREA – THE COVERAGE AREA OF A BROADCASTING STATION, OR A GROUP OF BROADCASTING STATIONS, IS MADE UP OF THE SUM OF THE INDIVIDUAL SMALL AREAS IN WHICH A GIVEN PERCENTAGE (TYPICALLY BETWEEN 70% AND 99%) OF COVERAGE IS ACHIEVED.

COVERAGE AREA

WHEN CALCULATING THE COVERAGE OF BROADCAST NETWORK, VARIOUS FACTORS NEED TO BE CONSIDERED.

WHEREAS IN ANALOGUE SYSTEMS THERE IS A GRACEFUL DEGRADATION IN PERFORMANCE AS THE EDGE OF COVERAGE AREA IS APPROACHED, THE “CLIFF-EDGE” FAILURE CHARACTERISTIC OF DIGITAL SYSTEMS MEANS THAT EVEN A SMALL MISMATCH BETWEEN PREDICTIONS AND MEASUREMENTS CAN LEAD TO LARGE DIFFERENCE BETWEEN PREDICTED AND ACTUAL COVERAGE AREAS.

1) PROPAGATIONS MODELS
2) INTERDEPENDENCE BETWEEN TRANSMITTING SITES AND SYSTEM VARIANT
3) TRANSMITTING ANTENNA RADIATION PATTERNS
4) FACTORS INFLUENCING THE FREQUENCY SEPARATION DISTANCE
5) MINIMUM CARRIER TO NOISE RATIO AND PROTECTION RATIO

FOR A DEEPENING ON PREDICTION METHODS AND PLANNING SOFTWARE, REPORT ITU-R BT.2137 “COVERAGE PREDICTION METHODS AND PLANNING SOFTWARE FOR DIGITAL TERRESTRIAL TELEVISION BROADCASTING (DTTB) NETWORKS”

