DVB-T/T2 Fundamentals

Presentation to DVB Workshop

KL March 2012

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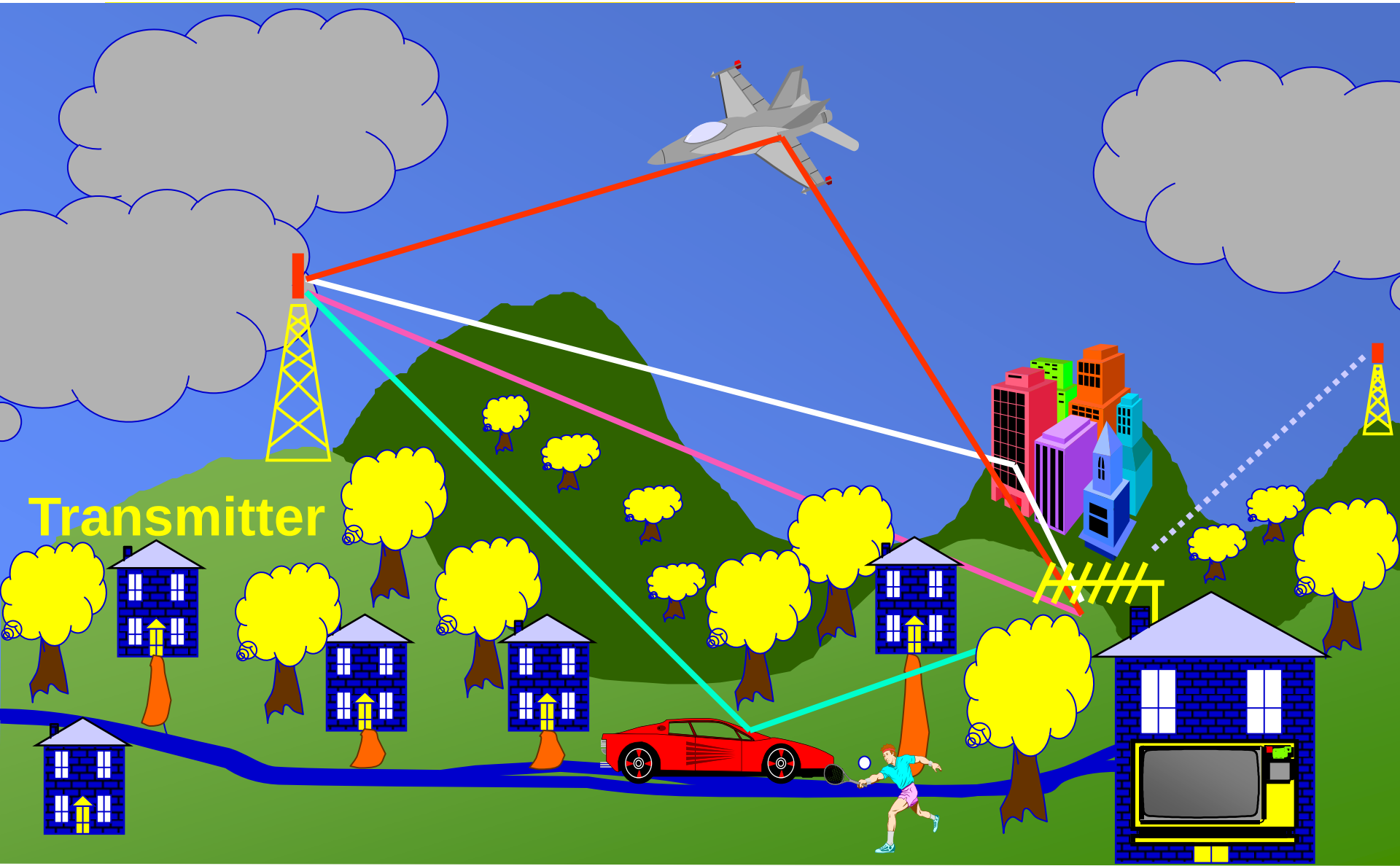
Part 1 Agenda

- Background
- COFDM
- DVB-T2 Technologies
- Performance of DVB-T2 relative to other standards

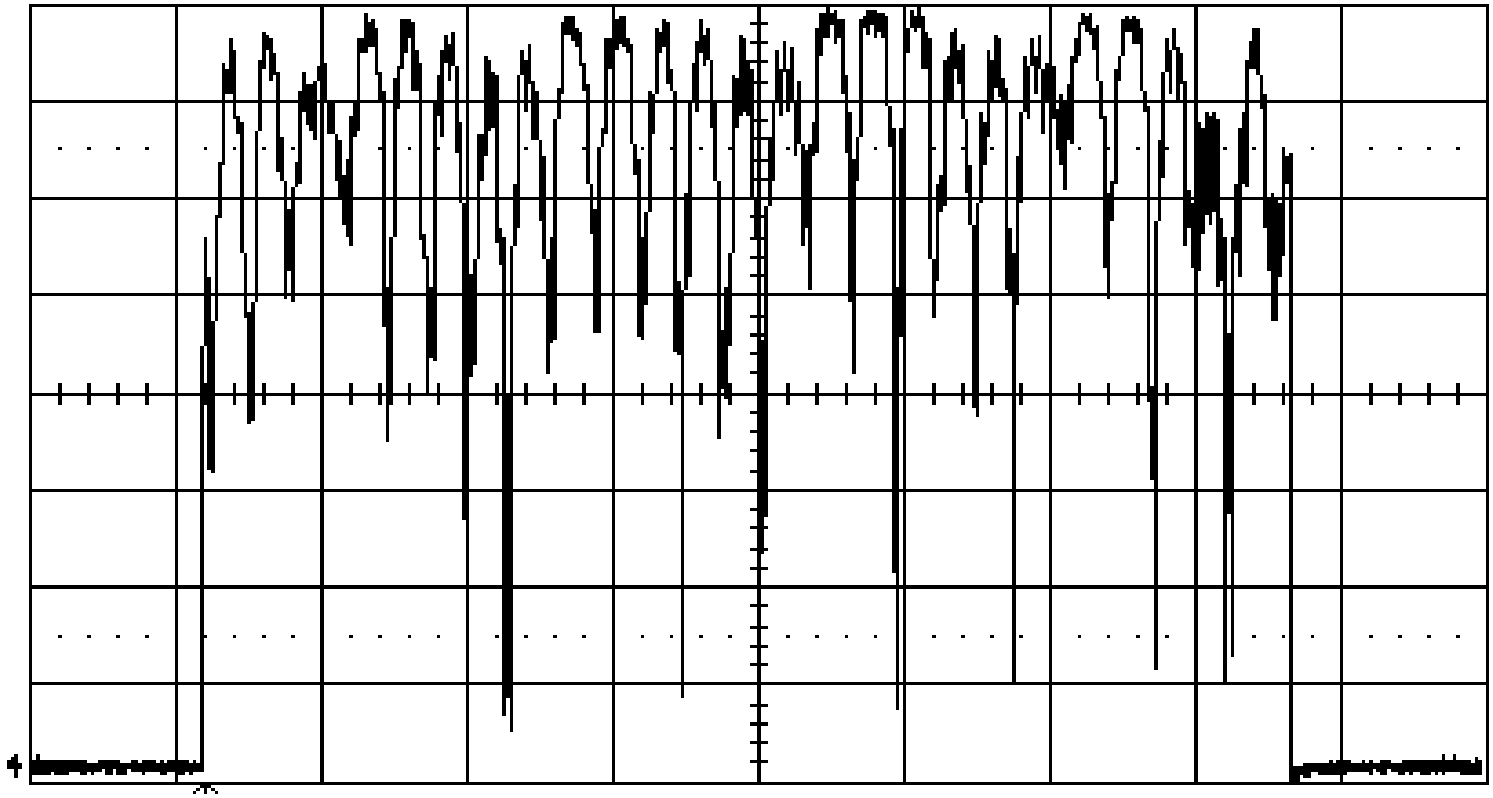
Terrestrial Propagation Realities



COFDM - What does it mean!

- Real life terrestrial delivery is complex.
- Received signal is a dynamic combination of signals arriving at varying delays.
- Resulting channel spectrum is far less than ideal
- Solution ;
  - Transmitted Data spread over large number of closely spaced frequency sub-bands.
  - Data protected before transmission
  - Coded Frequency Division Multiplex -COFDM

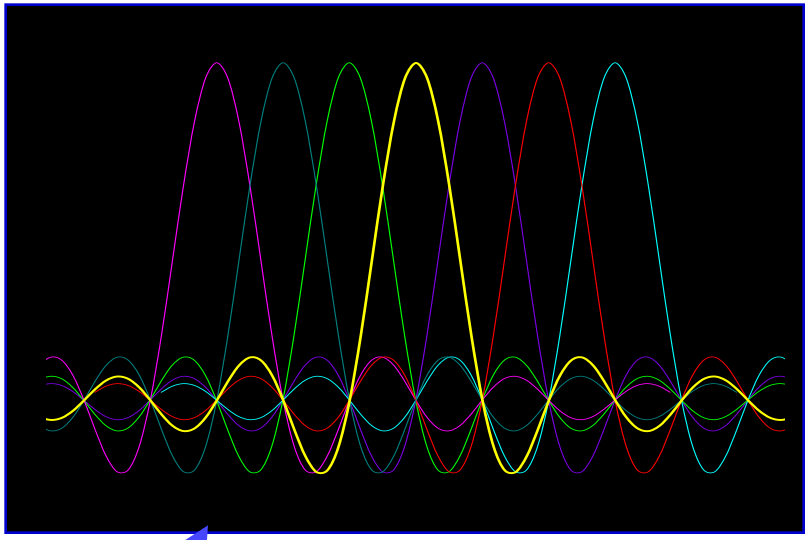
Terrestrial propagation - channel response



COFDM is the solution to cope with selective and time-variant frequency fading.

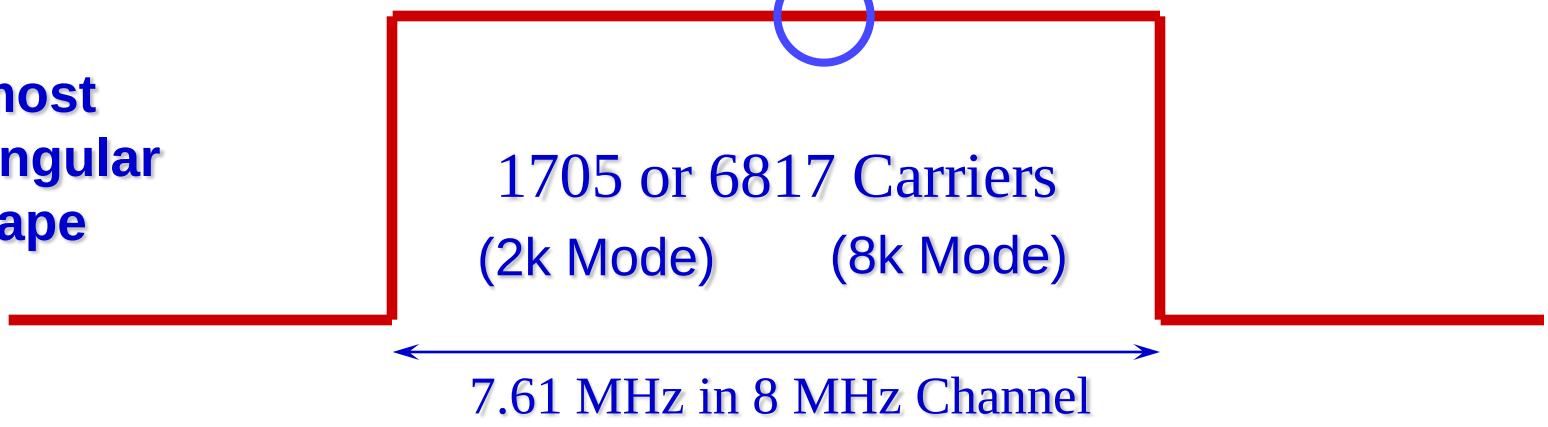
Spectrum of COFDM

Coded
Orthogonal
Frequency
Division
Multiplex



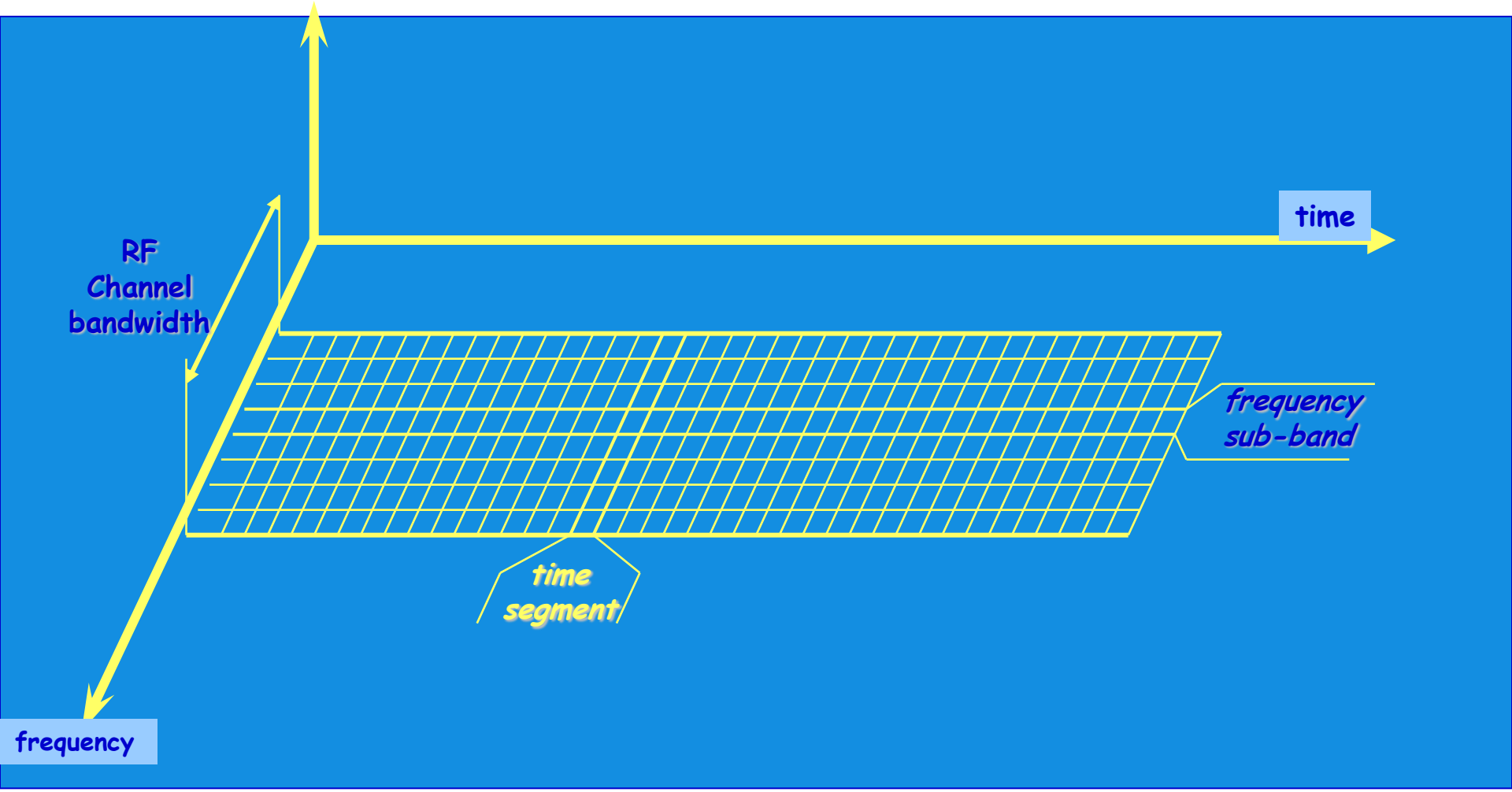
8MHz Carrier Spacing
2k Mode 4.47 kHz
8k Mode 1.12 kHz

Almost Rectangular Shape



COFDM : HOW ?

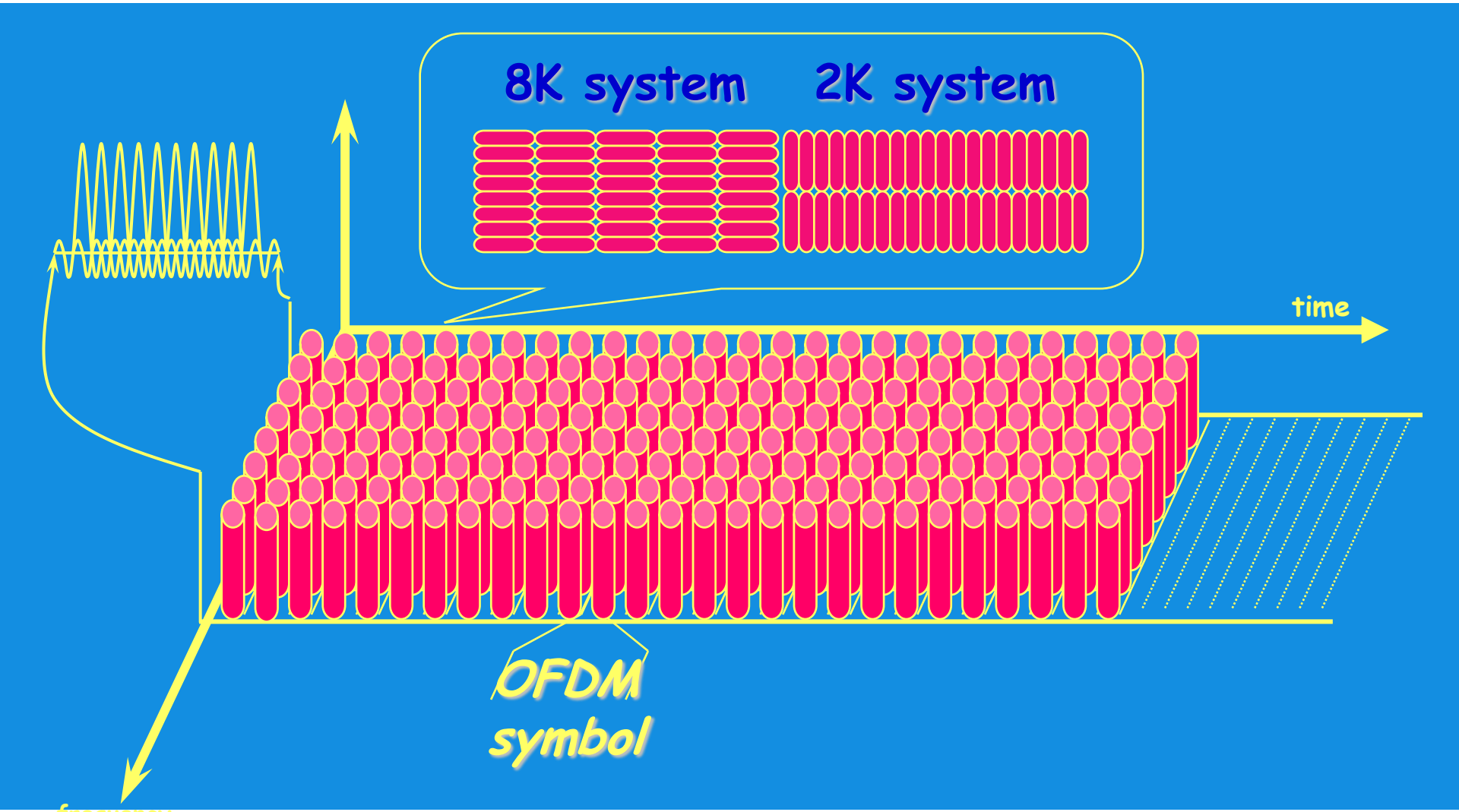
- 1 - Organize time & frequency partitions in the RF channel



Channel characteristics are based on "time vs frequency" cells

COFDM : HOW ?