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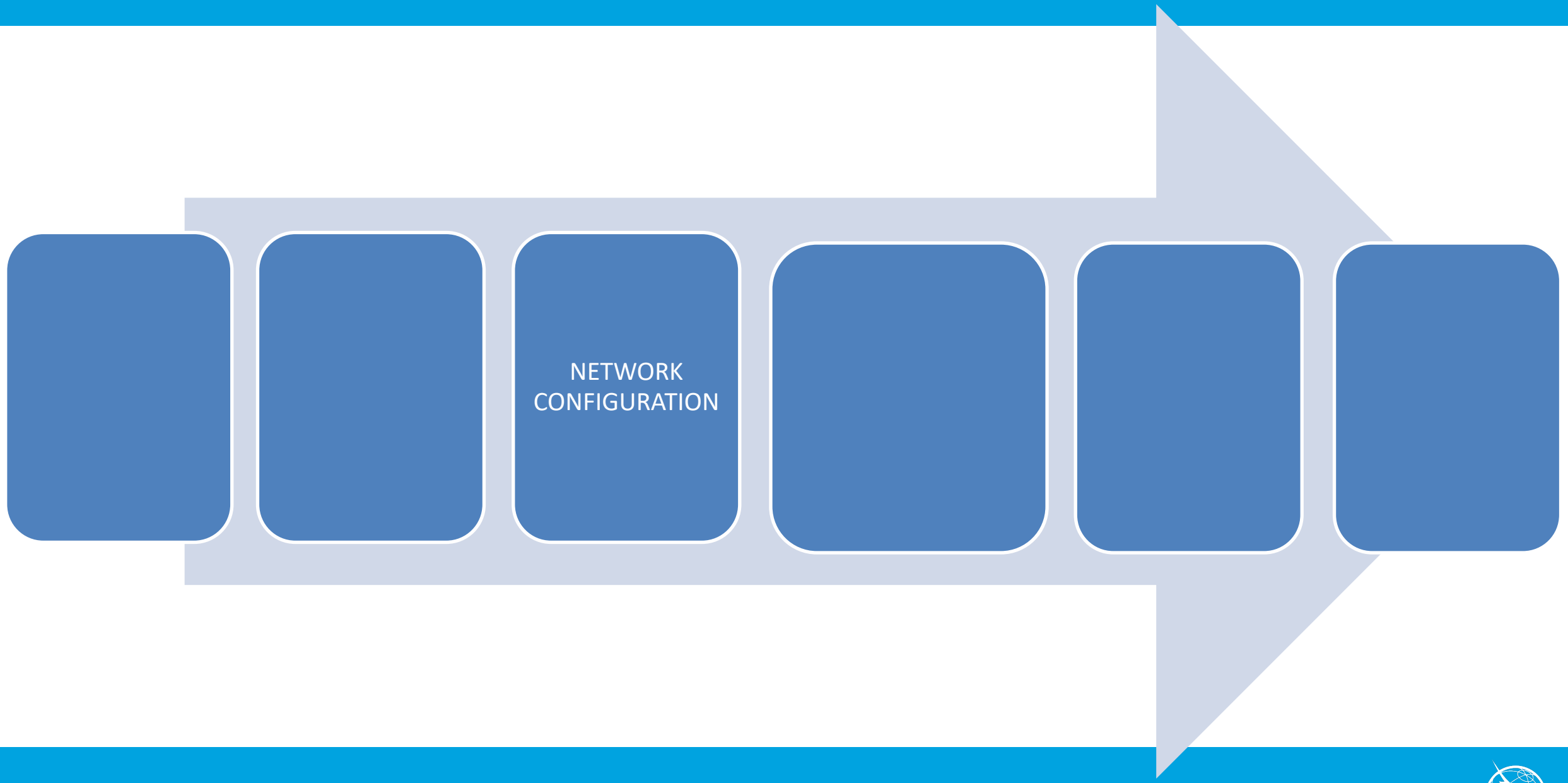
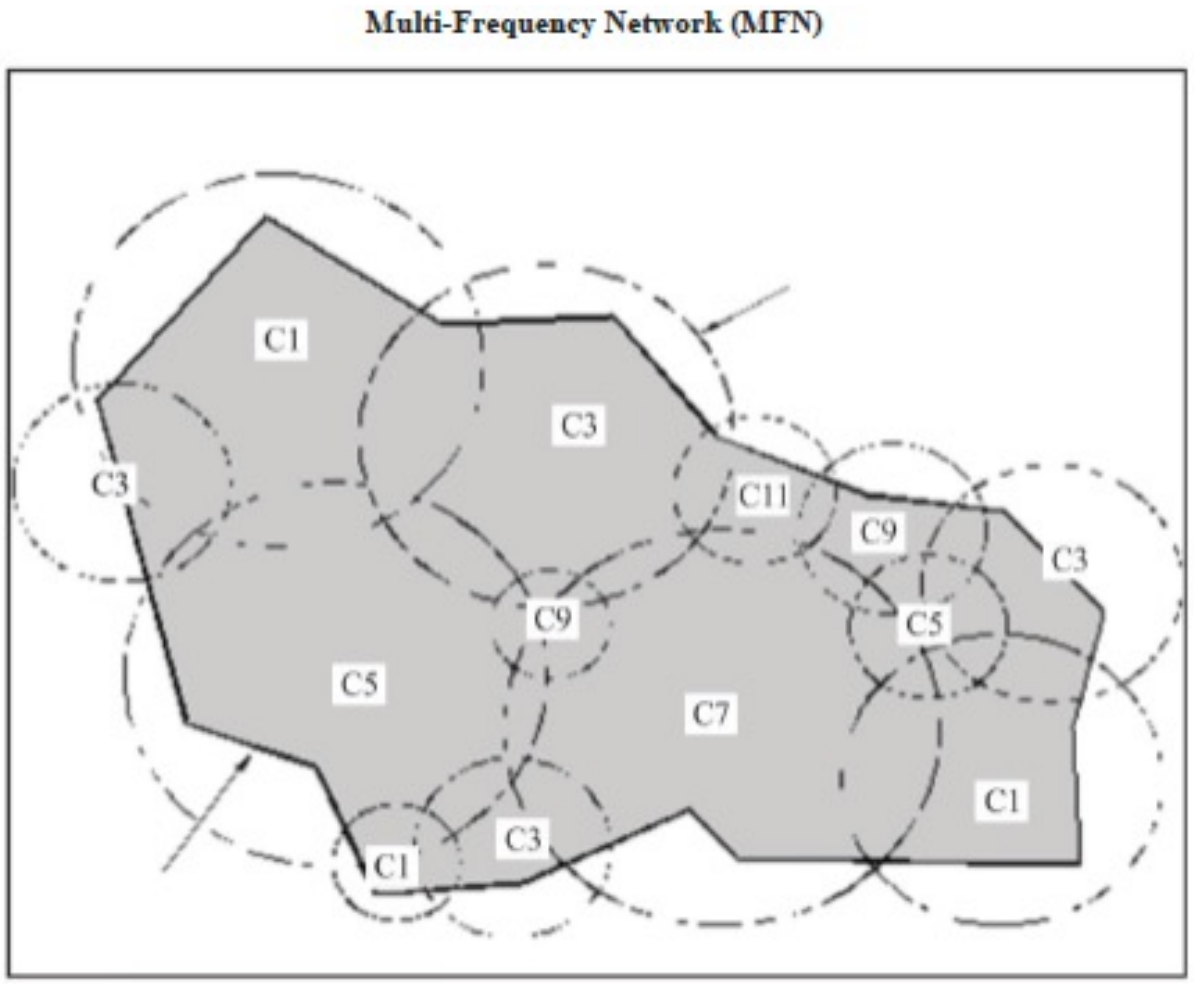


NETWORK CONFIGURATION – MULTI-FREQUENCY NETWORK (MFN)

A MULTI-FREQUENCY NETWORK (MFN) IS A NETWORK WHICH ASSIGNS A DIFFERENT FREQUENCY FOR EACH TRANSMITTER, I.E. FOR **N TRANSMITTERS, N FREQUENCY CHANNELS** ARE USED.

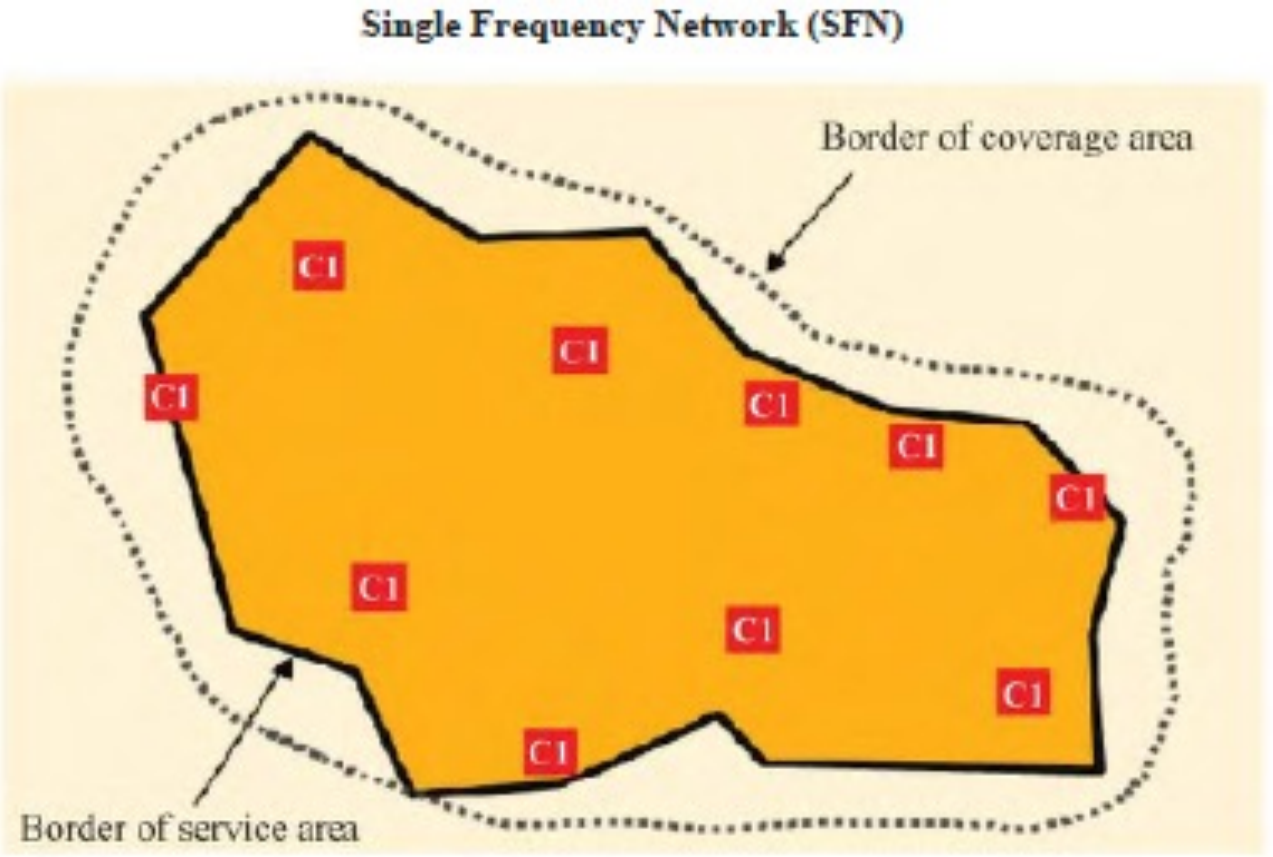
THE USE OF MULTIPLE FREQUENCIES AVOIDS UNACCEPTABLE CO-CHANNEL INTERFERENCE AMONG THE TRANSMITTERS, ALTHOUGH IN MOST PRACTICAL NETWORKS THERE WILL BE INSUFFICIENT FREQUENCY CHANNELS TO USE EACH ONLY ONCE, SO IN GENERAL, FREQUENCIES ARE REUSED AT A SUFFICIENT DISTANCE NOT TO CAUSE UNACCEPTABLE INTERFERENCE



NETWORK CONFIGURATION – SINGLE FREQUENCY NETWORK (SFN)

SINGLE FREQUENCY NETWORKS (SFNS) PROVIDE THE REQUIRED COVERAGE THROUGH THE USE OF **MULTIPLE TRANSMITTERS OPERATING ON THE SAME FREQUENCY** AND **CARRYING THE SAME CONTENT**.

OPERATION OF DTTB NETWORKS IN A SINGLE FREQUENCY CONFIGURATION IS FACILITATED BY USE OF THE MULTI-CARRIER ORTHOGONAL FREQUENCY DIVISION MULTIPLEXING (OFDM) MODULATION TECHNIQUE, WHICH ENABLES THE RECEPTION OF MORE THAN ONE USEFUL RF SIGNAL (MULTI-PATH IMMUNITY).



NETWORK CONFIGURATION – PROCEDURES OF PLANNING)

STEP 1: IDENTIFICATION OF WANTED SERVICE AREA	COMMON THAT THE SERVICE AREA FOR DTTB WILL BE THE SAME AS THE AREA COVERED BY THE ANALOGUE TV BROADCAST SYSTEM. AN ADVANTAGE OF DIGITAL TECHNOLOGY IS THE POSSIBILITY OF REDUCING THE TRANSMITTER POWER UP TO 16 DB COMPARED WITH THAT OF ANALOGUE TRANSMITTERS WHILE ACHIEVING THE SAME COVERAGE AREA
STEP 2: RECEPTION MODE	DTTB SYSTEMS ARE DESIGNED TO BE RECEIVABLE VIA FIXED (ROOFTOP) ANTENNAS, OR PORTABLE RECEIVERS, OR EVEN ON HANDHELD DEVICES..
STEP 3: PLANNING PARAMETERS	ENSURE THEY ARE AVAILABLE FOR HIGH PERCENTAGES OF TIME AND LOCATION PROBABILITY.
STEP 4: FREQUENCY ASSIGNMENT	GIVEN THE CHOICE OF RECEPTION MODE, AND REQUIRED DATA RATE, THE PROTECTION RATIO REQUIRED BY THE RECEIVER CAN BE ESTABLISHED..
STEP 5: COORDINATION	ONCE THE INTERFERENCE CAUSED TO AND FROM A NEW TRANSMITTER IS UNDERSTOOD, COORDINATION BETWEEN DTTB TRANSMITTERS MAY BE REQUIRED TO REDUCE UNACCEPTABLE INTERFERENCE.
STEP 6: GAP FILLING	EVEN THOUGH TRANSMITTERS ARE CONSTRUCTED AT HIGH ELEVATION SITES FOR WIDE COVERAGE, UNCOVERED AREAS MAY STILL EXIST.