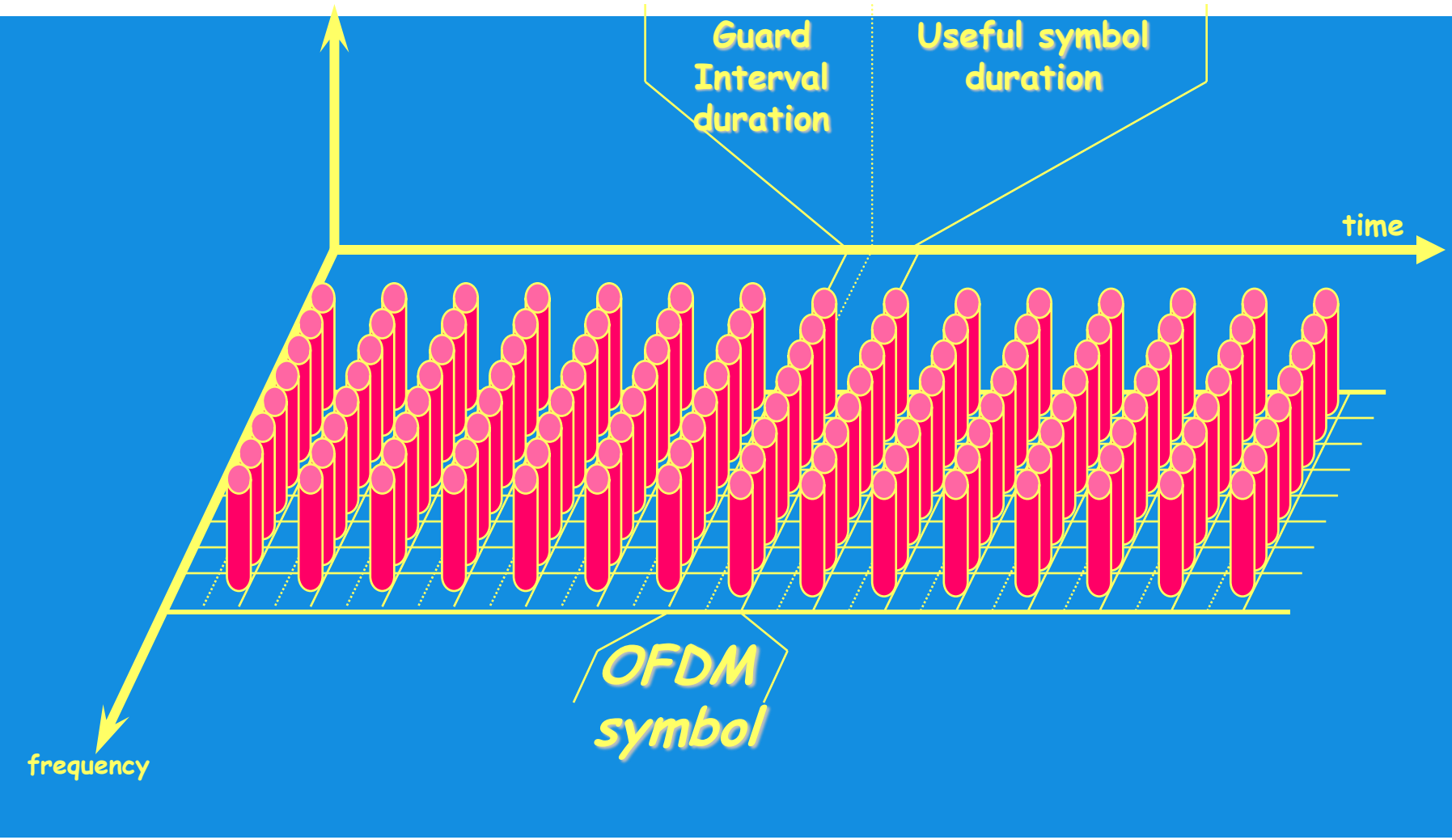
- 2 - Spread sub-carriers over “time vs frequency” cells



Sub-carriers are orthogonal (df=1/dt) to avoid “inter-carriers” interference

COFDM : HOW ?

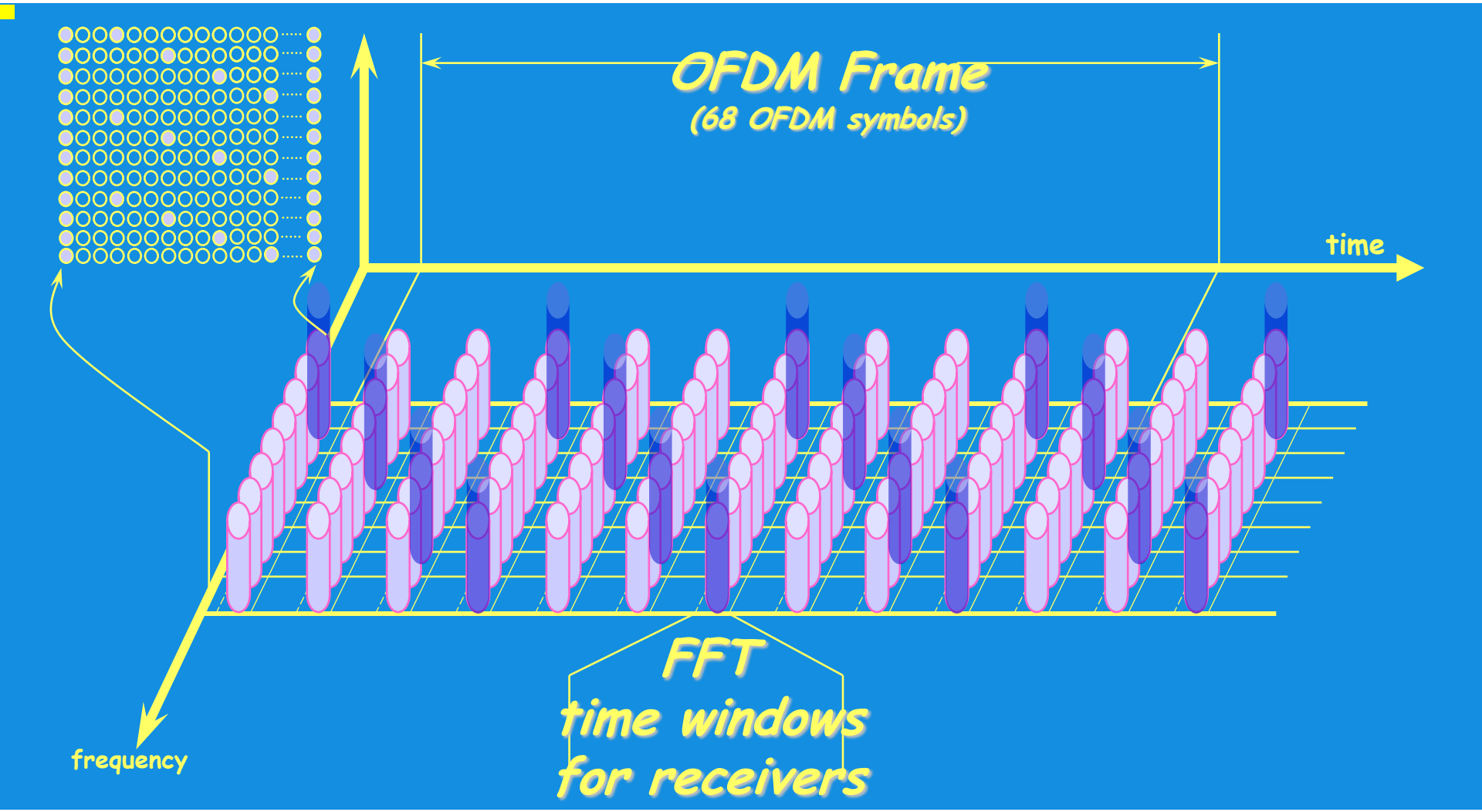
- 3 - Insert Guard Interval to avoid “inter-symbol” interference



NOTE: Guard interval introduces the first loss in transport capacity

COFDM : HOW ?

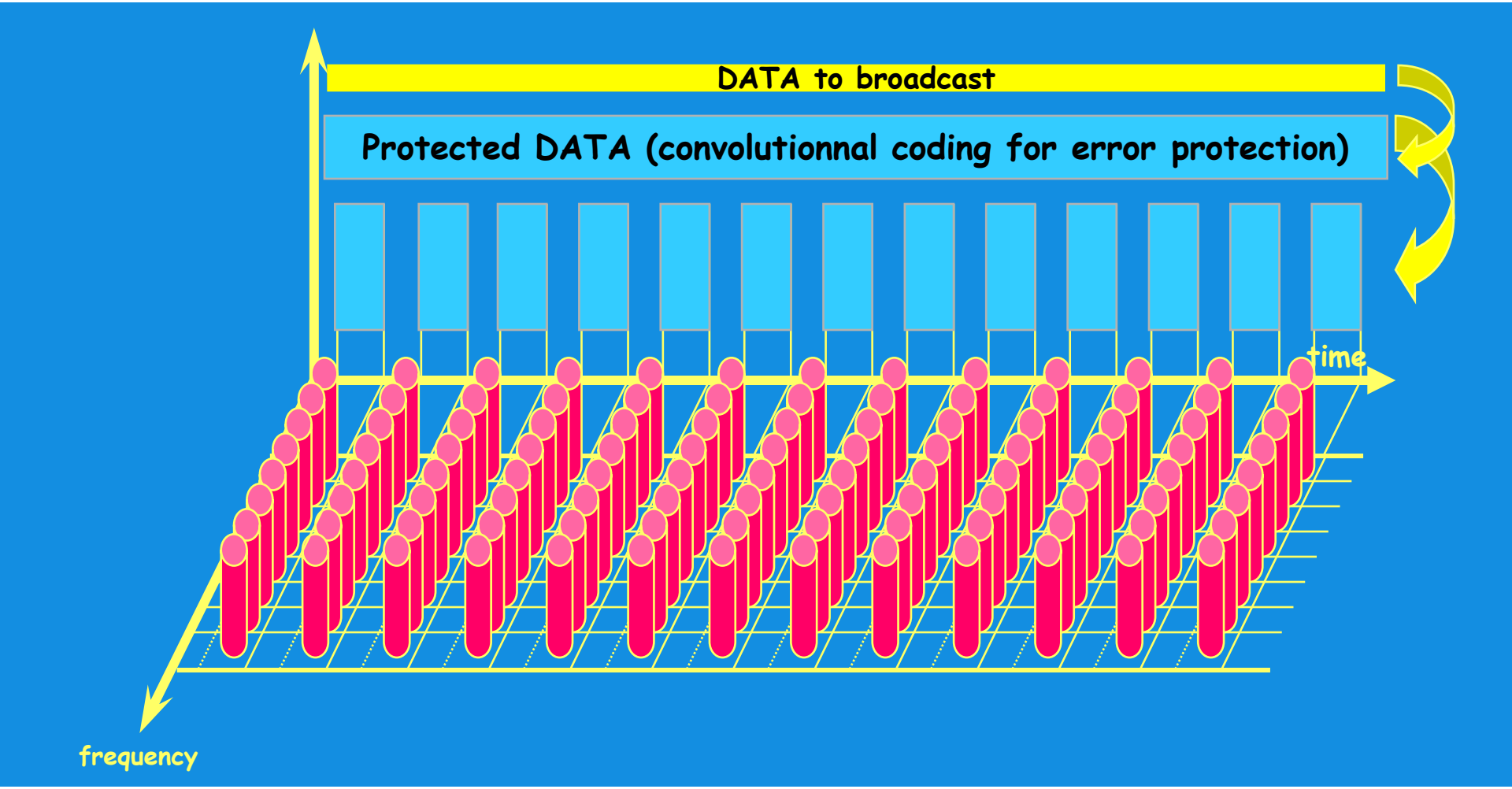
- 4 - Insert “Synchronization Pilots” to help Receivers to lock onto the useful signal



Note: Synchronization markers introduce a second loss in transport capacity

COFDM : HOW ?

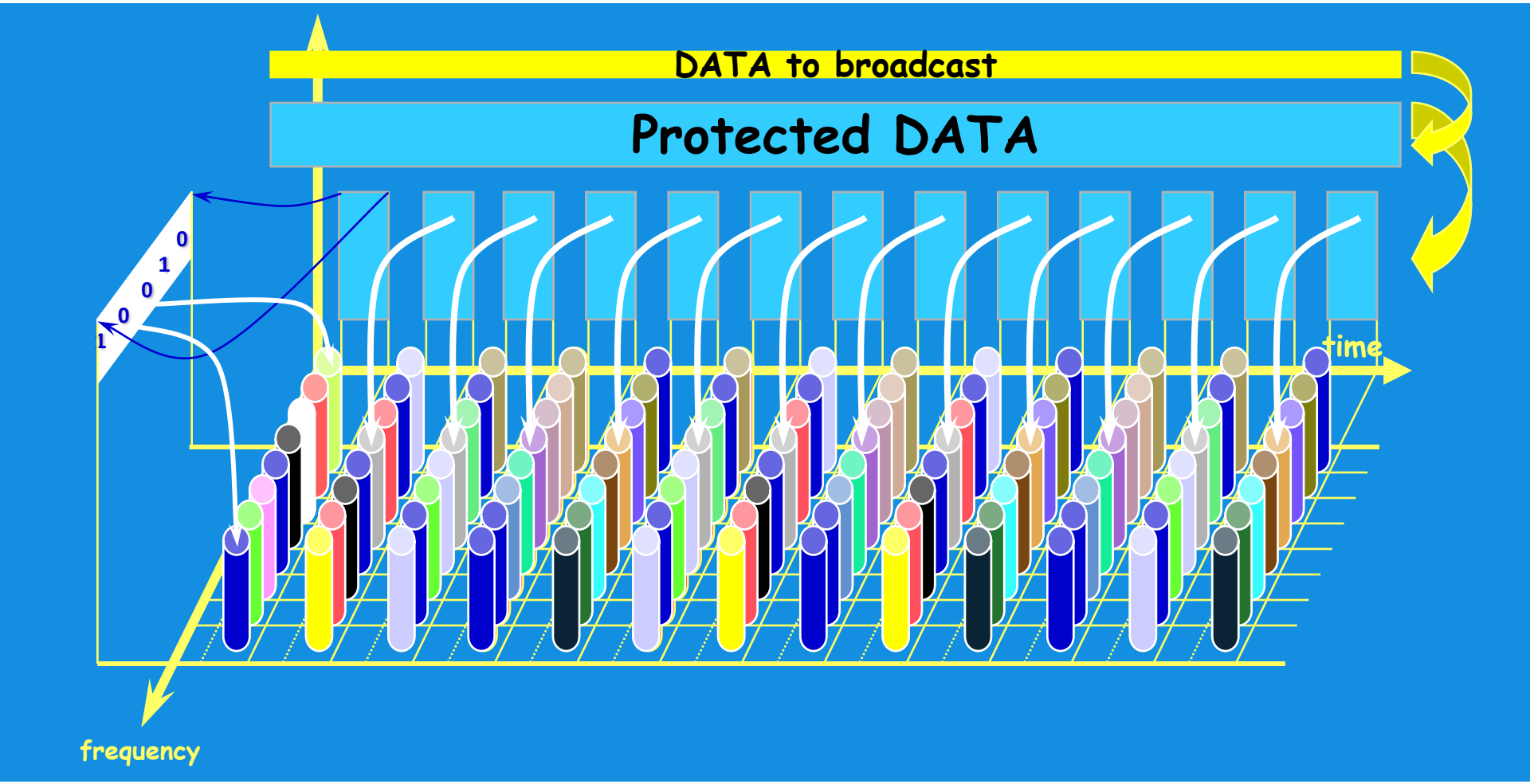
- **5 - Prepare data to be carried on OFDM symbols**



Note; Protection codes introduces a third loss in transport capacity

COFDM : HOW ?

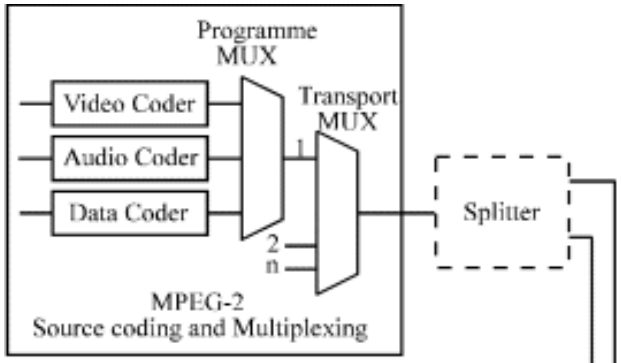
- **6 - Map bits onto OFDM : spread contiguous data bits over distant sub-carriers**

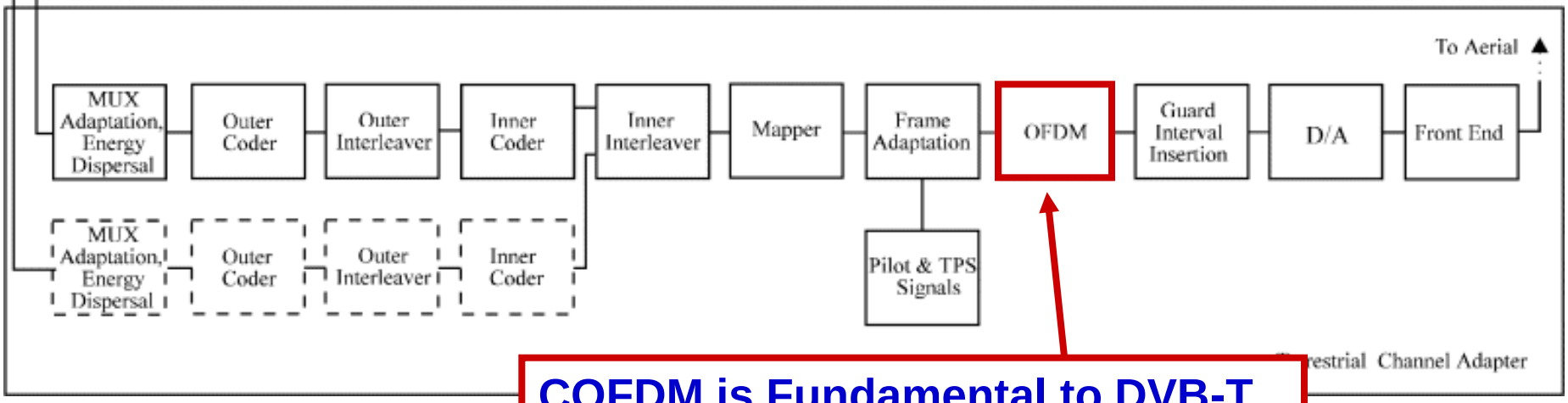


Create frequency diversity to improve robustness against selective fading

DVB-T

Parameter	8 k mode	2 k mode
Number of useful carriers / symbol	6 048	1 512
Number of carriers K	6 817	1 705
Value of carrier number K_{min}	0	0
Value of carrier number K_{max}	6 816	1 704
Duration T_U	896 µs	224 µs
Carrier spacing $1/T_U$	1 116 Hz	4 464 Hz
Spacing between carriers K_{min} and K_{max} $(K-1)/T_U$ (see note)	7,61 MHz	7,61 MHz
NOTE: 6,66 MHz in the case of 7 MHz wide channels.		



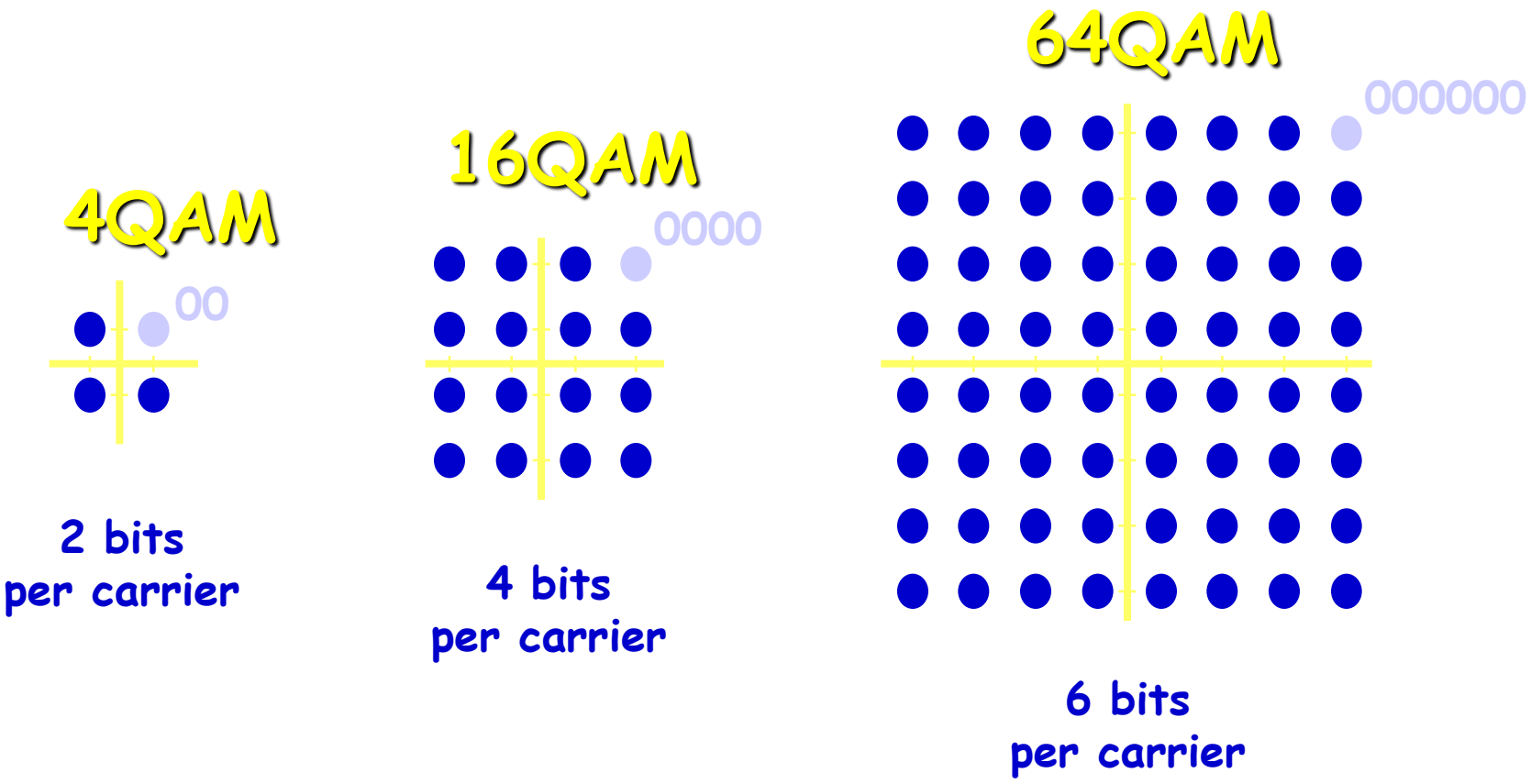


COFDM is Fundamental to DVB-T

DVB-T : Regular constellations

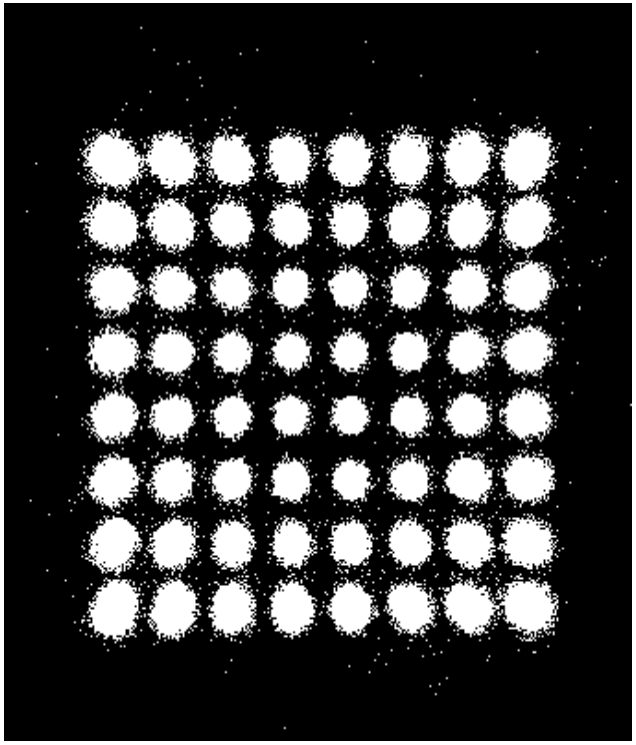
Digital Video Broadcasting

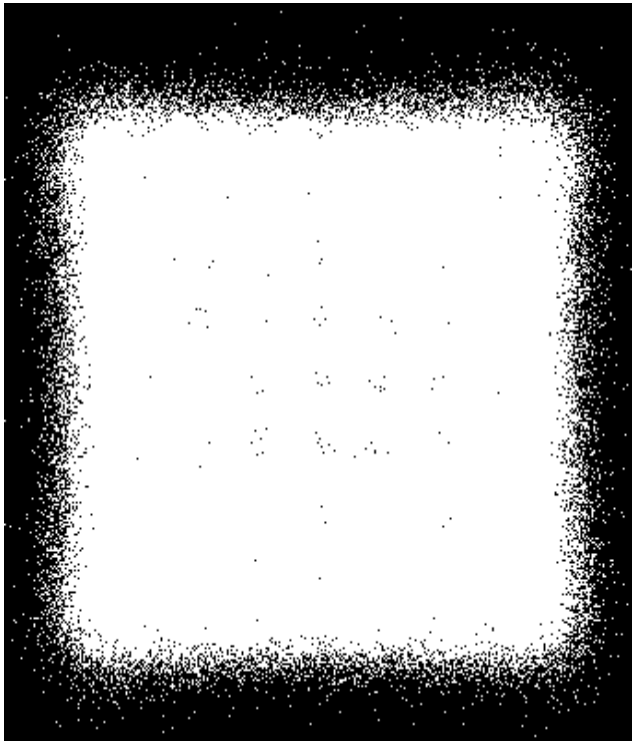
Data mapping is realised by applying one physical modulation to each sub-carrier



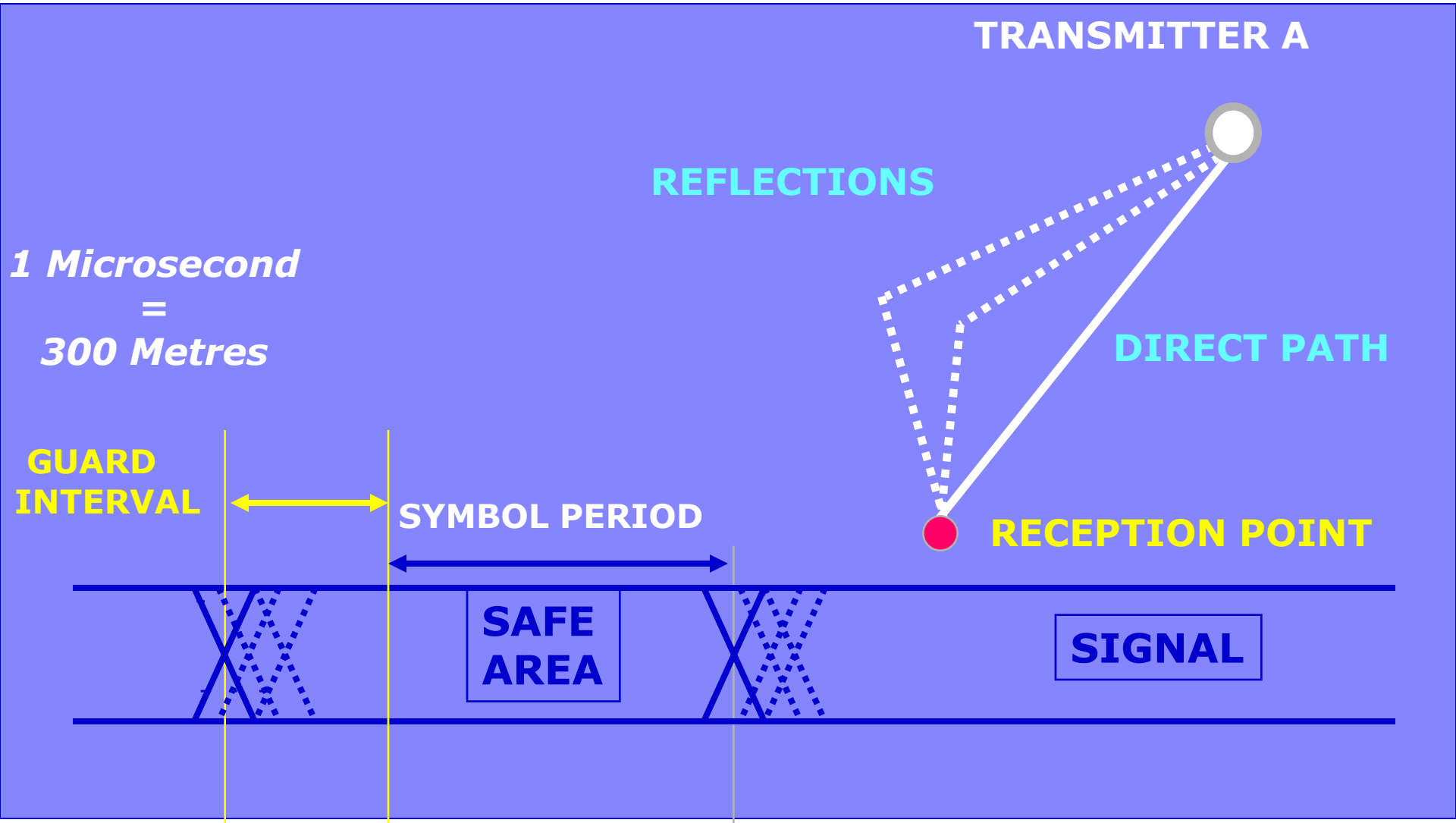
Each constellation gives to each sub-carrier a specific data transport capacity

64-QAM - Perfect & Failure

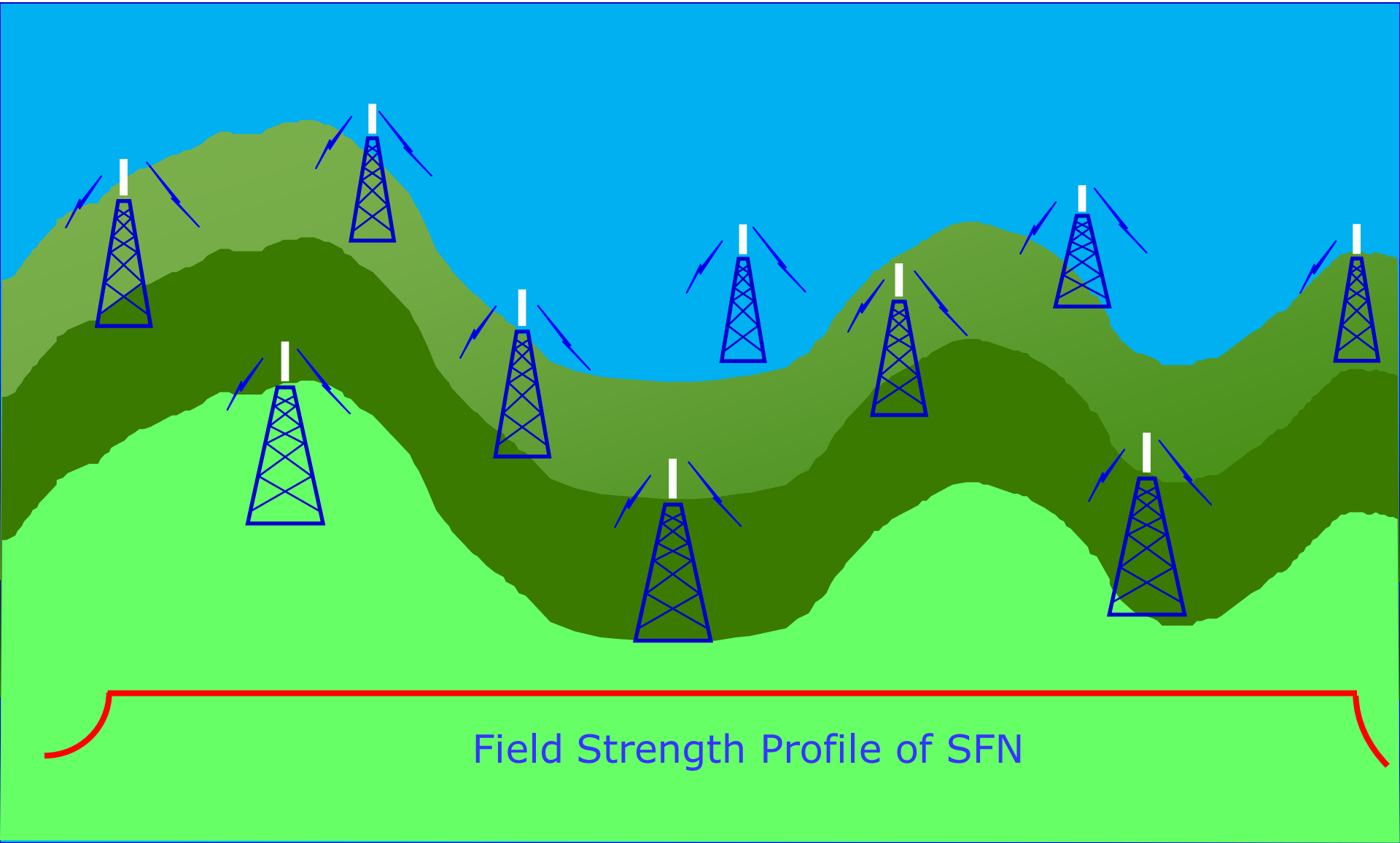




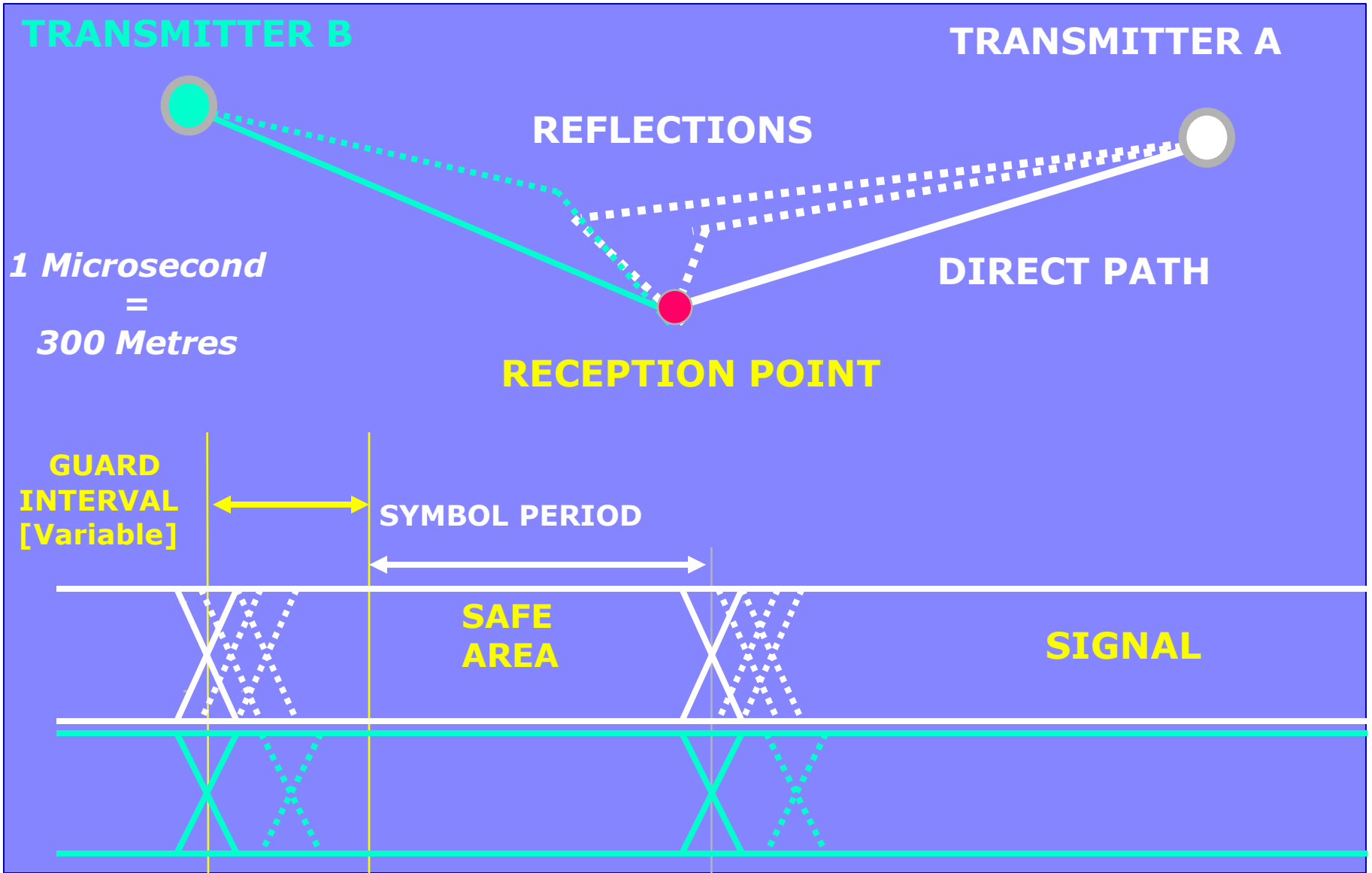
COFDM - *Multipath*



Single Frequency Networks



COFDM - *SFN*


TRANSMITTER B
TRANSMITTER A
REFLECTIONS
1 Microsecond
=
300 Metres
DIRECT PATH
RECEPTION POINT
GUARD
INTERVAL
[Variable]
SYMBOL PERIOD
SAFE
AREA
SIGNAL

A little about DVB-T2 Technologies

DVB T2 TERRESTRIAL

Birth Certificate

Name :	Second Generation of Digital Terrestrial TV
Nick Name :	DVB-T2
Date of Birth :	26 June 2008 (59th DVB Steering Board)
Standardisation :	WAVEFORM ETSI EN 302 755 V1.1.1 (2009-06) GUIDE LINE ETSI TS 102 831 V1.1.1 (2009-10) 2G DTTB SYSTEM ITU-R (R-REC-BT.1877 (2010-05)

Frequency bands :	VHF & UHF ... Up to 3 GHz
Signal Bandwidth :	**1.75 MHz**, 5 / 6 / 7 / 8 MHz, **10 MHz**
Waveform :	Multi-Carrier OFDM with cyclic prefix
. Transmission	MFN, SFN, SISO (1x1) & **MISO-Alamouti (2x1)** operation
. FFT sizes	**1K** / 2K / 4K / 8K / **16K** / **32K**
. Guard Interval	**1/128**, 1/32, 1/16, **19/256**, 1/8, **19/128**, 1/4
Framing :	
. Super Frame	up to 64 seconds (256 T2 frames & FEF frames)
. T2 frame	basic Physical Layer Frame (up to 250 ms),
. FEF frame	Future Extension Frame (not specified)
SSS :	
. Synchronisation	Preamble **P1** (1K OFDM with pre & post GI, DBPSK)
. Signalling	Preamble **P2** (OFDM symbol(s) immediately after P1)
. Sounding	8 sets of Pilot Pattern (including Continuous & Scattered)
PAPR :	**Peak to Average Power Reduction** (using ACE & TR)

. Pre-Processor	**TS** & **GSE** converted in Physical Layer Pipes (**PLP**),
. Input Processor	PLP converted in Base Band Frames
. **BICM**	Bit Interleaved Coded Modulation applied per PLP
↳ FEC	LPDC + BCH (from DVB-S2)
	2 block sizes : 64800 & 16200 bits
↳ Code Rate	1/2, 3/5, 2/3, 3/4, 4/5, 5/6
↳ Constellation	QPSK 16QAM 64QAM **256QAM**
↳ **Rotation**	29,0° 16,8° 8,6° atan(1/16)°
. Interleaver	Time Interleaver (up to 500 Kcells ~10 Mbits) per PLP,
	Frequency Interleaver per channel

DVB-T2: KEY FEATURES

- LDPC (Low Density Parity Check) error correcting codes (> 30% improvement over R-S coding)
- 256QAM, Increased FFT range & guard interval
- Extended Bandwidth
- Rotated Constellations
- OFDM Equalisation (overhead reduction 8%)
- Differentiated Protection (PLP)
- Interleaving (Bit, Time, & Frequency)
- Transmit diversity (Alamouti coding 30% SFN)
- Peak / Average power reduction (PAPR - 20%)

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DVB-T2 : Regular constellations

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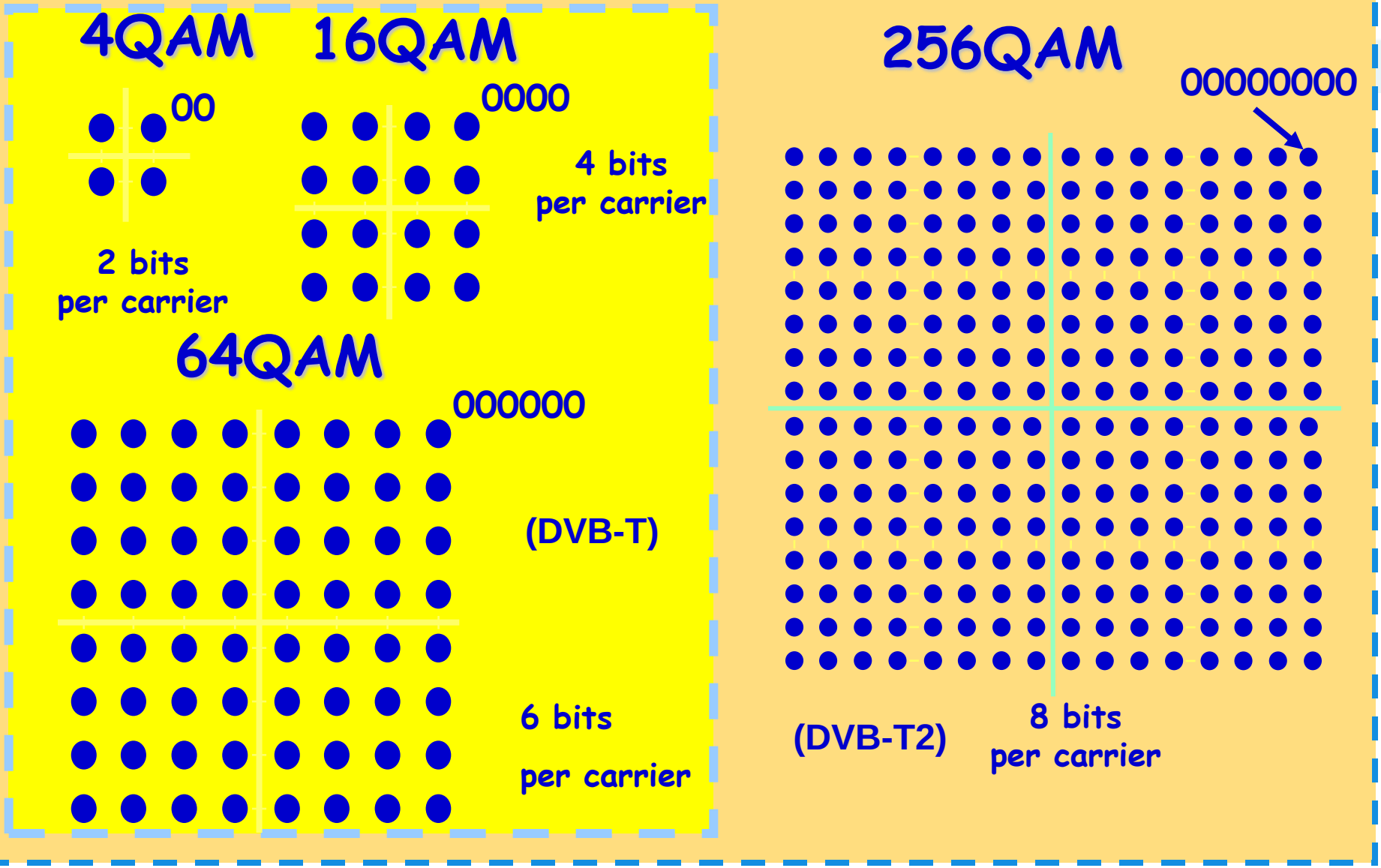
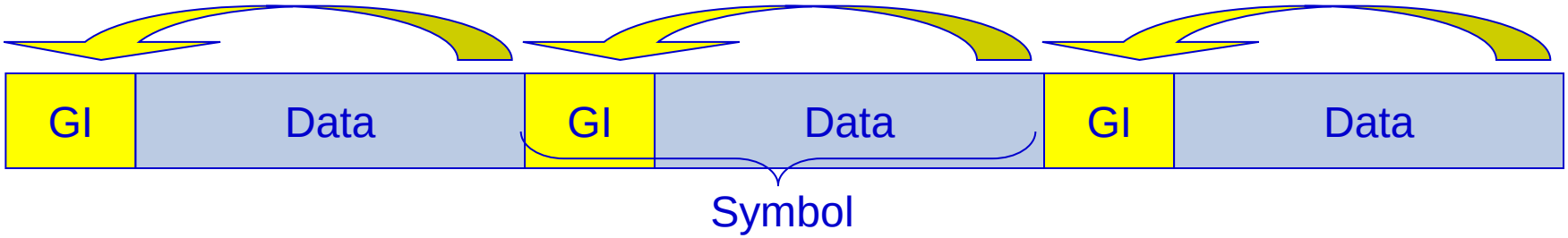