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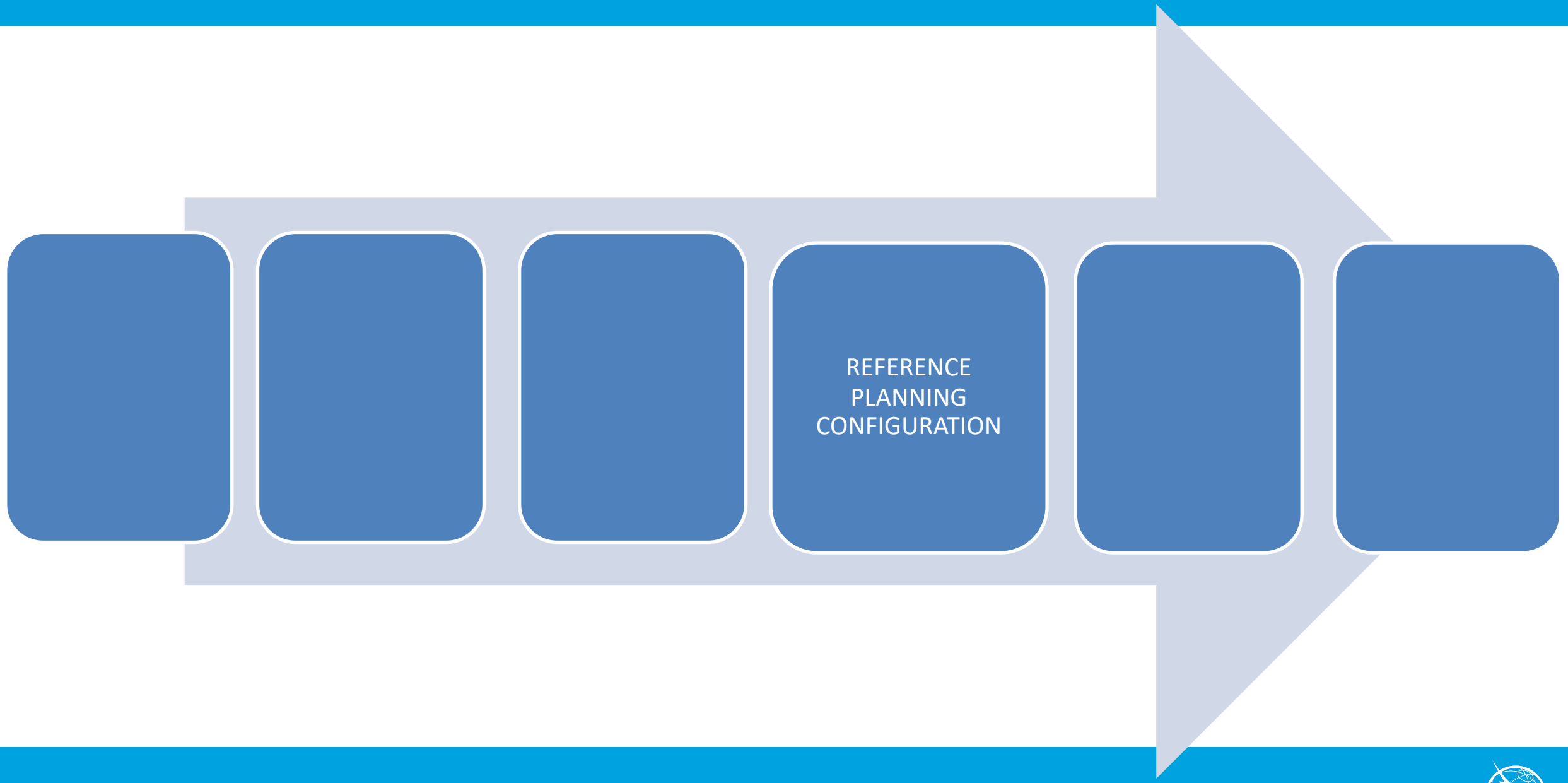


REFERENCE PLANNING CONFIGURATION – GENERAL

DTT TECHNIQUES ALLOW A LARGE VARIETY OF IMPLEMENTATION CONFIGURATIONS. IN ORDER TO CLASSIFY SUCH CONFIGURATIONS SO-CALLED REFERENCE PLANNING CONFIGURATIONS.

PLANNING CONFIGURATIONS (RPCS) CAN BE GROUPED ACCORDING TO RECEPTION MODE AND FREQUENCY BAND.

THE RECEPTION MODES HAVE BEEN GROUPED AS FOLLOWS:

1) FIXED RECEPTION;
2) PORTABLE OUTDOOR RECEPTION, MOBILE RECEPTION AND LOWER COVERAGE QUALITY PORTABLE INDOOR RECEPTION;
3) HIGHER COVERAGE-QUALITY PORTABLE INDOOR RECEPTION.

Reference Planning Configurations for DVB-T

RPC	RPC 1	RPC 2	RPC 3
Reference location probability	95%	95%	95%
Reference *C/N* (dB)	21	19	17
Reference $(E_{med})_{ref}$ (dB(μV/m)) at f_r = 200 MHz	50	67	76
Reference $(E_{med})_{ref}$ (dB(μV/m)) at f_r = 650 MHz	56	78	88