Each constellation gives to each sub-carrier a specific data transport capacity

Key Features: Modulation (1)

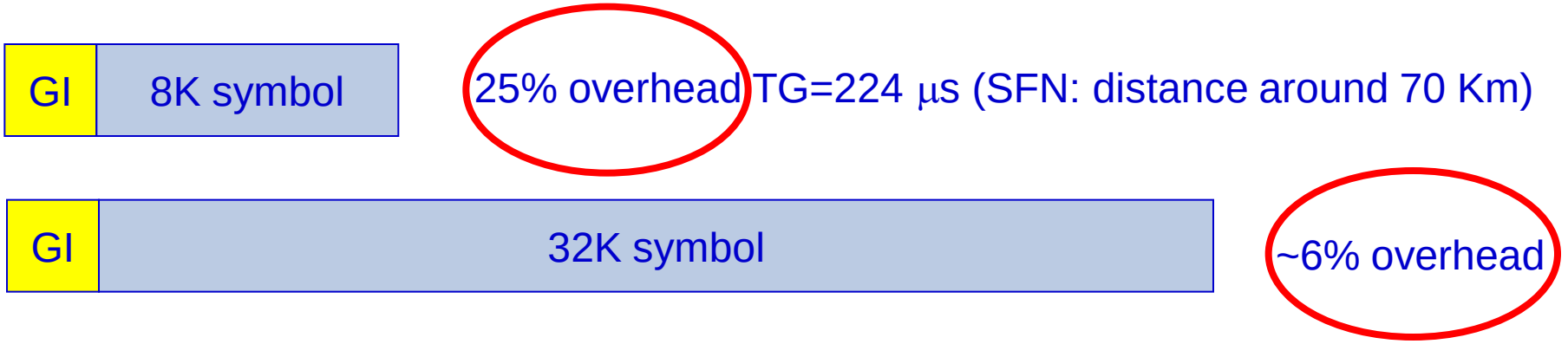
- T2 uses conventional Guard-Interval OFDM (GI-OFDM)
  - **as in DVB-T, GI "absorbs" intersymbol interference due to echoes**



- Each symbol carries data on a large number of separate carriers
  - **1K, 2K, 4K, 8K, 16K, 32K options are available in T2**
    - 16K and 32K: to give improved SFN performance
  - **Increasing the number of carriers increases the symbol period: (1 ms for 8K;....; 4 ms for 32K)**

Key Features: Modulation (2)

- Increasing the symbol period
  - **Can reduce guard interval overhead for given size of SF**



- T2 extends guard interval range to allow reduced overhead and additional flexibility
  - **GIs in T2: 1/128, 1/32, 1/16, 19/256, 1/8, 19/128, 1/4**

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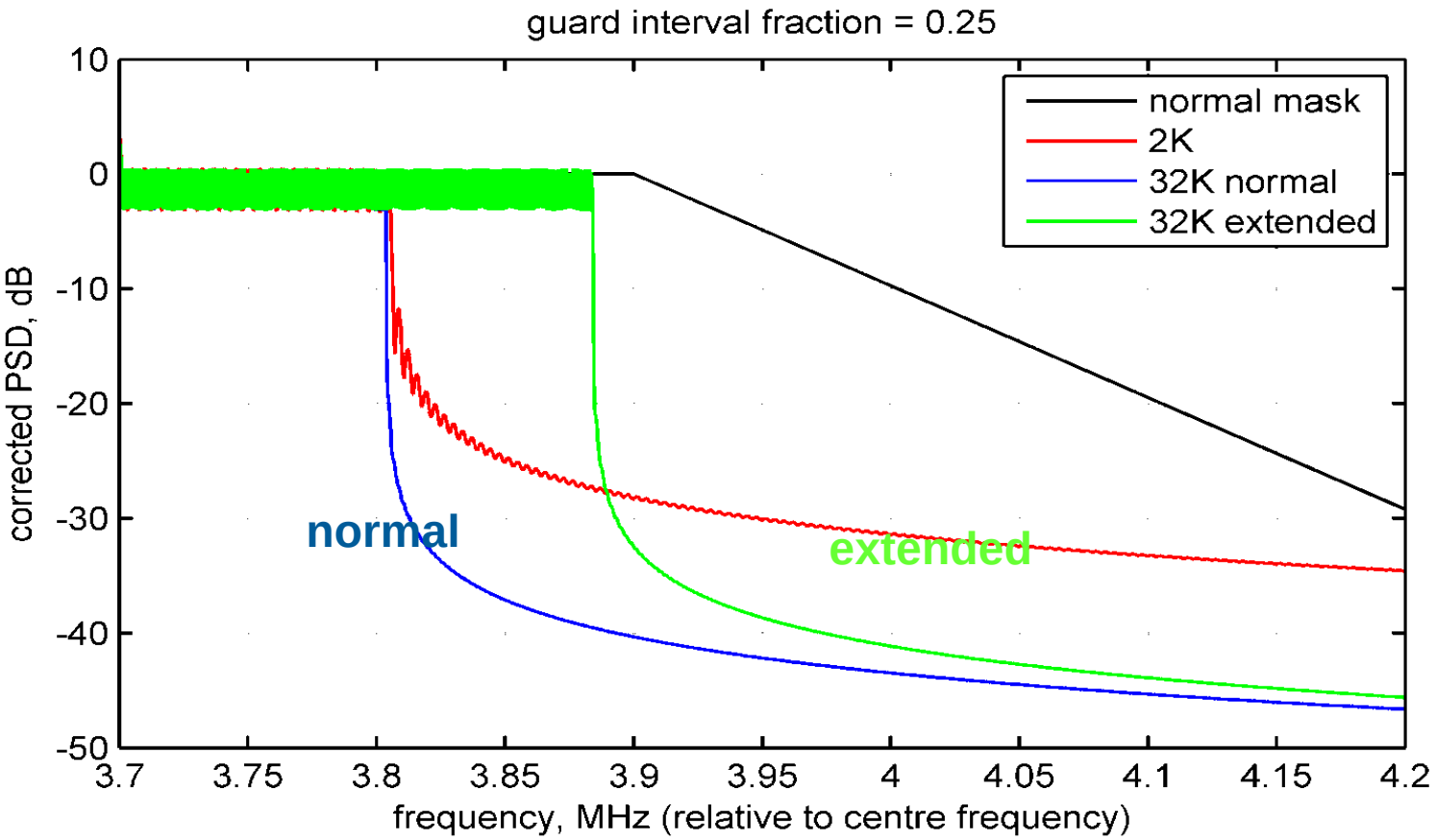
Key Features: Extended bandwidth mode

- Out of band spectrum for 32K mode falls away more quickly than spectrum for 2K mode
  - Allows 2% extra bandwidth/capacity whilst remaining within normal spectrum mask



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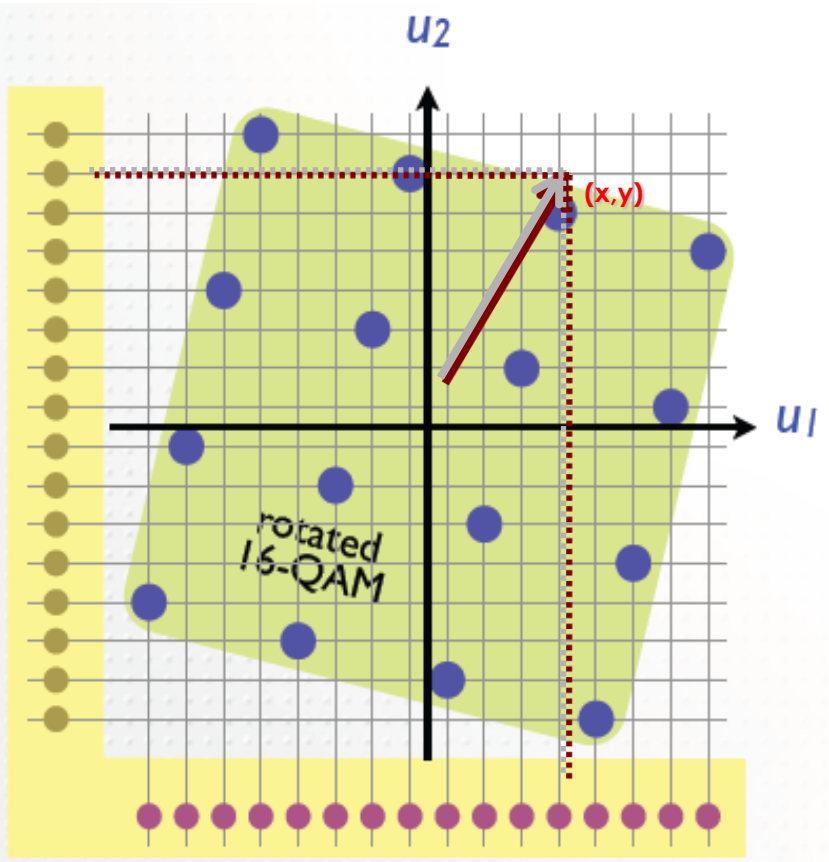
BICM (BIT INTERLEAVED CODED MOD) MAPPER USES THE ROTATED CONSTELLATIONS

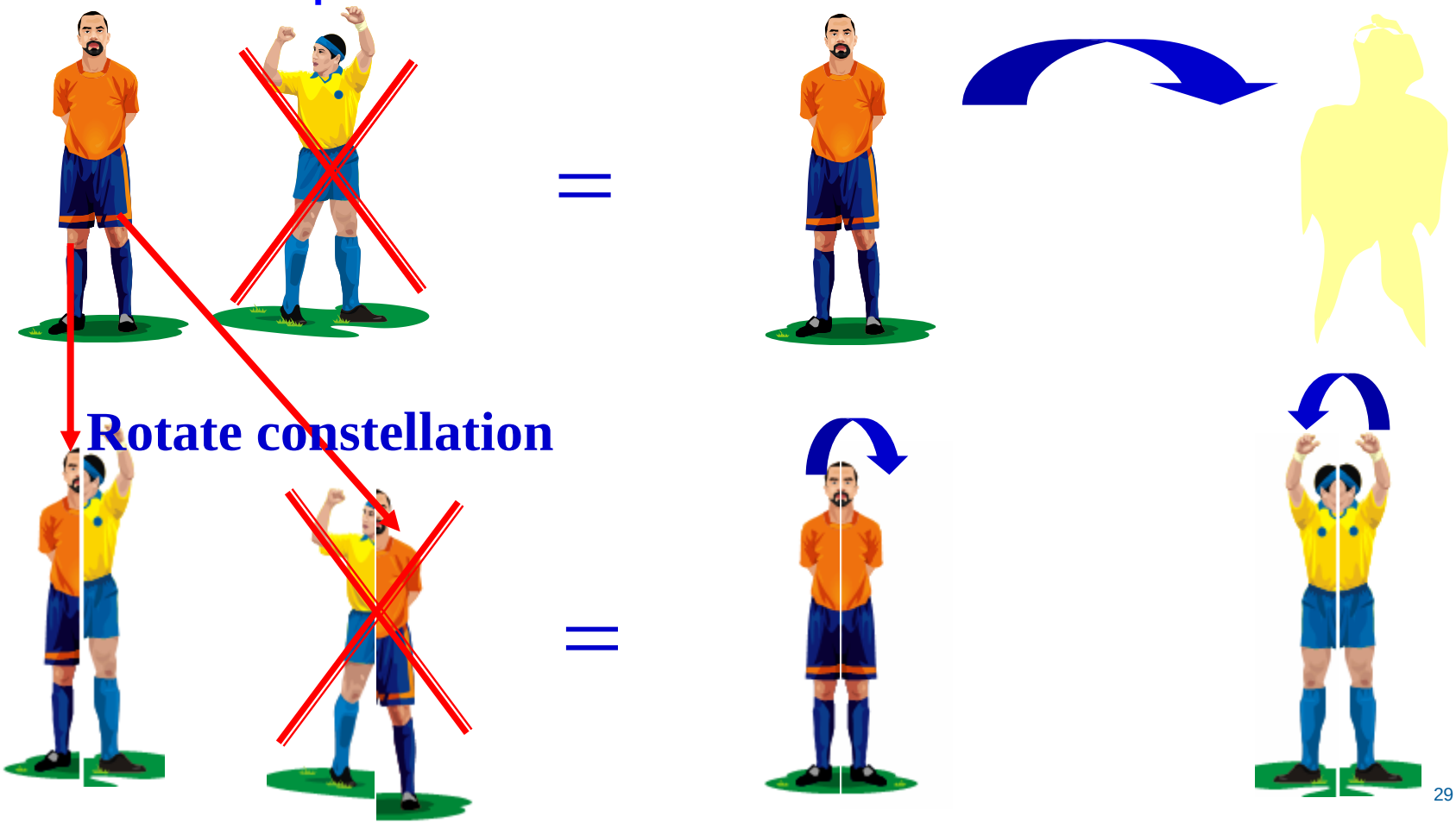


1) TO MAP DATA BITS (X,Y) ONTO A NORMAL QAM
2) DEFINE THE VALUE (I,Q) WHICH REPRESENT (X,Y)
   - (I,Q) can take each FOUR values
   - (I,Q) are required together to recover (x,y)
3) IF THE QAM CONSTELLATION IS ROTATED
   - (I,Q) become (u_1,u_2)
   - (u_1,u_2) can take each SIXTEEN values
4) (U_1,U_2) CARRIES EACH ALL THE INFO OF (X,Y)
   - Then only a single is required to recover (x,y) !!!!
5) THEN ENSURE U_1 AND U_2 TRAVEL IN DIFFERENT SUB-CARRIER
   - Probability to loss BOTH u1 and u2 decreases!
6) RE-ASSEMBLES U_1 AND U_2 TOGETHER IN THE RECEIVER
   - To recover (x,y) with either u1 or u2 only !

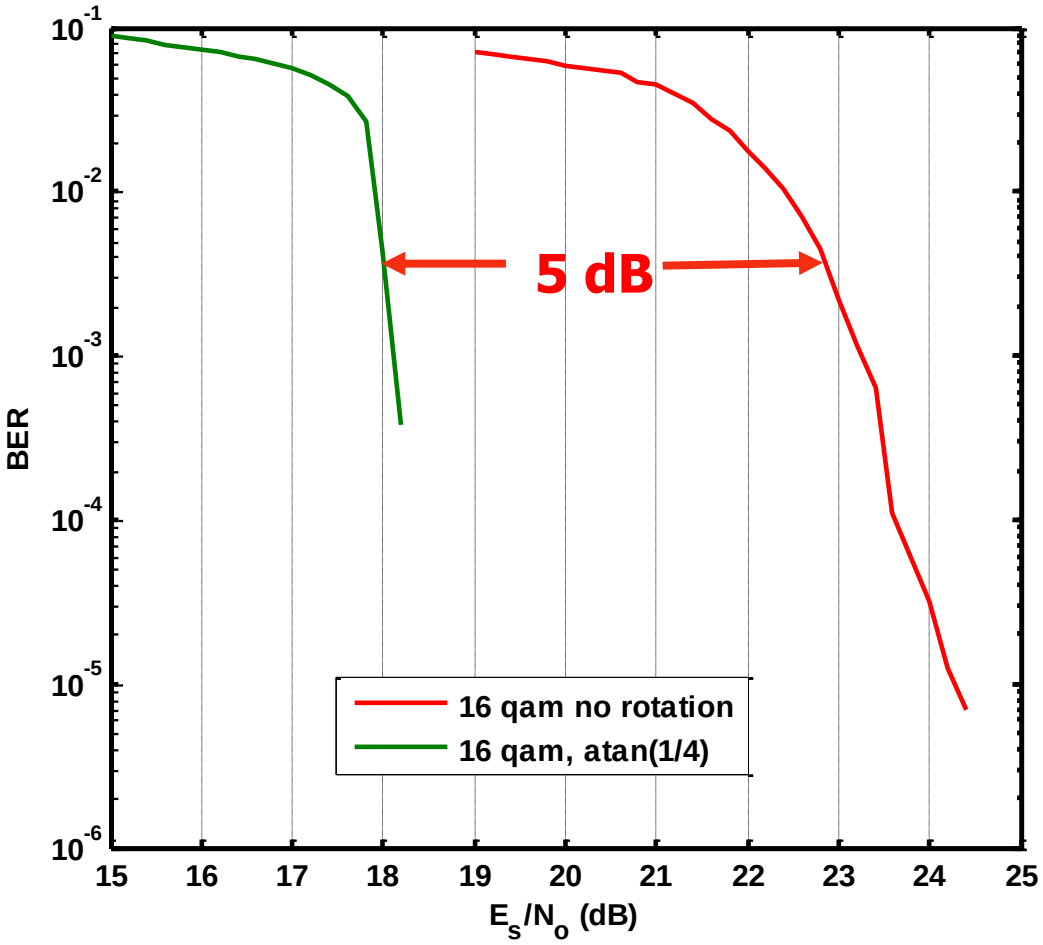
Rotated constellation A simple example

- The code reconstructs the destroyed info

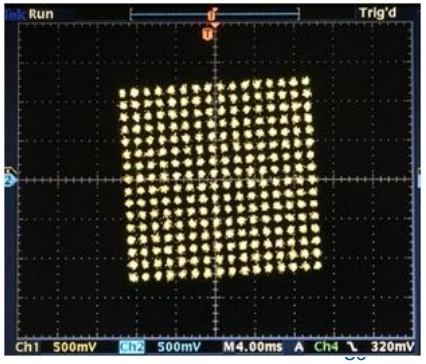
- **One carrier is killed by multipath**



Rotated Constellations



- **Rotated constellations provide significantly improved robustness against loss of data cells**
  - **No degradation (nor gain) in Gaussian channel**
  - **Can achieve gains of 5 – 7 dB on difficult channels**
    - **e.g. 15% cell loss channel**
  - **Can translate into increased bit rate by choosing less robust FEC with lower overhead**



Comparison of performance for rotated/non-rotated constellations (code rate=4/5; channel = Rayleigh + 15% erasures of subcarriers)

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OFDM MODULATION : Choice of EIGHT PILOT PATTERNS TO TUNE OVERHEAD

FFT size	Guard interval						
	1/128	1/32	1/16	19/256	1/8	19/128	1/4
32K	PP7	PP4 PP6	PP2 PP8 PP4	PP2 PP8 PP4	PP2 PP8	PP2 PP8	NA
16K	PP7	PP7 PP4 PP6	PP2 PP8 PP4 PP5	PP2 PP8 PP4 PP5	PP2 PP3 PP8	PP2 PP3 PP8	PP1 PP8
8K	PP7	PP7 PP4	PP8 PP4 PP5	PP8 PP4 PP5	PP2 PP3 PP8	PP2 PP3 PP8	PP1 PP8
4K, 2K	NA	PP7 PP4	PP4 PP5	NA	PP2 PP3	NA	PP1
1K	NA	NA	PP4 PP5	NA	PP2 PP3	NA	PP1

Less Pilots - Less Overhead

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DVB-T2: Multi layering with PLP's

HD/3D

SD

OP1

OP2

OP3

PLP1

PLP2

PLP3

PLP256

SI

Mobile

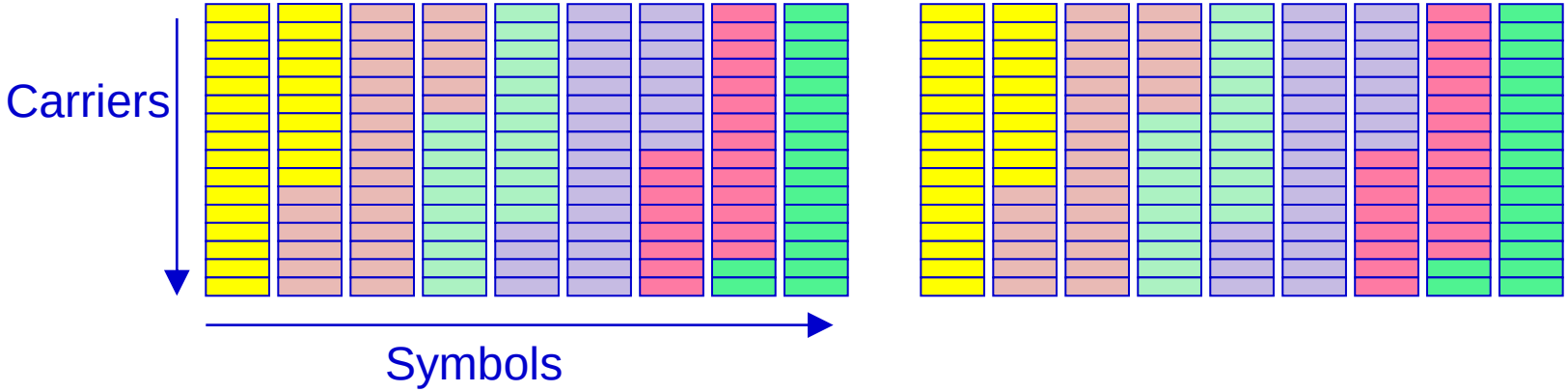
Billboards

QPSK, Rotated Constellations

Radio

PLP provide Service Specific Robustness

- Each service can be given its own modulation mode (e.g. 256QAM, 16 QAM) and FEC coding rate (e.g. rate 3/5, rate 3/4)
- Different applications: roof-top reception/portables/ Handheld etc



- Each service is given a slice of data cells within a frame
  - Each slice is part of a Physical Layer Pipe (PLP) for that service
  - Also enables power saving in the receiver

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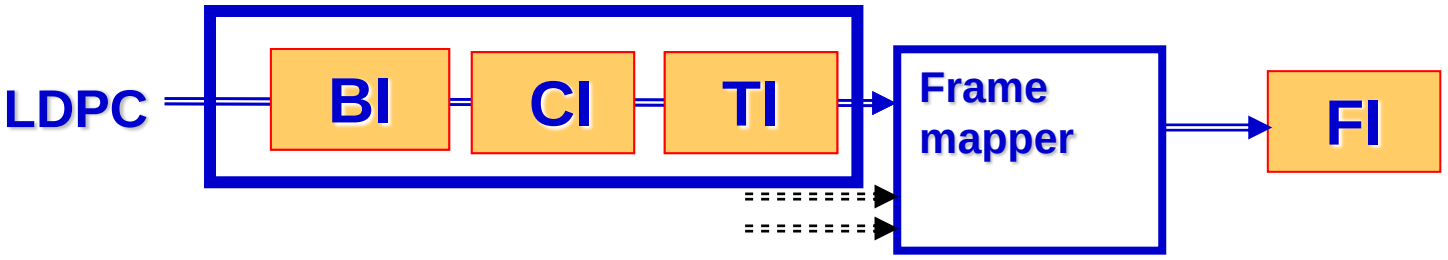
Interleaving

- **T2 uses three main interleavers – applied per PLP**
  - **Bit Interleaving within an FEC block (BI)**
    - Based on a row/column block interleaver
  - **Time & Cell Interleaver (TI, CI)**
    - Disperses data cells from FEC blocks of a given service throughout slice (/subslices) for that service
  - **Frequency Interleaving (FI) (Similar to DVB-T)**
    - Causes randomisation of possibly-damaged adjacent data cells within an OFDM symbol
    - Provides robustness against a frequency-selective channel
    - T2 uses twin interleavers (**based on DVB-T interleaver**)



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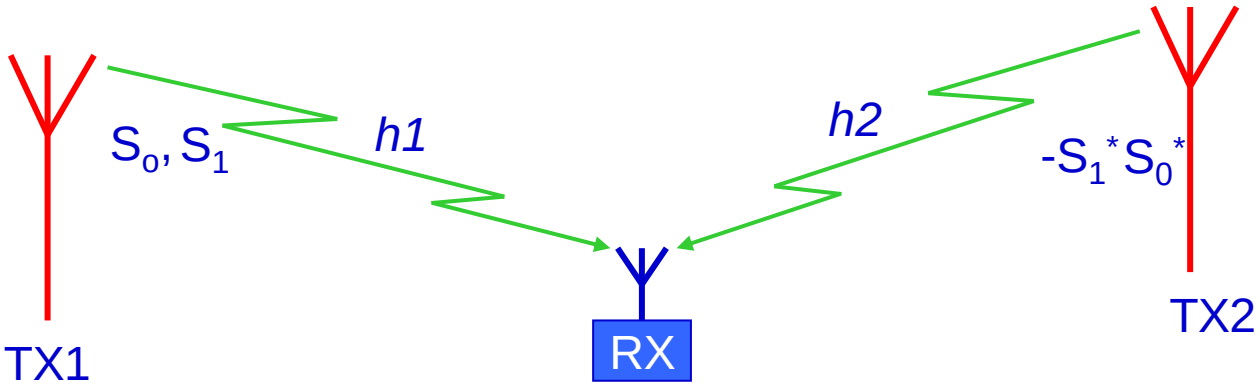
Transmit Diversity using MISO

- **T2 includes Alamouti coding mode for simple SFNs**
  - **While Tx1 transmits pair of data cells S_0,S_1, Tx2 transmits $-S_1^*$,S_0^***
  - **Also involves modification of pilot patterns to measure *h1 and h2***
  - **Transmitters can be**
    - **Physically separated**
    - **Same locations `but using different polarisations**

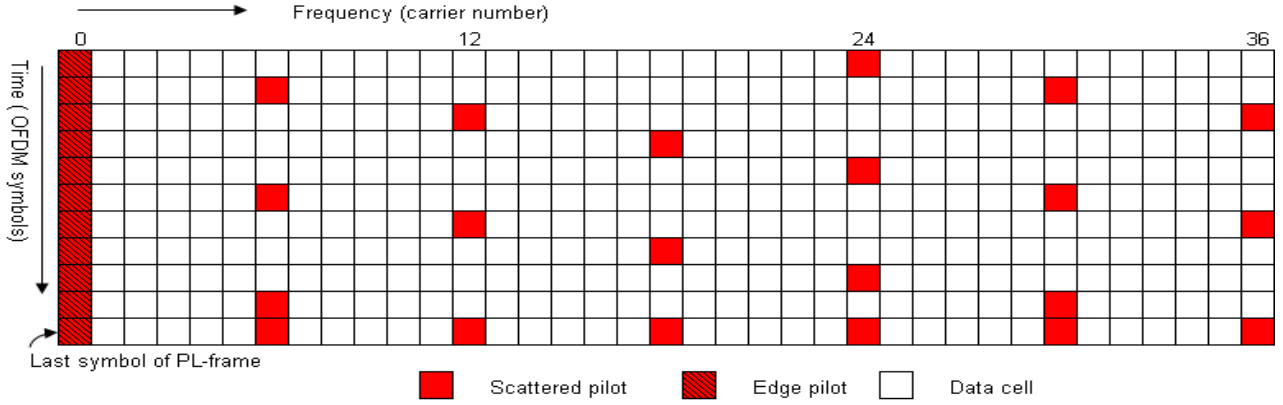


- **Trial studies have shown 30% increase in coverage area for simple SFNs (2.5 db gain)**

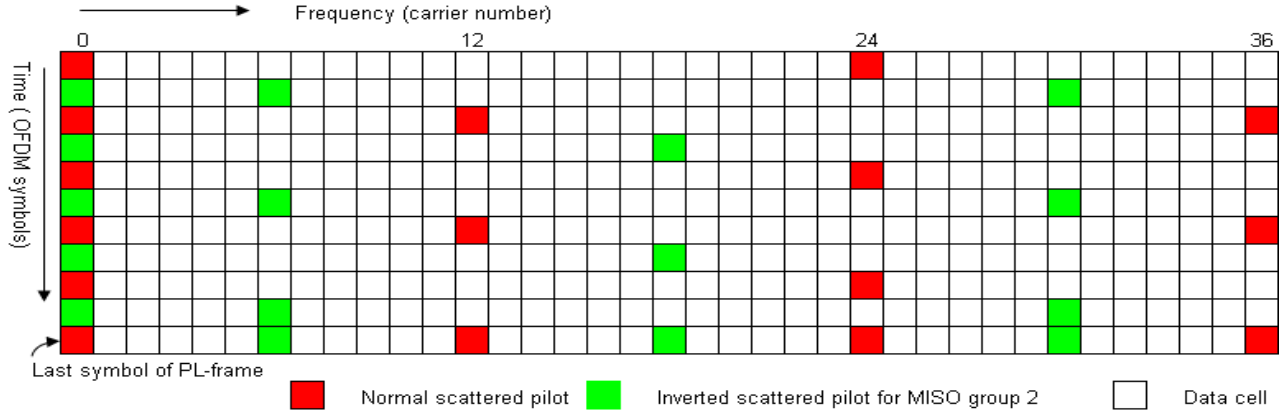
Transmit Diversity (2)

- **Scattered pilot patterns are modified (for second transmitter) to enable measurement of channels h1 and h2; e.g. -**

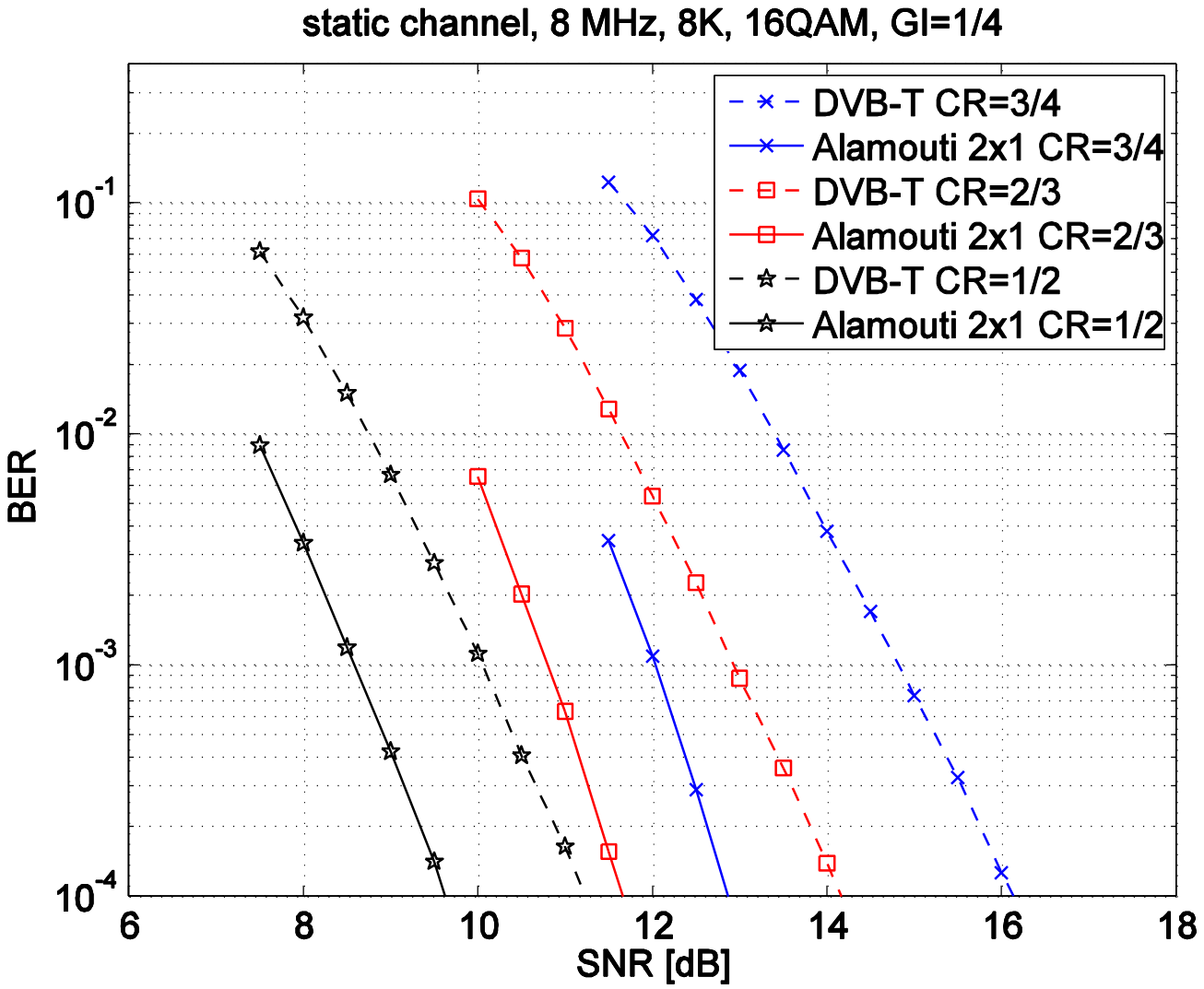
Transmitter 1



Transmitter 2

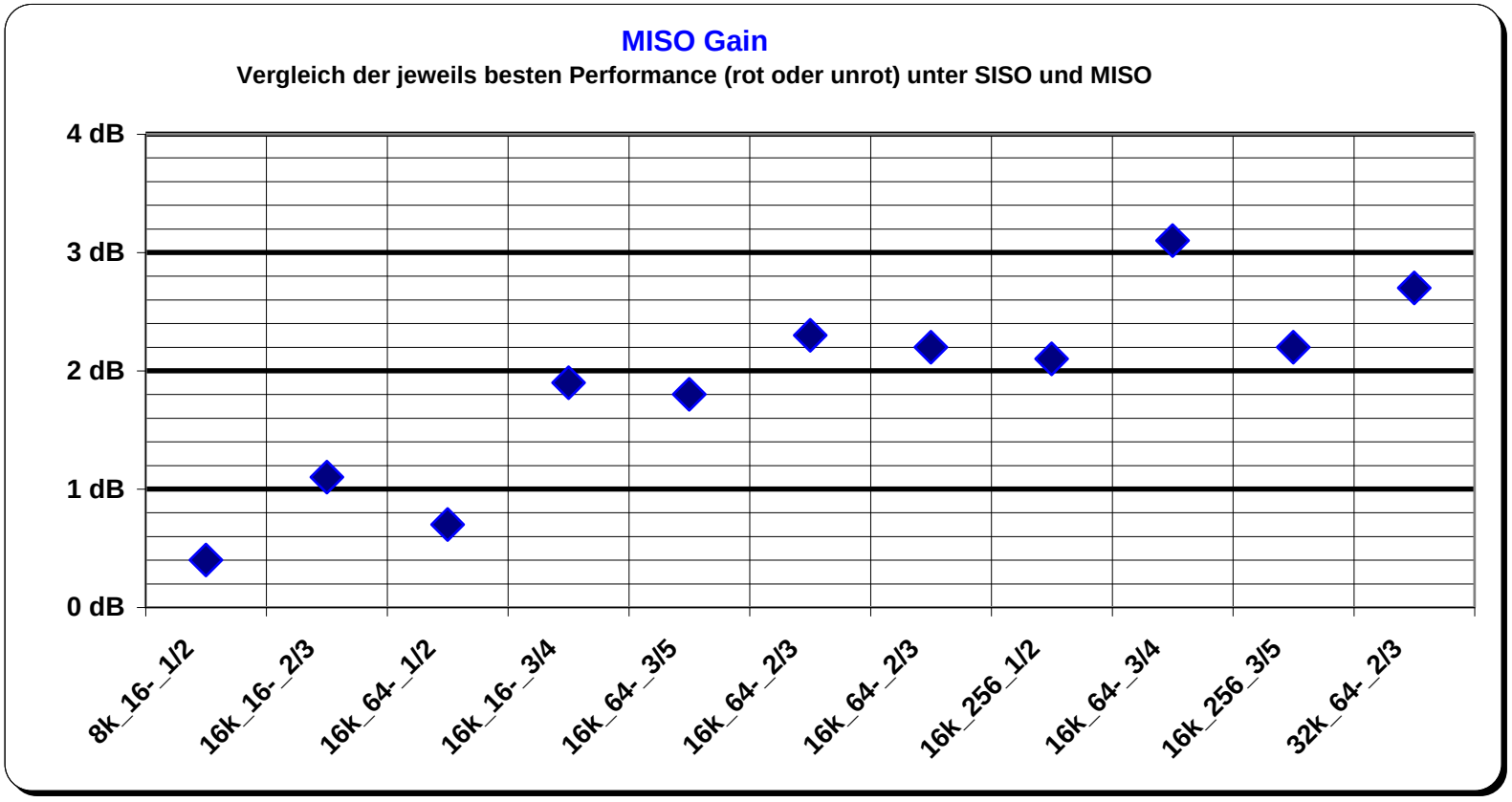


Simulation results for the SFN in Germany



BER gain:
3dB for CR ¾
2.2dB for CR 2/3
1.8dB for CR 1/2

DVB-T2 Northern Germany.
Measurement results: MISO gain



DVB-T2: KEY FEATURES

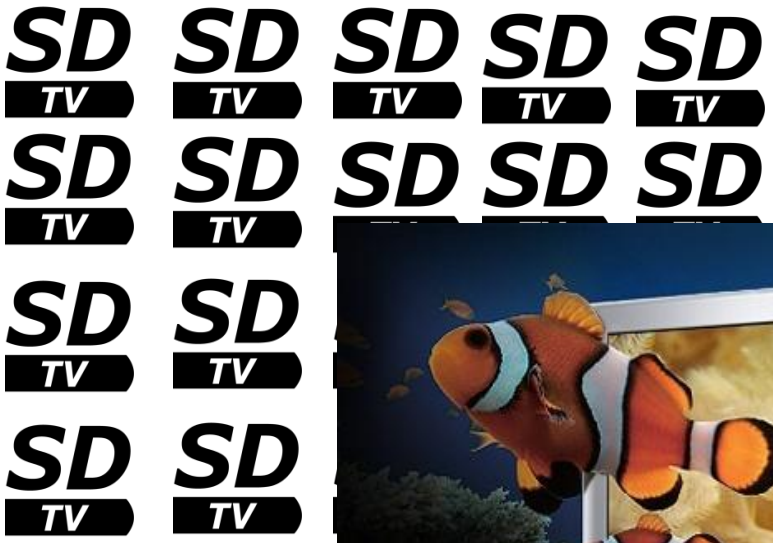
- LDPC (Low Density Parity Check) error correcting codes (30% improvement over R-S coding)
- 256QAM, Increased FFT range & guard interval
- Extended Bandwidth
- Rotated Constellations
- OFDM Equalisation (overhead reduction 8%)
- Differentiated Protection (PLP)
- Interleaving (Bit, Time, & Frequency)
- Transmit diversity (Alamouti coding 30% SFN)
- Peak / Average power reduction (PAPR - 20%)

Data rates provided and C/N values required in DVB-T2

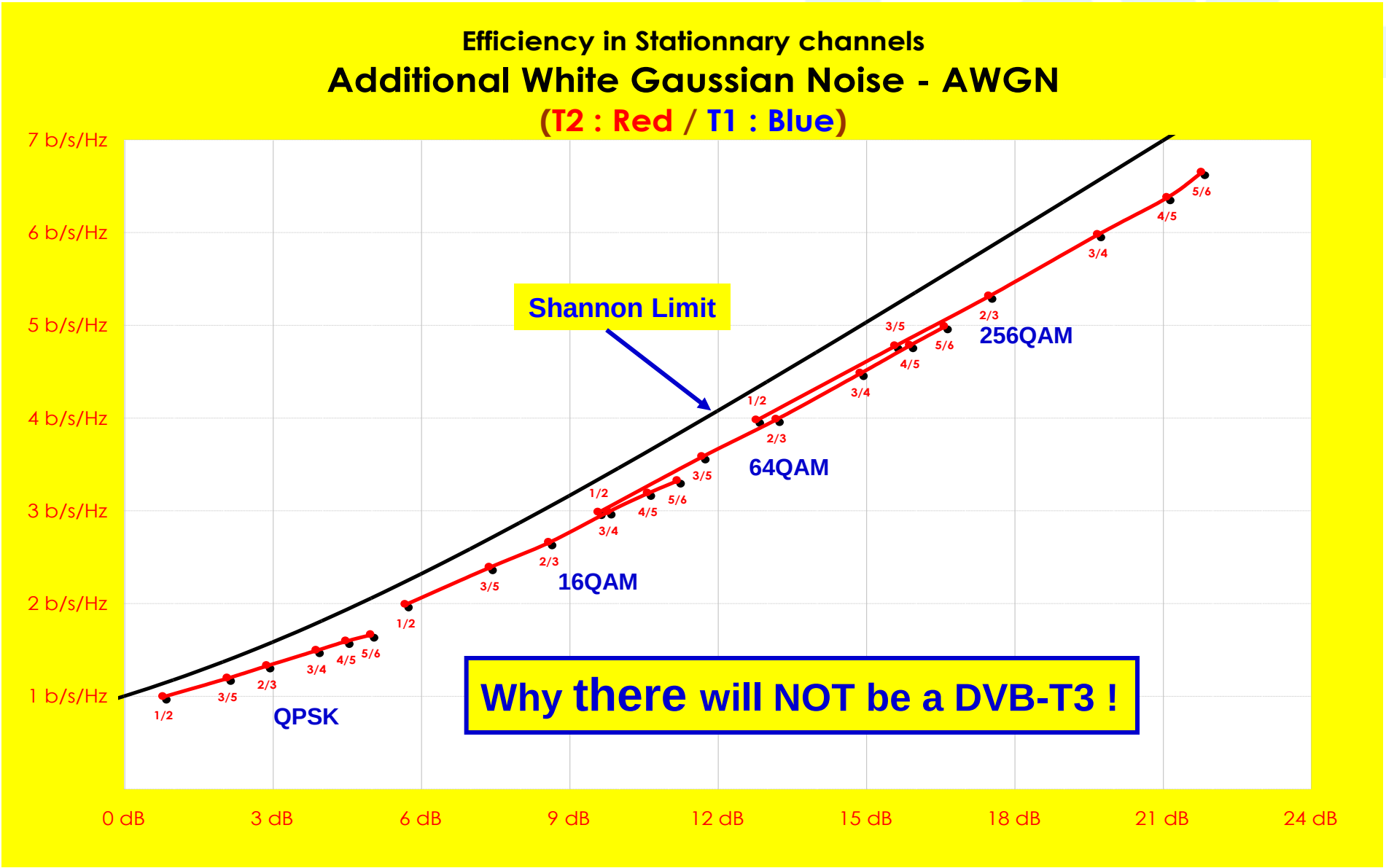
Modulation / Coderate	QPSK	16 QAM	64 QAM	256 QAM
1/2	7.5 Mbit/s 0.8 dB	**15.0 Mbit/s** **5.7 dB**	**22.5 Mbit/s** **9.6 dB**	**30.1 Mbit/s** **12.8 dB**
3/5	**9.0 Mbit/s** **2.1 dB**	**18.1 Mbit/s** **7.4 dB**	**27.1 Mbit/s** **11.7 dB**	**36.2 Mbit/s** **15.6 dB**
2/3	**10.0 Mbit/s** **2.9dB**	**20.1 Mbit/s** **8.6 dB**	**30.1 Mbit/s** **13.2 dB**	**40.2 Mbit/s** **17.5 dB**
3/4	**11.3 Mbit/s** **3.9 dB**	**22.6 Mbit/s** **9.8 dB**	**33.9 Mbit/s** **14.9 dB**	**45.2 Mbit/s** **17.5 dB**
4/5	**12.0 Mbit/s** **4.5 dB**	**24.1 Mbit/s** **10.6 dB**	**36.1 Mbit/s** **15.9 dB**	**48.3 Mbit/s** **21.1 dB**
5/6	**12.5 Mbit/s** **5.0 dB**	**25.2 Mbit/s** **11.2 dB**	**37.7 Mbit/s** **16.6 dB**	50.3 Mbit/s 21.8 dB