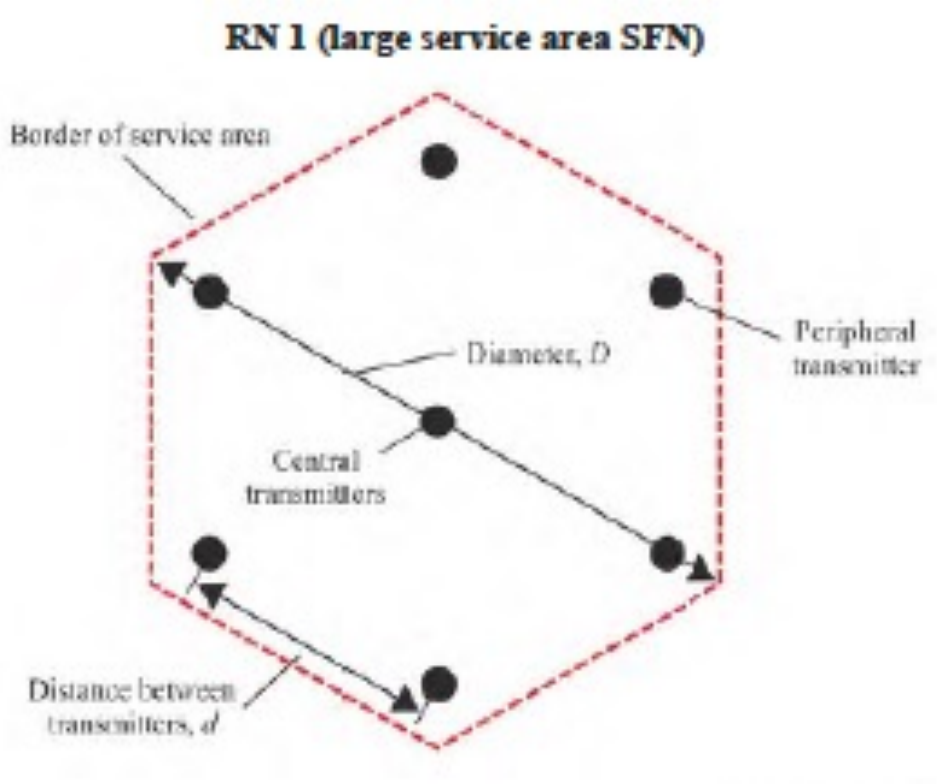
$(E_{med})_{ref}$: Reference value for minimum median field strength
RPC 1: RPC for fixed reception
RPC 2: RPC for portable outdoor reception or lower coverage quality portable indoor reception or mobile reception
RPC 3: RPC for higher coverage quality for portable indoor reception

REFERENCE PLANNING CONFIGURATION – REFERENCE NETWORK 1 (LARGE SERVICE AREA SFN)

RN1 CONSISTS OF SEVEN TRANSMITTERS SITUATED AT THE CENTRE AND AT THE VERTICES OF A HEXAGONAL LATTICE. AN OPEN NETWORK TYPE HAS BEEN CHOSEN, I.E. THE TRANSMITTERS HAVE NON-DIRECTIONAL ANTENNA PATTERNS AND THE SERVICE AREA IS ASSUMED TO EXCEED THE TRANSMITTER HEXAGON BY ABOUT 15%.

RN 1 IS APPLIED TO DIFFERENT CASES: FIXED (RPC 1), OUTDOOR/MOBILE (RPC 2) AND INDOOR (RPC 3) RECEPTION, FOR BOTH BAND III AND BANDS IV/V.

RN 1 IS INTENDED FOR LARGE SERVICE AREA SFN COVERAGE. IT IS ASSUMED THAT MAIN TRANSMITTER SITES WITH AN APPROPRIATE EFFECTIVE ANTENNA HEIGHT ARE USED AS A BACKBONE FOR THIS TYPE OF NETWORK.



REFERENCE PLANNING CONFIGURATION – REFERENCE NETWORK 1 (LARGE SERVICE AREA SFN)

Parameters of RN 1 (large service area SFN)

RPC and reception type		RPC 1 Fixed antenna	RPC 2 Portable outdoor and mobile	RPC 3 Portable indoor
Type of network		Open	Open	Open
Geometry of service area		Hexagon	Hexagon	Hexagon
Number of transmitters		7	7	7
Geometry of transmitter lattice		Hexagon	Hexagon	Hexagon
Distance between transmitters *d* (km)		70	50	40
Service area diameter *D* (km)		161	115	92
Tx effective antenna height (m)		150	150	150
Tx antenna pattern		Non-directional	Non-directional	Non-directional
e.r.p. (dBW)	Band III	34.1	36.2	40.0
	Bands IV/V	42.8	49.7	52.4

NOTE – The e.r.p. is given for 200 MHz in Band III and 650 MHz in Bands IV/V; for other frequencies (*f* in MHz) the frequency correction factor to be added is: 20 $\log_{10}$ (*f*/200 or *f*/650) for RPC 1 and 30 $\log_{10}$ (*f*/200 or *f*/650) for RPC 2 and RPC 3. The e.r.p. values indicated in this table incorporate an additional power margin of 3 dB.

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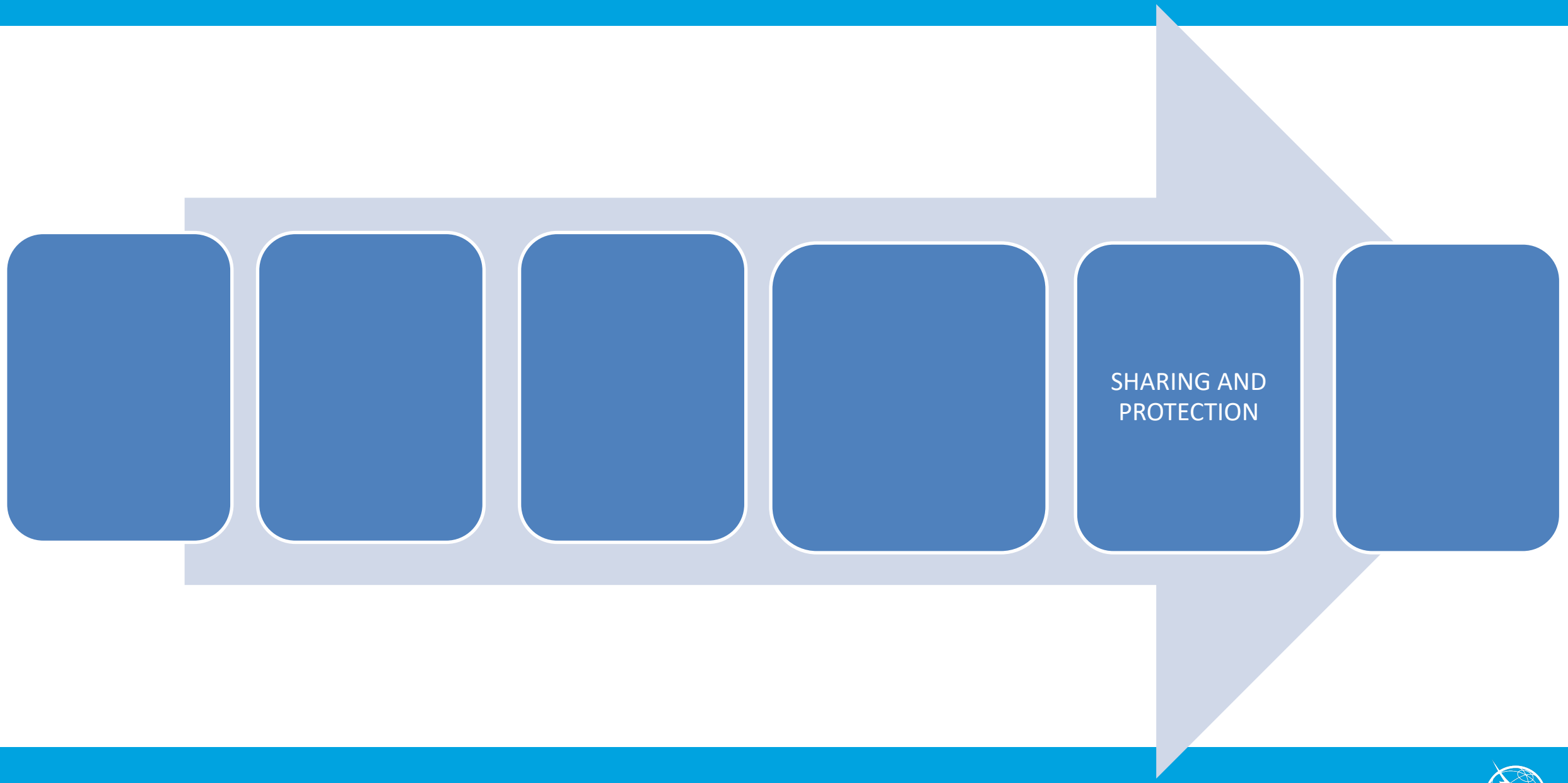

SHARING AND PROTECTION – CATEGORIES OF INTERFERENCE

INTERFERENCE TO DTTB CAN ARISE FROM:

- OTHER SYSTEMS (INTER SYSTEM COMPATIBILITY) DESIGNED TO EMIT RADIO SIGNALS (E.G. MOBILE BROADBAND NETWORKS) OR
- SYSTEMS NOT DESIGNED TO EMIT RADIO SIGNALS, BUT WHICH DO SO ANYWAY (E.G. POWER-LINE TRANSMISSION NETWORKS).
- PHYSICAL OBJECTS THAT LIE IN THE SIGNAL PATH BETWEEN TRANSMITTER AND RECEIVER (E.G. WIND TURBINE GENERATORS).

INTERFERENCE MAY BE THE RESULT OF:

- UNWANTED EMISSIONS OUTSIDE THE NECESSARY BANDWIDTH OF THE SOURCE OF INTERFERENCE OCCURRING IN THE “OUT OF BAND” DOMAIN OR THE “SPURIOUS” DOMAIN WHICH OVERLAP THE WANTED DTTB CHANNEL,
- DISTURBANCES, INTERNAL TO DTTB RECEIVERS, GENERATED BY OVERLOAD, CROSS MODULATION
- INTERMODULATION INVOLVING STRONG SIGNALS FROM OTHER RADIOCOMMUNICATION SYSTEMS OPERATING IN THE SAME OR ADJACENT FREQUENCY BANDS.

SHARING AND PROTECTION– CATEGORIES OF INTERFERENCE

IN THE CASE OF IN-BAND INTERFERENCE (THAT ORIGINATES FROM EMISSIONS IN THE SAME FREQUENCY BAND OR CHANNEL AS THE WANTED DTTB SIGNAL), MITIGATION IS GENERALLY ACCOMPLISHED BY UTILIZING NETWORK DESIGN ELEMENTS, SUCH AS GEOGRAPHICAL SPACING OR ANTENNA DISCRIMINATION.

FOR OUT-OF-BAND AND SPURIOUS INTERFERENCE (THAT ORIGINATES IN OTHER FREQUENCY BANDS OR CHANNELS, TYPICALLY ADJACENT BANDS), IT IS USUAL TO SPECIFY ACCEPTABLE OUT-OF-BAND AND SPURIOUS EMISSION LEVELS FOR THE EQUIPMENT BEFORE IT COMES TO MARKET.

AS FOR UNWANTED EMISSIONS FROM EQUIPMENT NOT DESIGNED TO EMIT RADIO SIGNALS AT ALL, IT IS USUAL TO SPECIFY ACCEPTABLE EMISSION LEVELS FOR THE EQUIPMENT BEFORE IT COMES TO MARKET.