DVB-T: (most robust mode) **6 Mbit/s @ 3.5dB**
DVB-T: (maximum data rate) **31.7 Mbit/s @ 20.2dB**

DVB-T2 enables more services



Modulation and Coding performance T2



DVB-T2 Technical Comparison

	DVB-T		DVB-T2	
COFDM	Guard Interval OFDM		Guard Interval OFDM	
FEC	5	Reed Solomon 1/2; 2/3; 3/4; 5/6; 7/8	6	Low Density Parity Check 1/2; 3/5; 2/3; 3/4; 4/5; 5/6
Modes	3	QPSK; 16QAM; 64QAM	4	QPSK; 16QAM; 64QAM; 256QAM
Guard Interval	4	1/4;1/8; 1/16; 1/32	8	1/4; 5/32; 1/8; 5/64; 1/16; 1/32; 1/64; 1/128
FFT size	2	2K; 8K	6	1K; 2K; 4K; 8K; 16K; 32K
Scattered Pilots	12%		1%	
Continual Pilots	2.6%		0.35%	

Comparison Capacity DVB-T / DVB-T2 (UK)

	DVB-T	T2
Modulation	64QAM	256QAM
FFT size	2K	32K
Guard Interval	1/32	1/128
FEC	2/3 CC + RS (8%)	2/3 LDPC + BCH (0.3%)
Scattered Pilots	8%	1%
Continual Pilots	2.6%	0.35%
P1/P2 overhead	0%	0.7%
Bandwidth	Standard	Extended
Capacity	24.1 Mbit/s	40.2 Mbit/s

Source: OFCOM

Capacity of DVB-T2 = DVB-T + 66%

4 - 6 HDTV channels in MPEG- 4 (or 12–16 SDTV)

DVB-T2 Trial @ ABU Symposium

Ch46

idTV

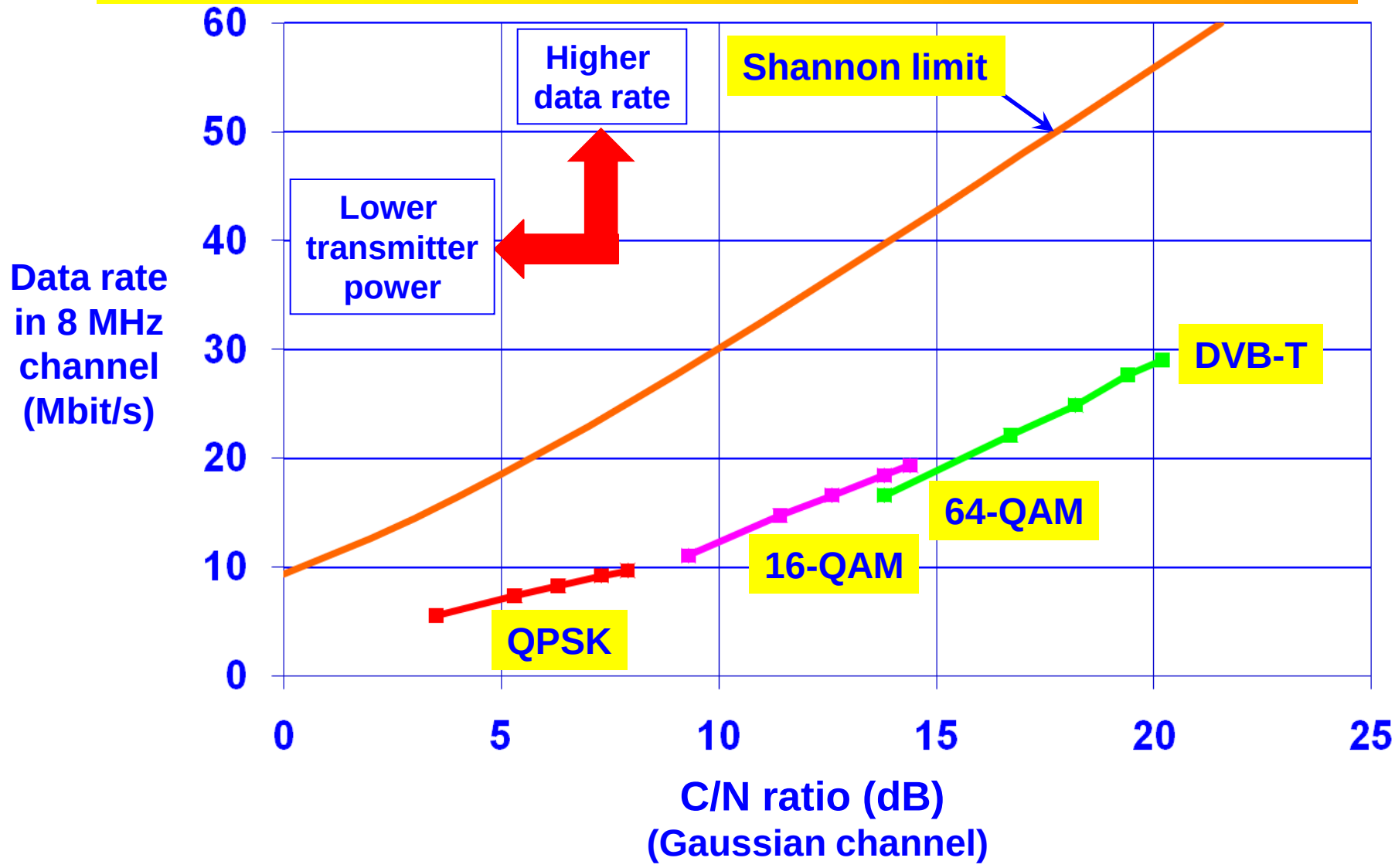
STB

R & S ETL TV Analyser

Payload 40.2 Mb/s – 4 x HD services + MHEG services

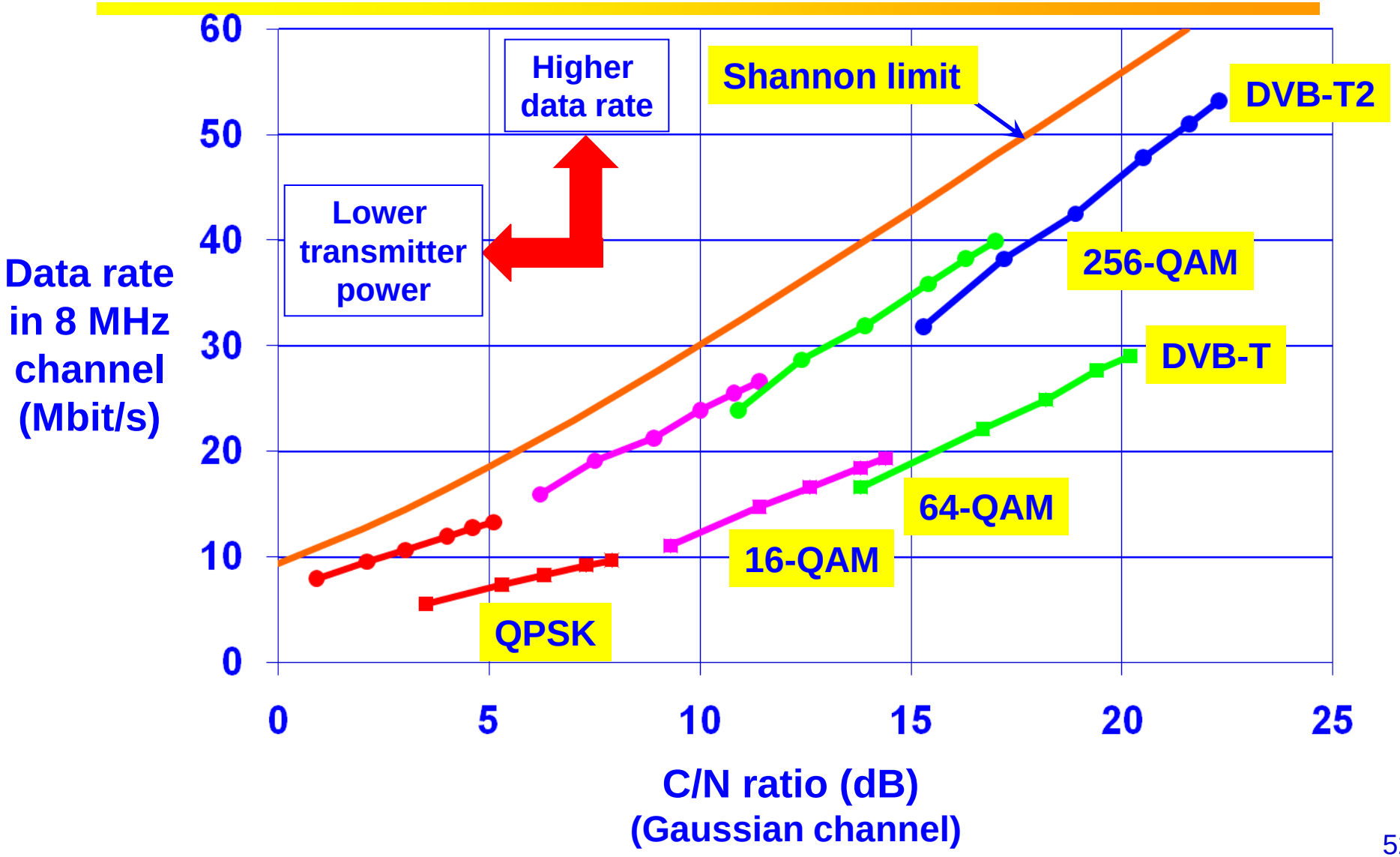
DVB-T2 Relative Performance

DVB-T - Gaussian Transmission Performance (AWGN)



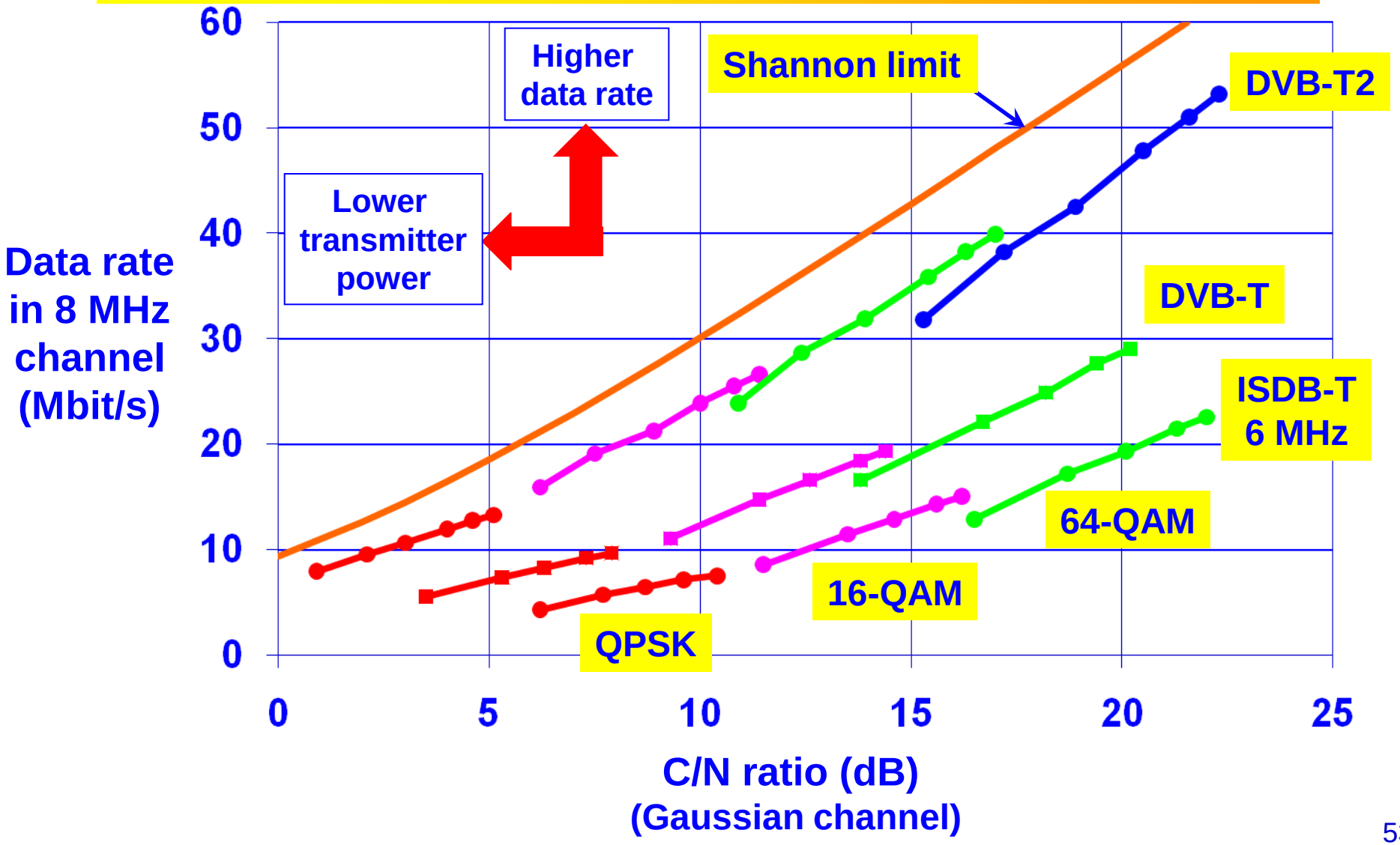
DVB-T data from Table A1 of ETSI EN 300 744 V1.6.1.

DVB-T & DVB-T2



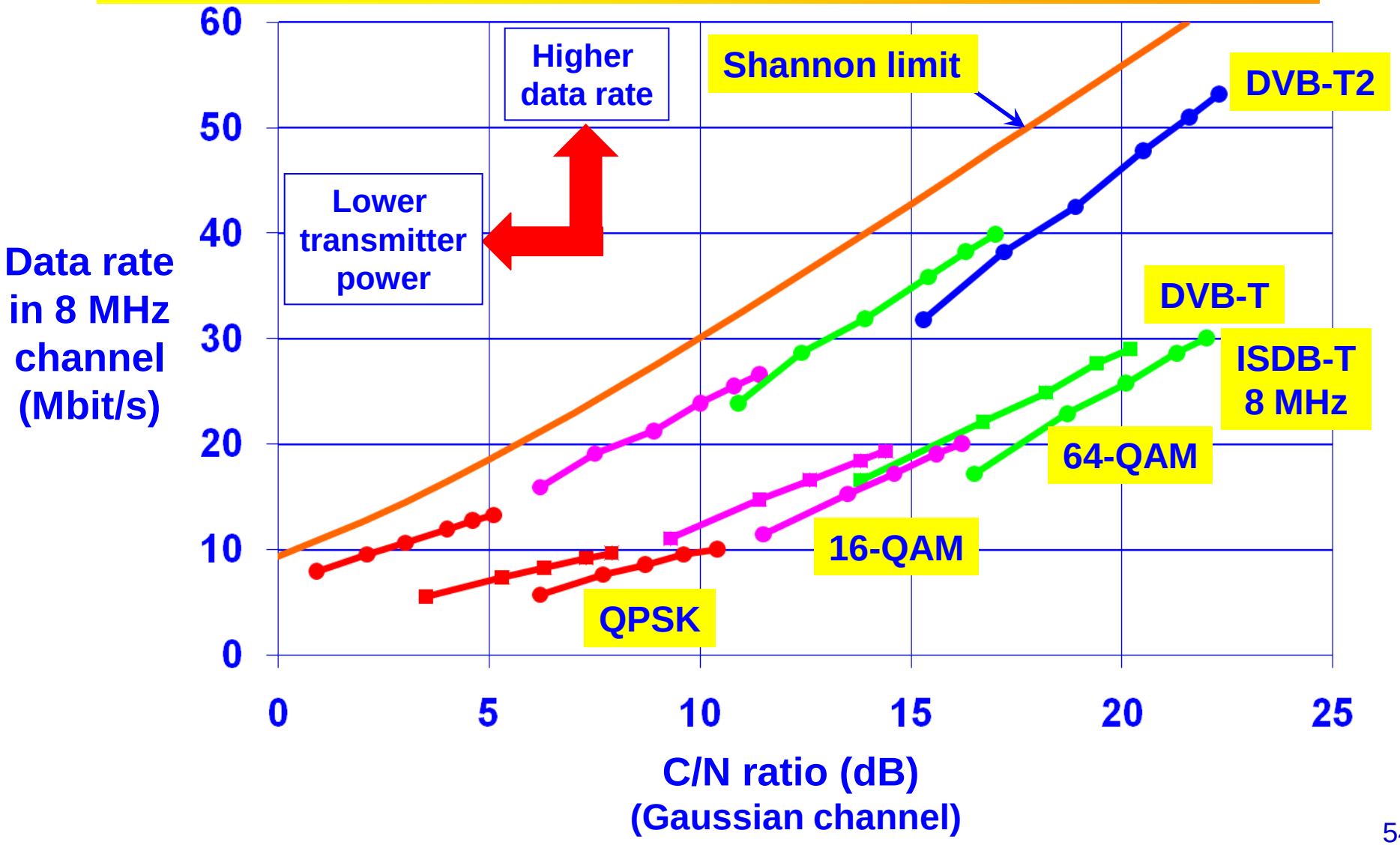
DVB-T data from Table A1 of ETSI EN 300 744 V1.6.1. DVB-T2 data from Table 44 of DVB Blue Book A133.

DVB-T, DVB-T2 and ISDB-T (MHz)



ISDB-T data from Table 3-4 and Table A3.3-2 of ARIB STD-B31 Version 1.6

DVB-T, DVB-T2 and ISDB-T (8 MHz)



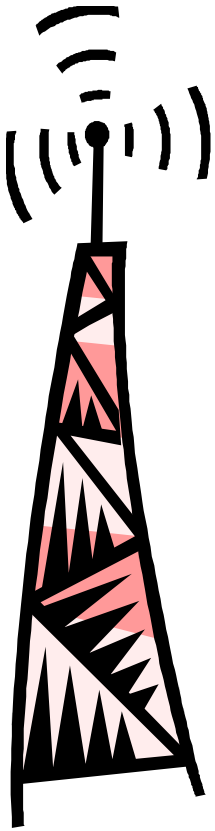
Case Study- DVB-T @ (8 MHz)

DVB-T Reference Mode	
Modulation	64 QAM
Error code rate	3/4
Guard Interval	1/4
FFT	8k
Bit rate (Payload)	22.39 Mbps
C/N required - (Gaussian/Ricean)	(18.2/18.9) dB

Reference TX & Rx systems	
Bandwidth	8 MHz

Notes

- GI = 1/4 Selected to support large SFN operation
- Code Rate 3/4 chosen to provide C/N approx 19dB-20dB
- Ricean propagation model chosen.