IN ADDITION, IMPROVING SELECTIVITY OF THE DTTB RECEIVING INSTALLATION AS WELL AS GEOGRAPHICAL SPACING AND ANTENNA DISCRIMINATION CAN ALSO BE USED TO OVERCOME THE VARIOUS INTERFERENCE MECHANISMS THAT CAN ARISE.

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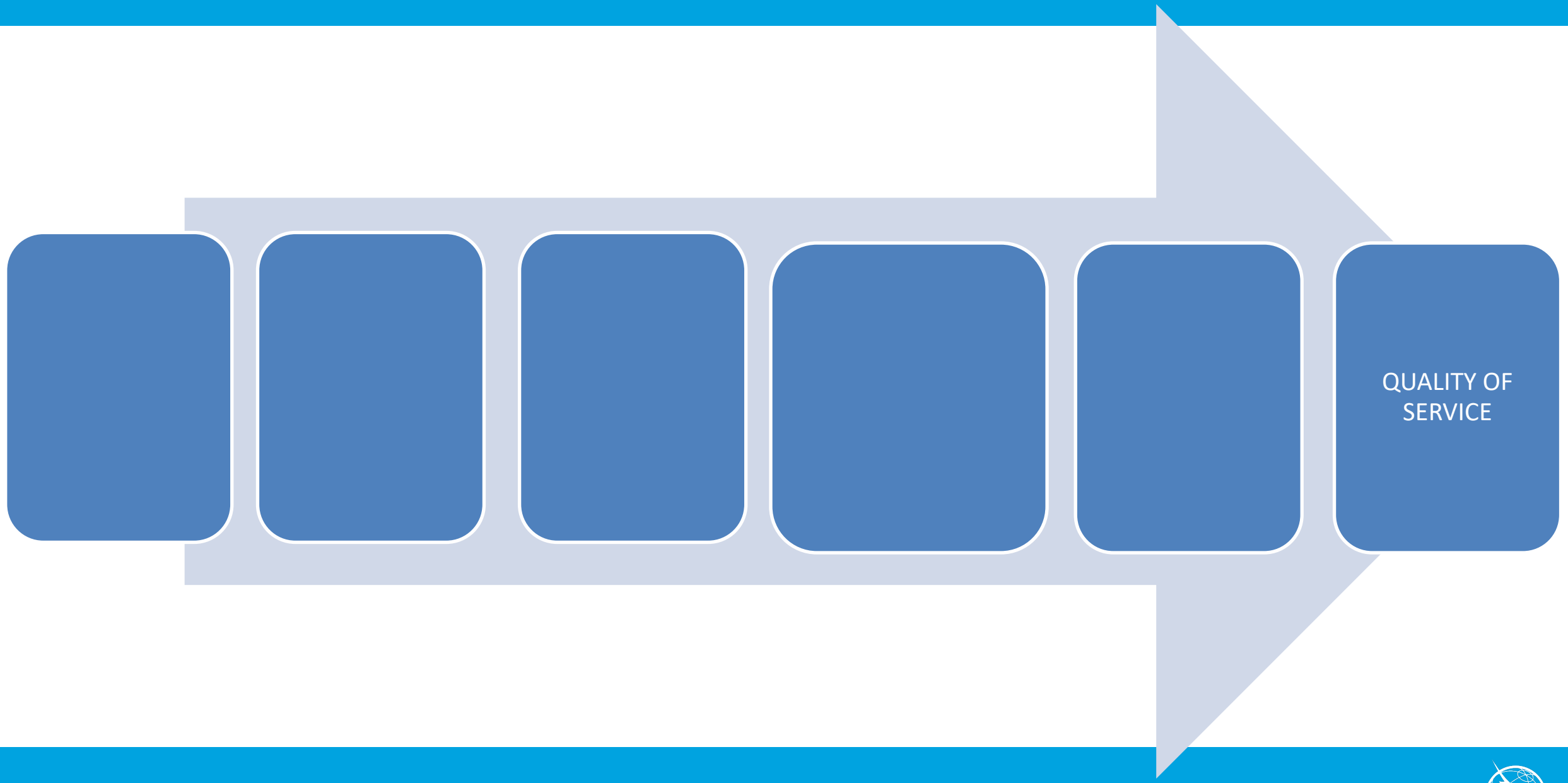


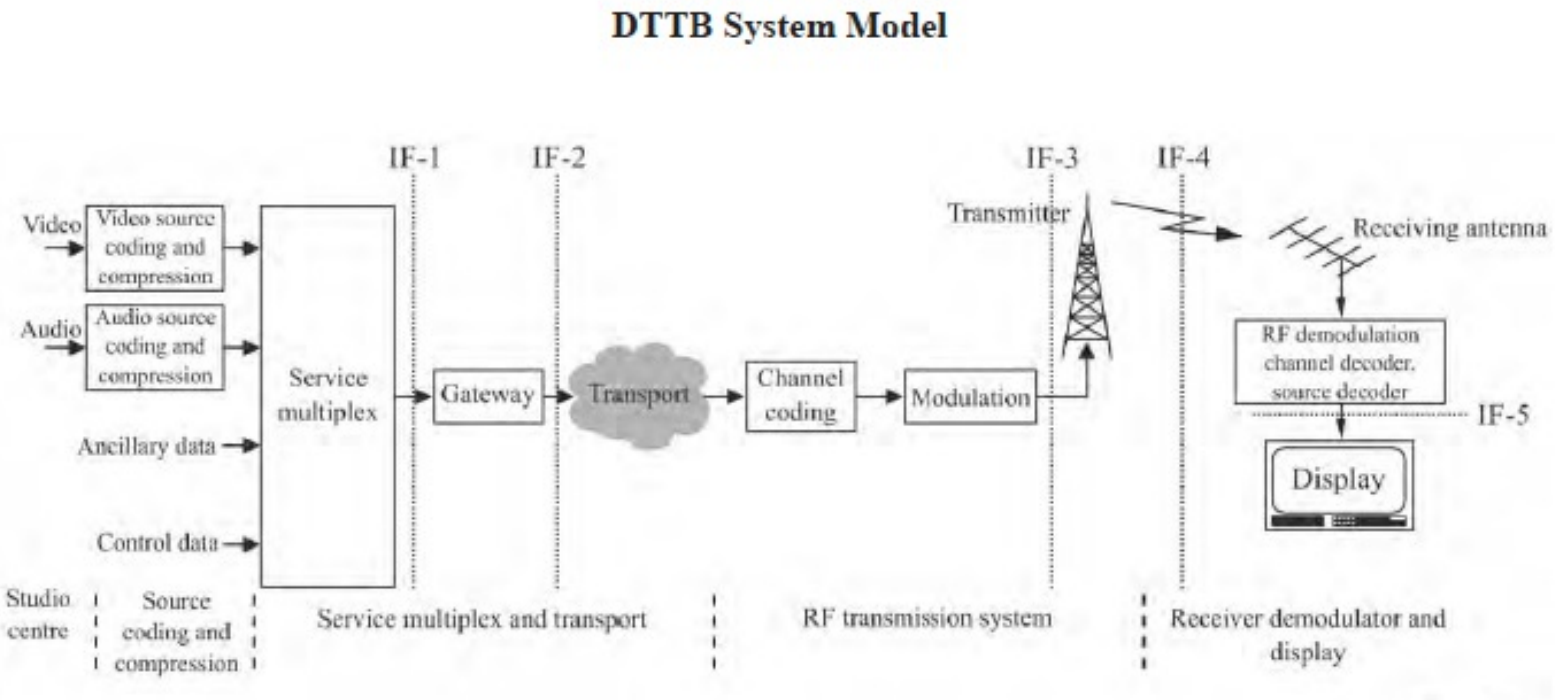
QUALITY OF SERVICE

QUALITY OF RECEPTION INCLUDING THE PICTURE AND SOUND QUALITY DEPEND ON MULTIPLE FACTORS.

PERFORMANCE OF THE RECEIVING SYSTEM CANNOT BE AFFECTED BY THE SERVICE PLANNING AND IS NOT UNDER THE CONTROL OF THE BROADCASTER OR BROADCAST NETWORK OPERATOR

QUALITY OF SERVICE REQUIREMENTS CAN BE DEFINED AT INTERFACES IF-1, IF-2 AND IF-3.

IN ORDER TO AVOID THE PROBLEM THAT THE RECEIVER CANNOT RECEIVE THE SIGNAL AS PLANNED, A MINIMUM RECEIVER SPECIFICATION SHOULD BE ESTABLISHED



QUALITY OF SERVICE – MEASURMENTS FOR MONITORING QoS

MEASUREMENTS AT INTERFACE IF-1	DATA STREAM IS EITHER A TS (TRANSPORT STREAM) OR A TS ENCAPSULATED IN IP. IT CONTAINS VIDEO AND AUDIO DATA, AS WELL AS SERVICE DATA TO BE TRANSMITTED. MEASUREMENTS SHOULD BE CARRIED OUT BOTH BEFORE THE LAUNCH OF TRANSMISSION AND ALSO DURING OPERATION. ERRORS THAT OCCUR HERE CAN HAVE AN IMPACT ON THE RECEPTION QUALITY OF EVERY RECEIVER.
MEASUREMENTS AT INTERFACE IF-2	DATA STREAM IS EITHER A TS (TRANSPORT STREAM) OR A TS ENCAPSULATED IN IP. GATEWAY HAS ADDED THE INFORMATION THAT IS NECESSARY FOR THE TRANSMITTER TO BUILD THE REQUIRED SIGNAL. MEASUREMENTS SHOULD BE CARRIED OUT BOTH BEFORE THE LAUNCH OF TRANSMISSION AND ALSO DURING OPERATION. ERRORS THAT OCCUR HERE CAN HAVE AN IMPACT ON THE RECEPTION QUALITY OF EVERY RECEIVER.

QUALITY OF SERVICE – MEASURMENTS FOR MONITORING QoS

MEASUREMENTS AT INTERFACE IF-3	MEASUREMENTS DIRECTLY AT THE TRANSMITTER OUTPUT USING A DIRECTIONAL COUPLER, OR IN THE LABORATORY USING A SIGNAL GENERATOR. SIGNAL FORMAT IS A FULLY CREATED RF SIGNAL. MEASUREMENTS SHOULD BE CARRIED OUT BEFORE THE LAUNCH OF TRANSMISSION TO ENSURE THAT THE TRANSMITTED SIGNAL FULFILS THE REQUIREMENTS.
MEASUREMENTS AT INTERFACE IF-4	MEASUREMENTS ARE CARRIED OUT IN THE FIELD. SIGNAL FORMAT IS THE SAME AS THE RF SIGNAL EMITTED FROM A DTT STATION BUT IT WILL HAVE BEEN ALTERED BY THE EFFECTS OF THE RF PROPAGATION CHANNEL. FOCUS SHOULD BE ON THE RECEIVED FIELD STRENGTH AND SIGNAL QUALITY PARAMETERS.
MEASUREMENTS AT INTERFACE IF-5	DATA STREAM IS EITHER A TS (TRANSPORT STREAM) OR A TS ENCAPSULATED IN IP. MEASUREMENT RECEIVER IS NECESSARY TO ANALYSE THE TS DATA.

MERCI !!!