DVB-T Reference mode

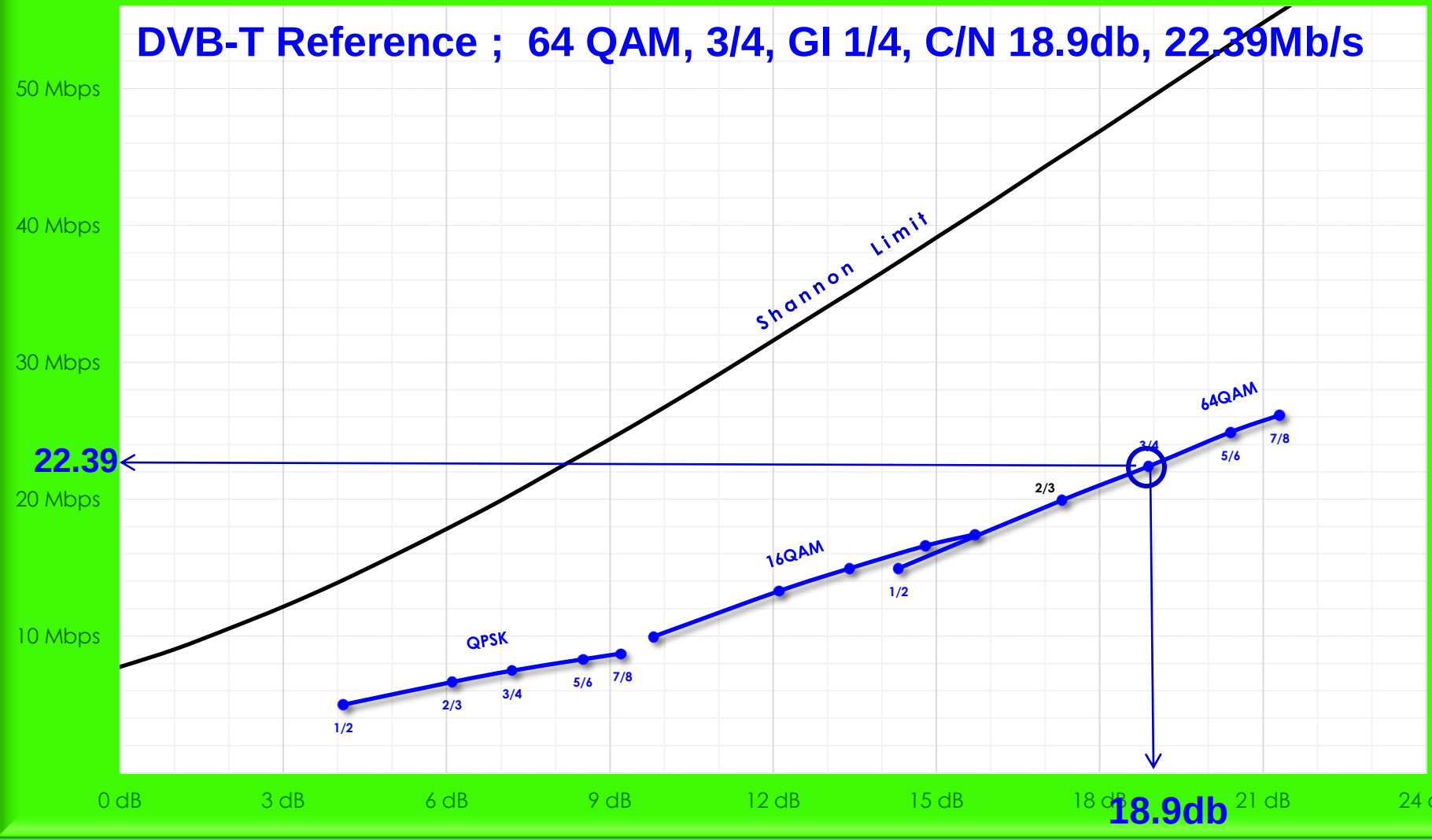
DVB T2
2ND GENERATION TERRESTRIAL

Net Capacity in 8 MHz Stationnary channels

F1 : Fix Reception - LOS - Rice

(T1 : GI=1/4)

DVB-T

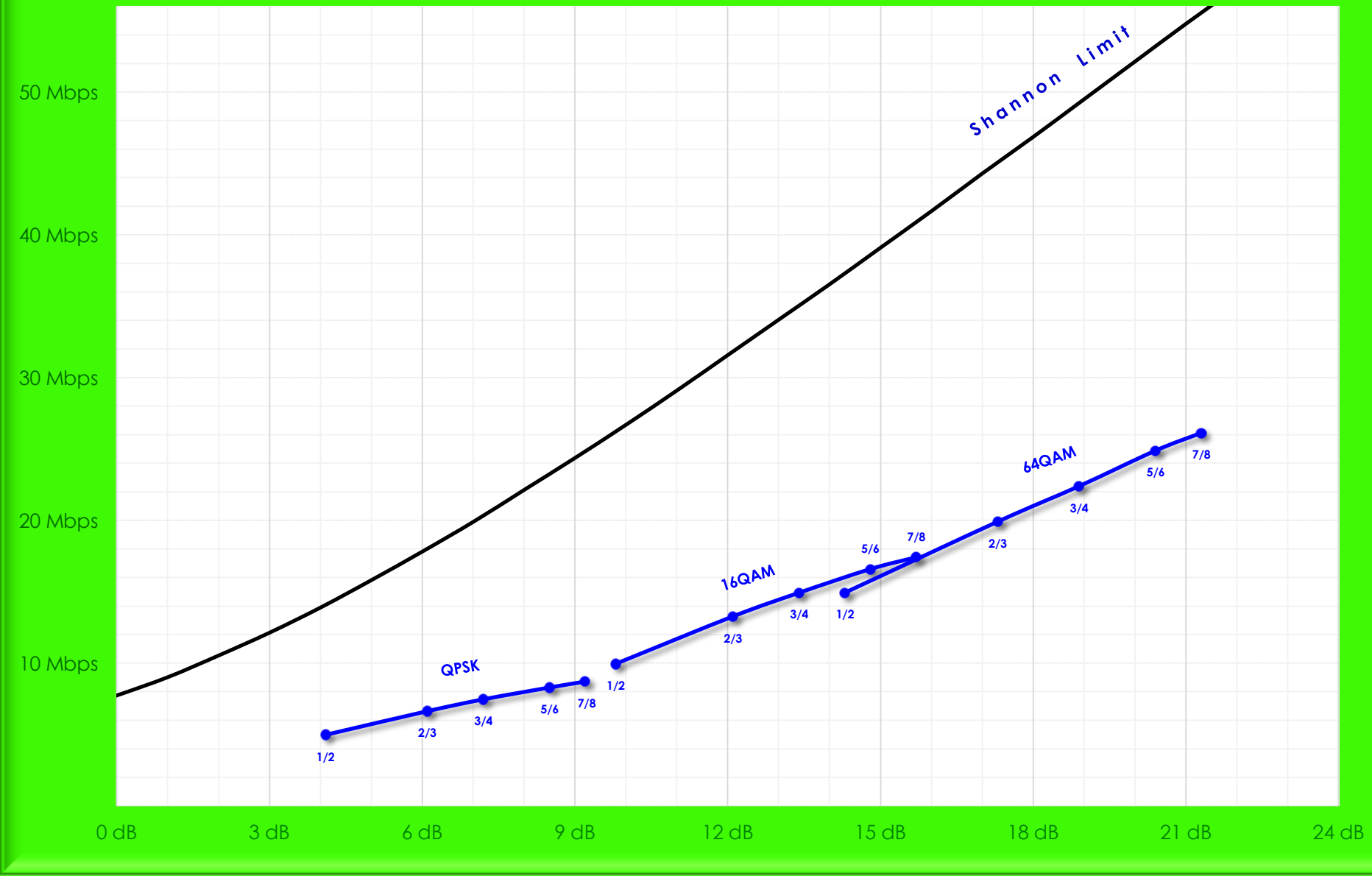


DVB T2
2ND GENERATION TERRESTRIAL

Net Capacity in 8 MHz Stationnary channels

F1 : Fix Reception - LOS - Rice

(T1 : GI=1/4)



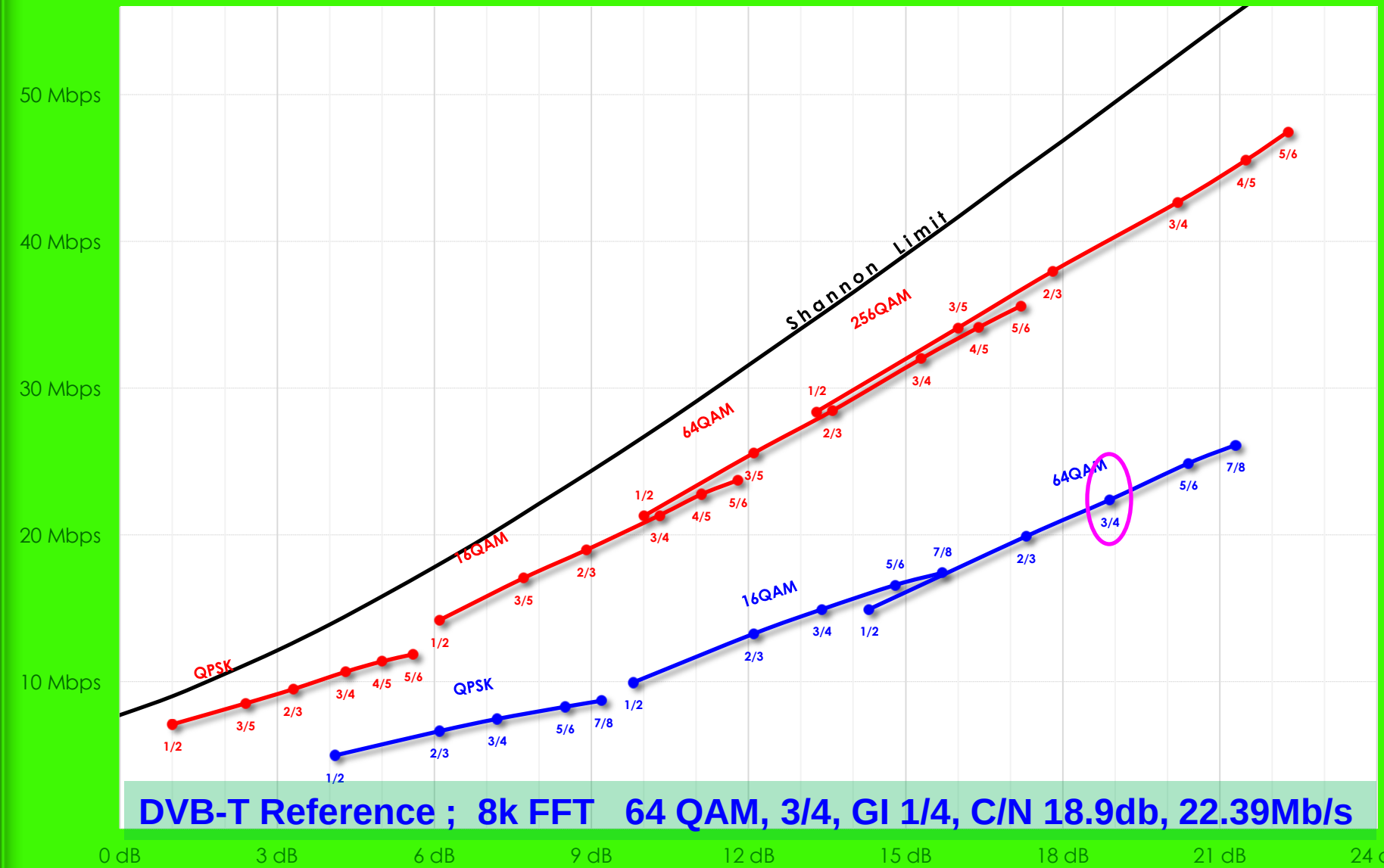
DVB T2
2ND GENERATION TERRESTRIAL

Net Capacity in 8 MHz Stationnary channels

F1 : Fix Reception - LOS - Rice

(T2: GI=1/16 / T1: GI=1/4)

DVB-T



DVB-T Reference ; 8k FFT 64 QAM, 3/4, GI 1/4, C/N 18.9db, 22.39Mb/s

DVB T2
2ND GENERATION TERRESTRIAL

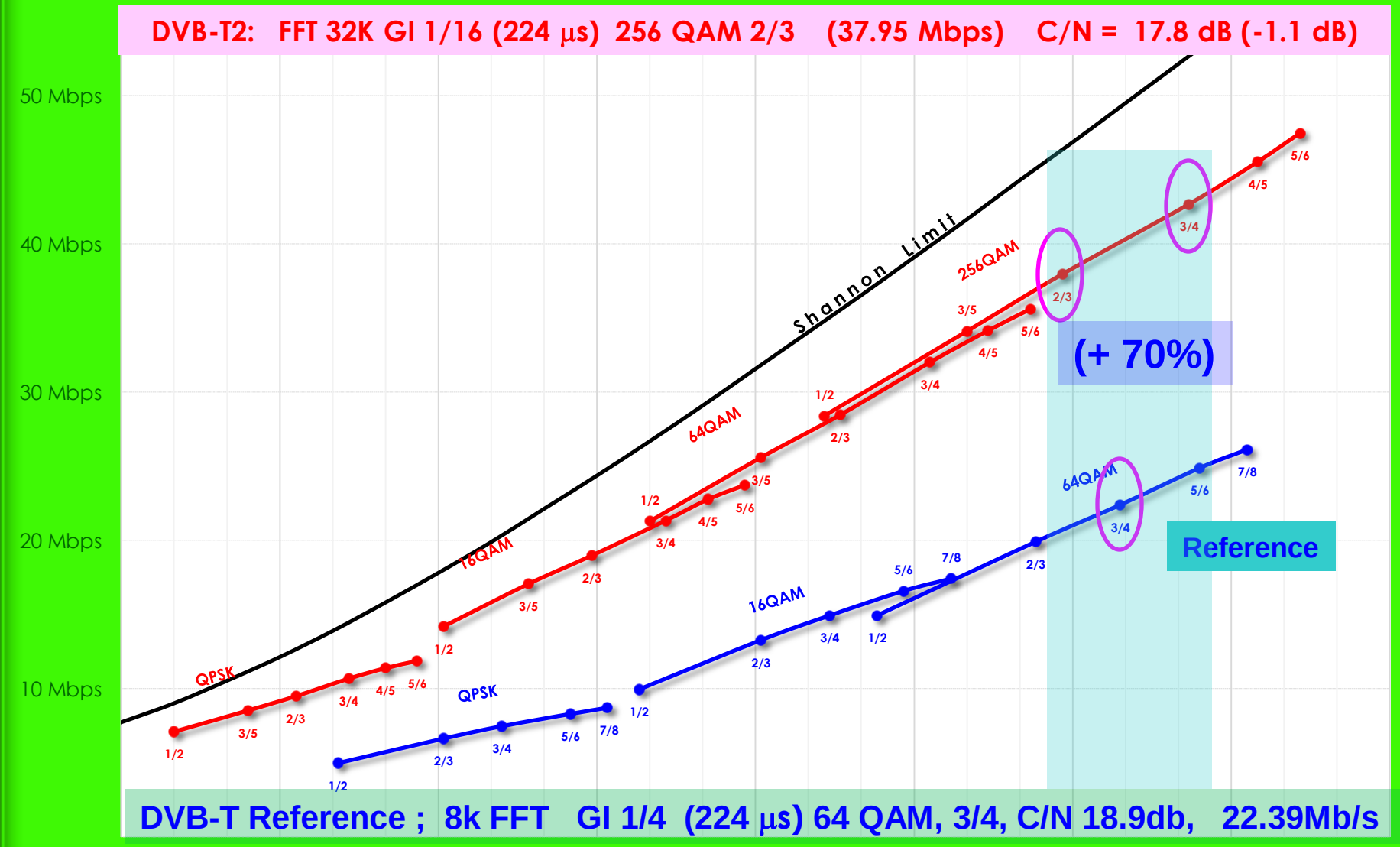
Net Capacity in 8 MHz Stationnary channels

F1 : Fix Reception - LOS - Rice

Same Coverage modes

DVB-T

DVB-T2: FFT 32K GI 1/16 (224 µs) 256 QAM 2/3 (37.95 Mbps) C/N = 17.8 dB (-1.1 dB)



DVB-T Reference ; 8k FFT GI 1/4 (224 µs) 64 QAM, 3/4, C/N 18.9db, 22.39Mb/s

DVB T2
2ND GENERATION TERRESTRIAL

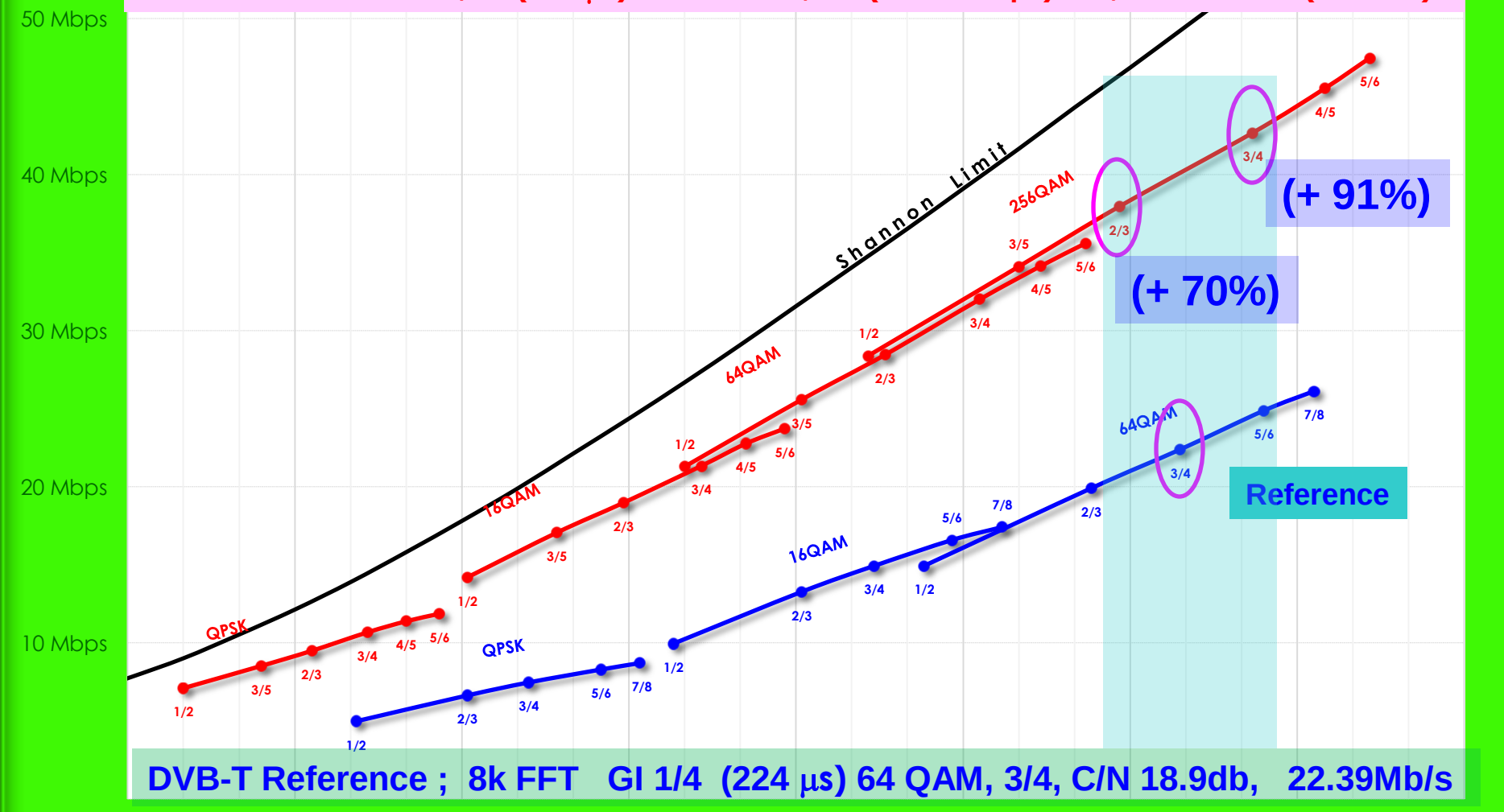
Net Capacity in 8 MHz Stationnary channels

F1 : Fix Reception - LOS - Rice

Same Coverage modes

DVB-T

DVB-T2: FFT 32K GI 1/16 (224 µs) 256 QAM 2/3 (37.95 Mbps) C/N = 17.8 dB (-1.1 dB)
DVB-T2: FFT 32K GI 1/16 (224 µs) 256 QAM 3/4 (42.68 Mbps) C/N = 20.2 dB (+1.3 dB)



DVB-T Reference ; 8k FFT GI 1/4 (224 µs) 64 QAM, 3/4, C/N 18.9db, 22.39Mb/s

DVB T2
2ND GENERATION TERRESTRIAL

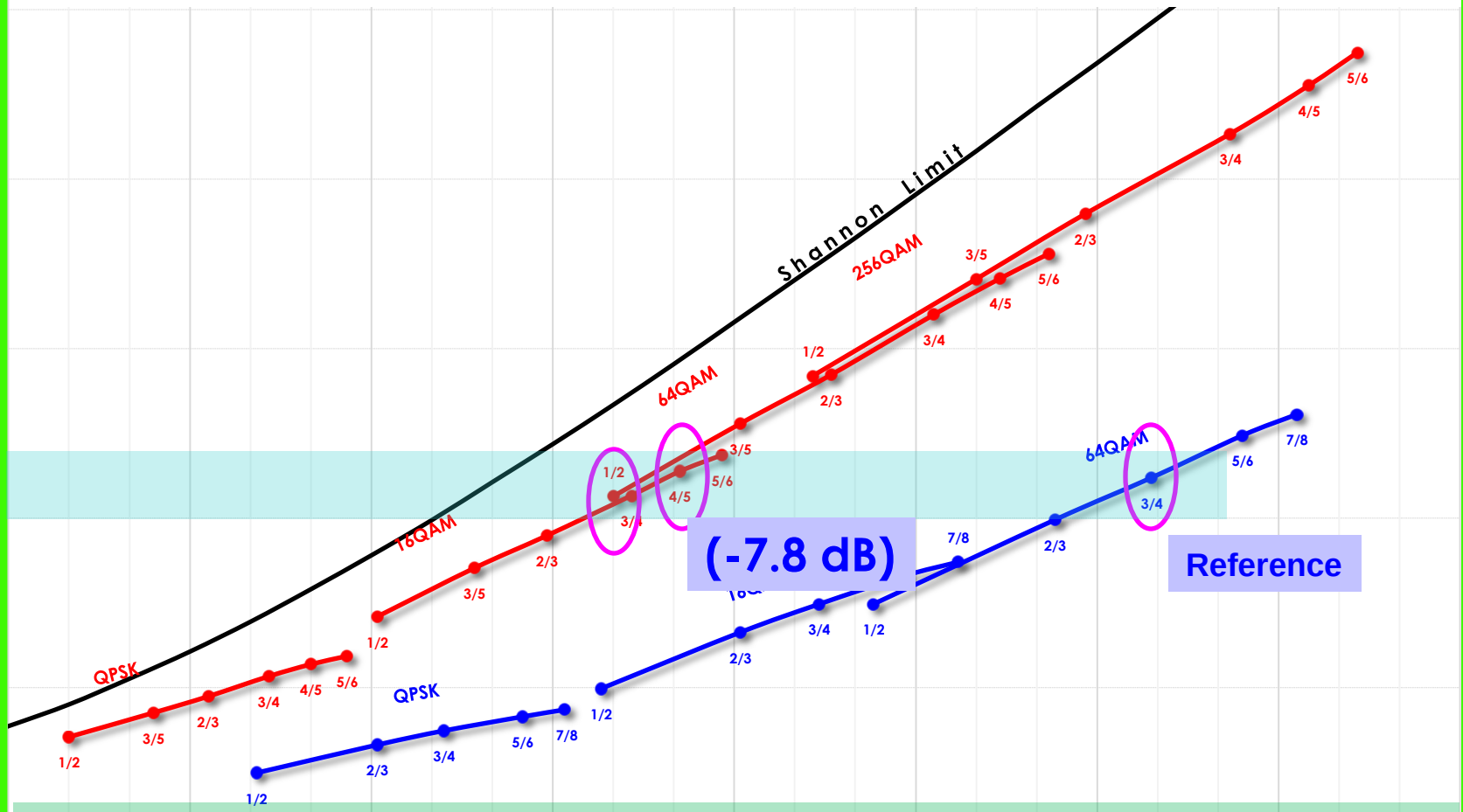
Net Capacity in 8 MHz Stationnary channels

F1 : Fix Reception - LOS - Rice

Same Payload modes

DVB-T

DVB-T2: FFT 32K GI 1/16 (224 µs) 16QAM 4/5 (22.70 Mbps) C/N = 11.1 dB (-7.8 dB)



DVB-T Reference ; 8k FFT 64 QAM, 3/4, GI 1/4, C/N 18.9db, 22.39Mb/s

DVB T2
2ND GENERATION TERRESTRIAL

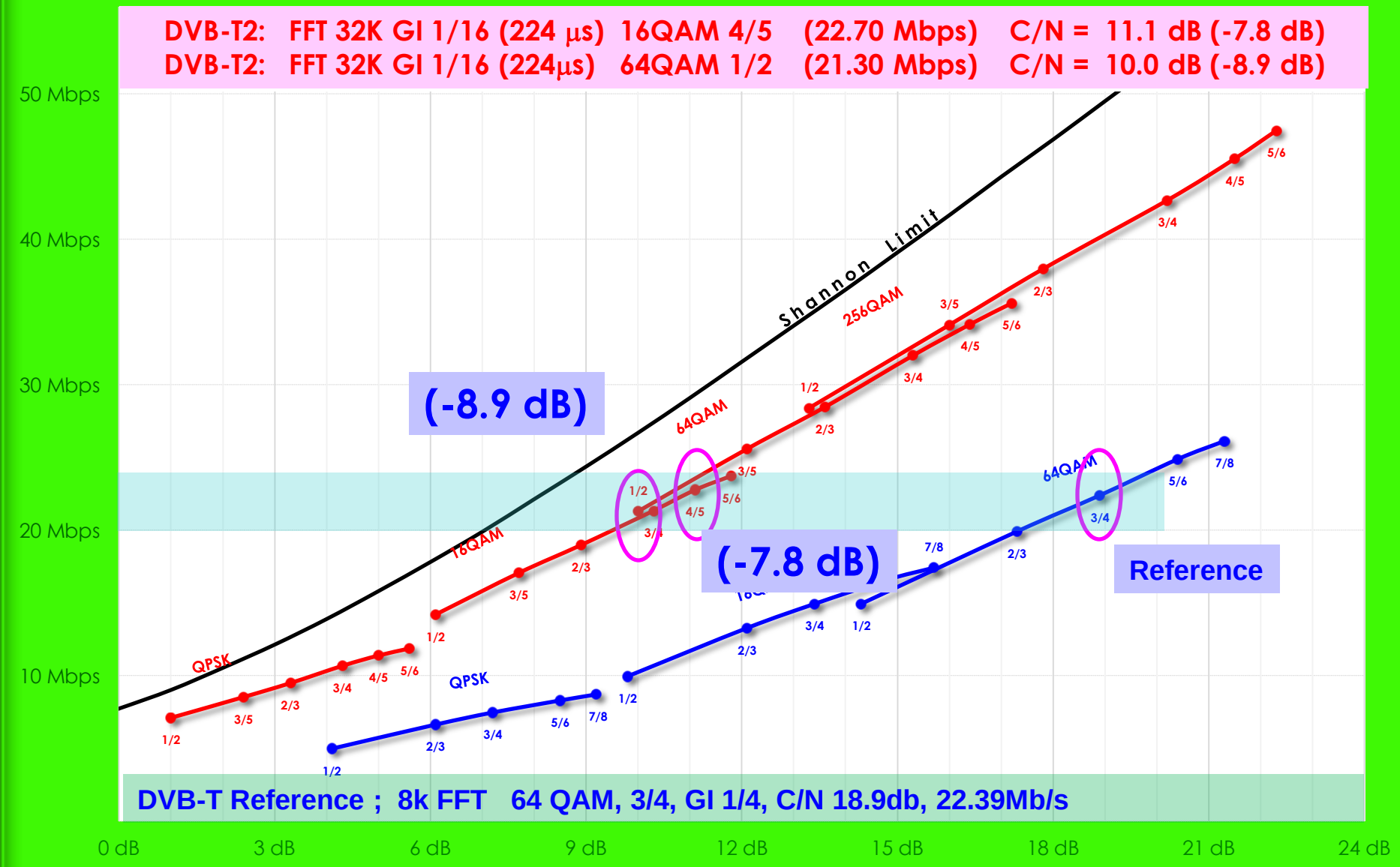
Net Capacity in 8 MHz Stationnary channels

F1 : Fix Reception - LOS - Rice

Same Payload modes

DVB-T

DVB-T2: FFT 32K GI 1/16 (224 µs) 16QAM 4/5 (22.70 Mbps) C/N = 11.1 dB (-7.8 dB)
DVB-T2: FFT 32K GI 1/16 (224µs) 64QAM 1/2 (21.30 Mbps) C/N = 10.0 dB (-8.9 dB)



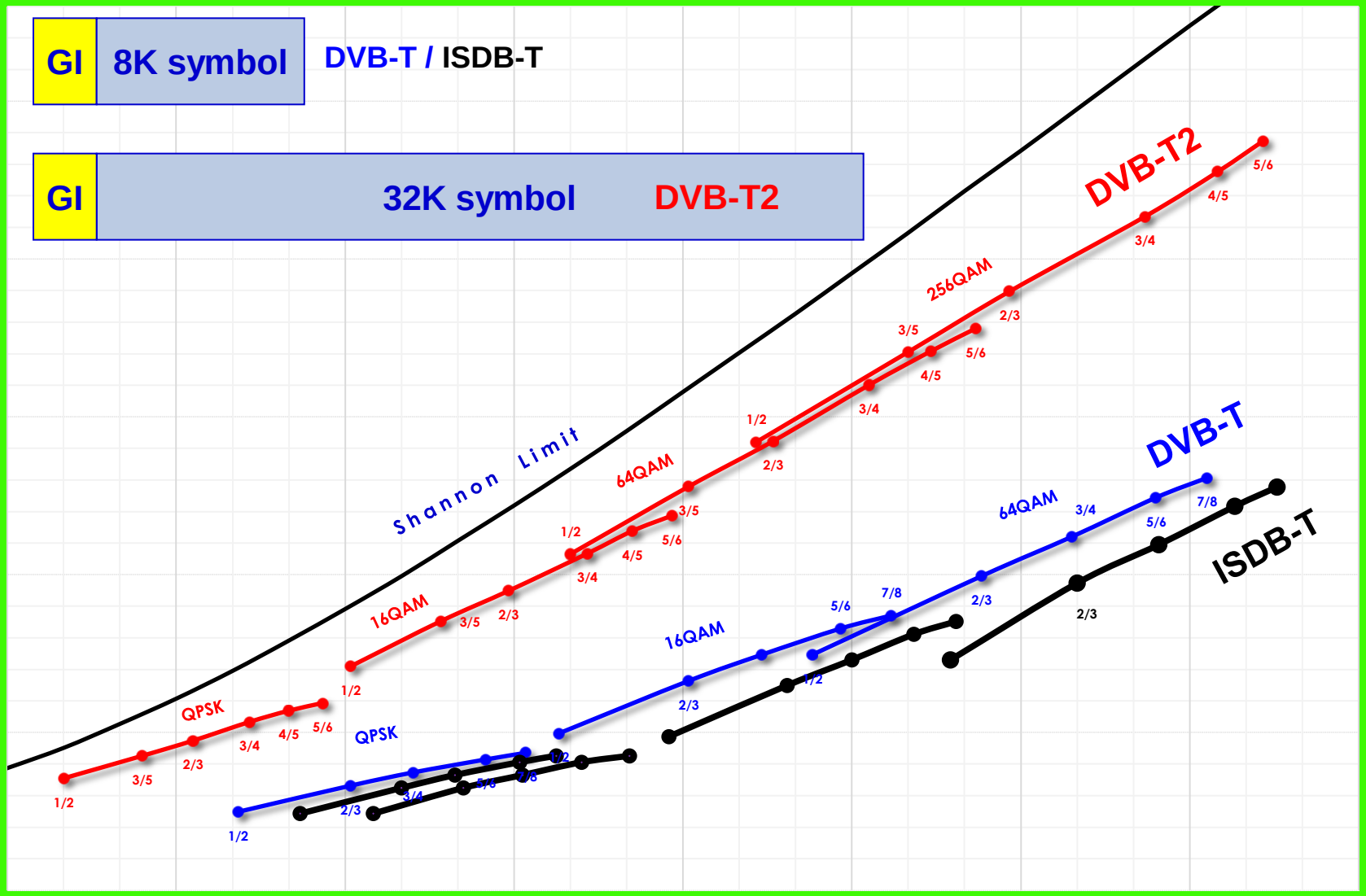
DVB-T Reference ; 8k FFT 64 QAM, 3/4, GI 1/4, C/N 18.9db, 22.39Mb/s

DVB T2
2ND GENERATION TERRESTRIAL

Net Capacity in 8 MHz Stationnary channels

F1 : Fix Reception - LOS - Rice

(T2 : GI = 1/16 / T1 : GI = 1/4 / ISDB (8MHz) : GI= 1/4)



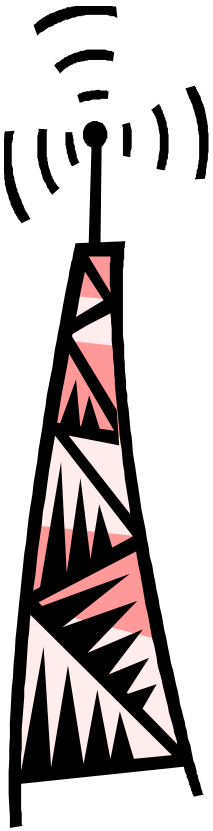
Case Study- ISDB (8 MHz)

ISDB-T Reference Mode	
Modulation (13 Segments)	64 QAM
Error code rate	2/3
Guard Interval	1/4
FFT	8k
Bit rate (Payload)	19.47 Mbps
C/N required - (Gaussian/Ricean)	(18.6/19.3) dB

Reference TX & Rx systems	
Bandwidth	8 MHz

Notes

- GI = 1/4 Selected to support large SFN operation
- Ricean propagation model chosen.
- ISDB Characteristics obtained by normalising 6 MHz data to 8 MHz



ISDB-T Reference System

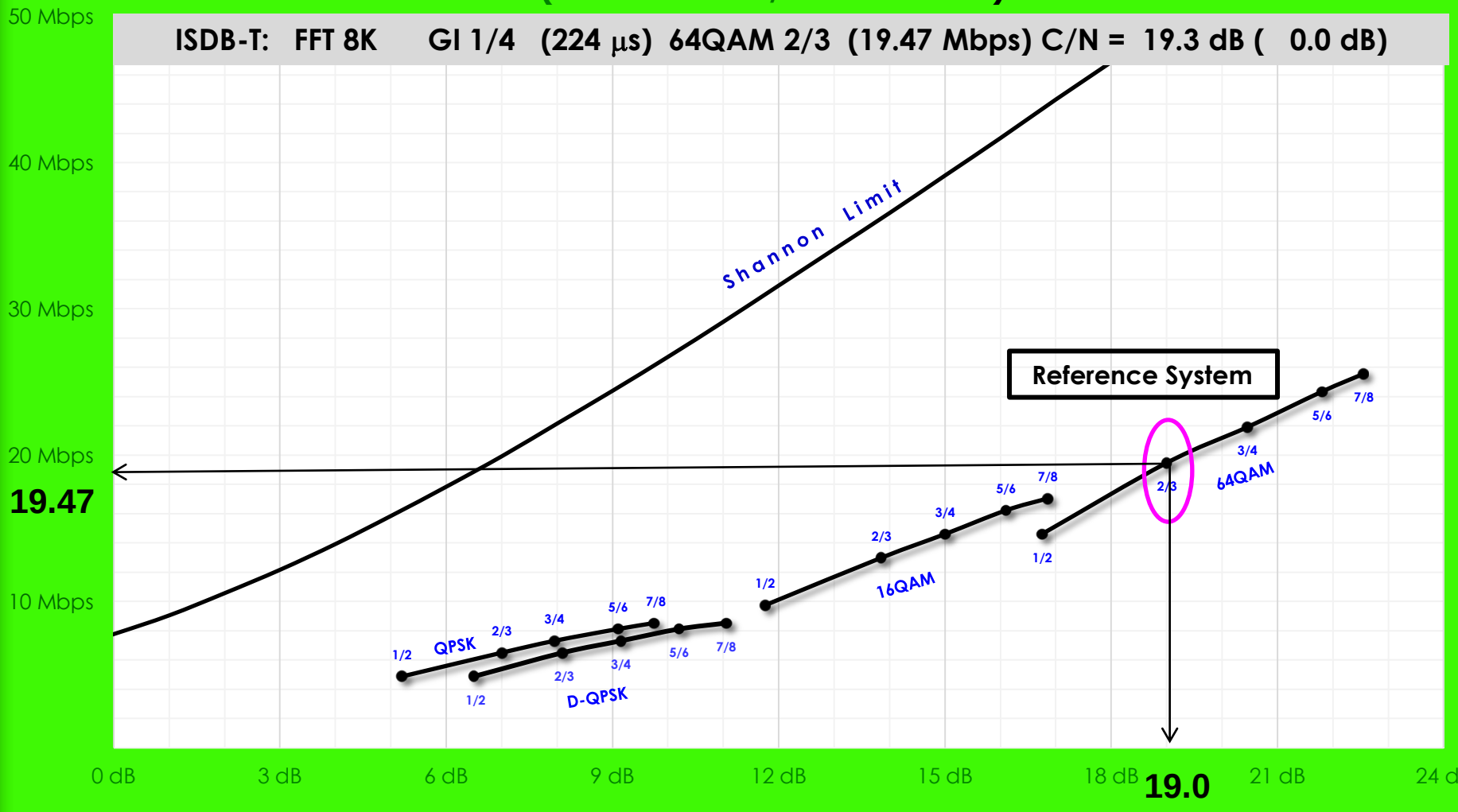
DVB Digital Video Broadcasting

DVB T2 2ND GENERATION TERRESTRIAL

Net Capacity in 8MHz Stationnary channels

F1 : Fix Reception - LOS - Rice

(DVB-T2 : Red / ISDB-T : Blue)



DVB T2
2ND GENERATION TERRESTRIAL

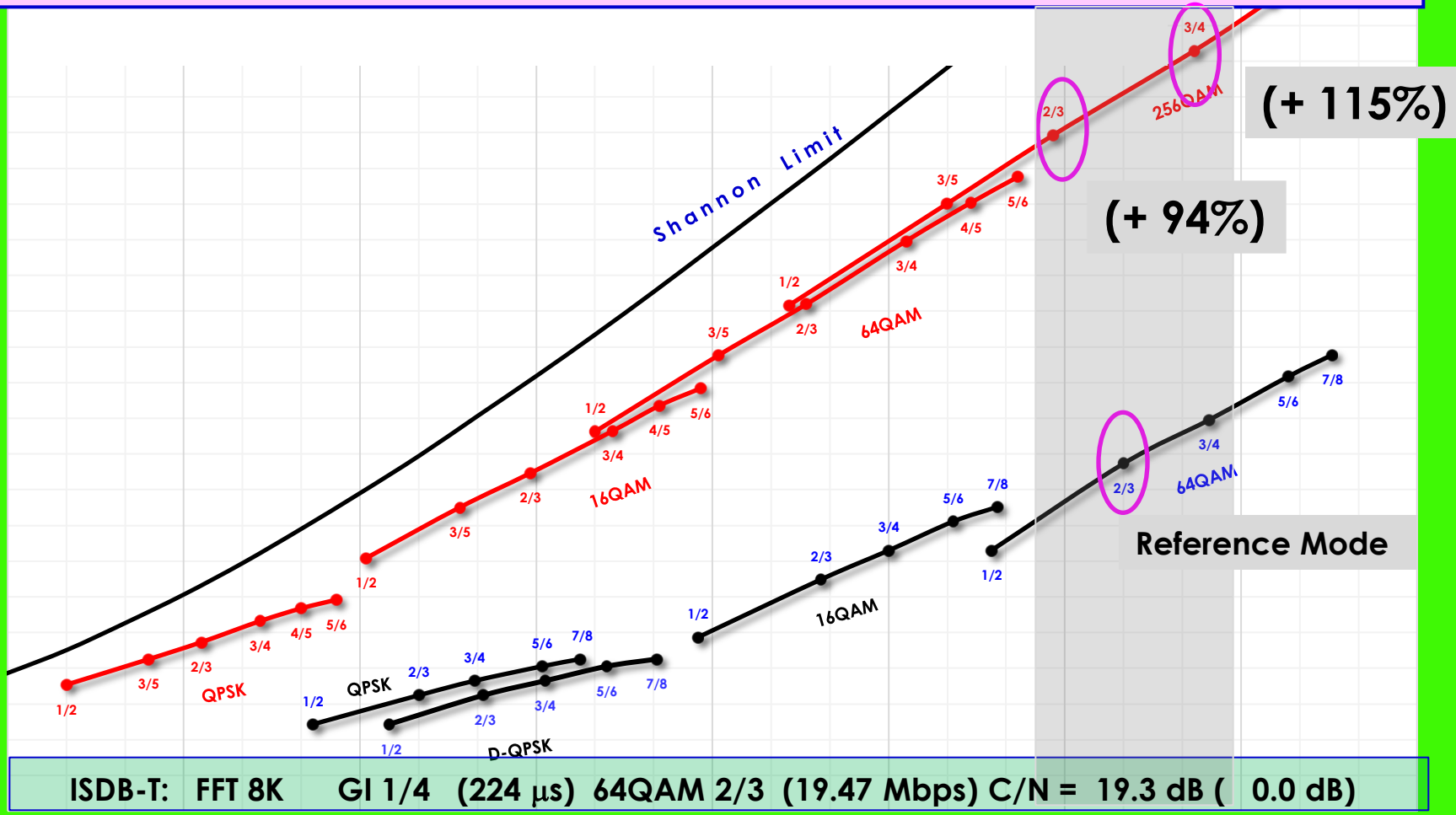
Net Capacity in 8MHz Stationnary channels

F1 : Fix Reception - LOS - Rice

Same Coverage modes

ISDB-T

DVB-T2: FFT 32K GI 1/16 (224 µs) 256QAM 3/4 (42.58 Mbps) C/N = 20.2 dB (+ 1.2 dB)
DVB-T2: FFT 32K GI 1/16 (224 µs) 256QAM 2/3 (37.86 Mbps) C/N = 17.8 dB (- 1.2 dB)



ISDB-T: FFT 8K GI 1/4 (224 µs) 64QAM 2/3 (19.47 Mbps) C/N = 19.3 dB (0.0 dB)

0 dB 3 dB 6 dB 9 dB 12 dB 15 dB 18 dB 21 dB 24 dB

DVB T2
2ND GENERATION TERRESTRIAL

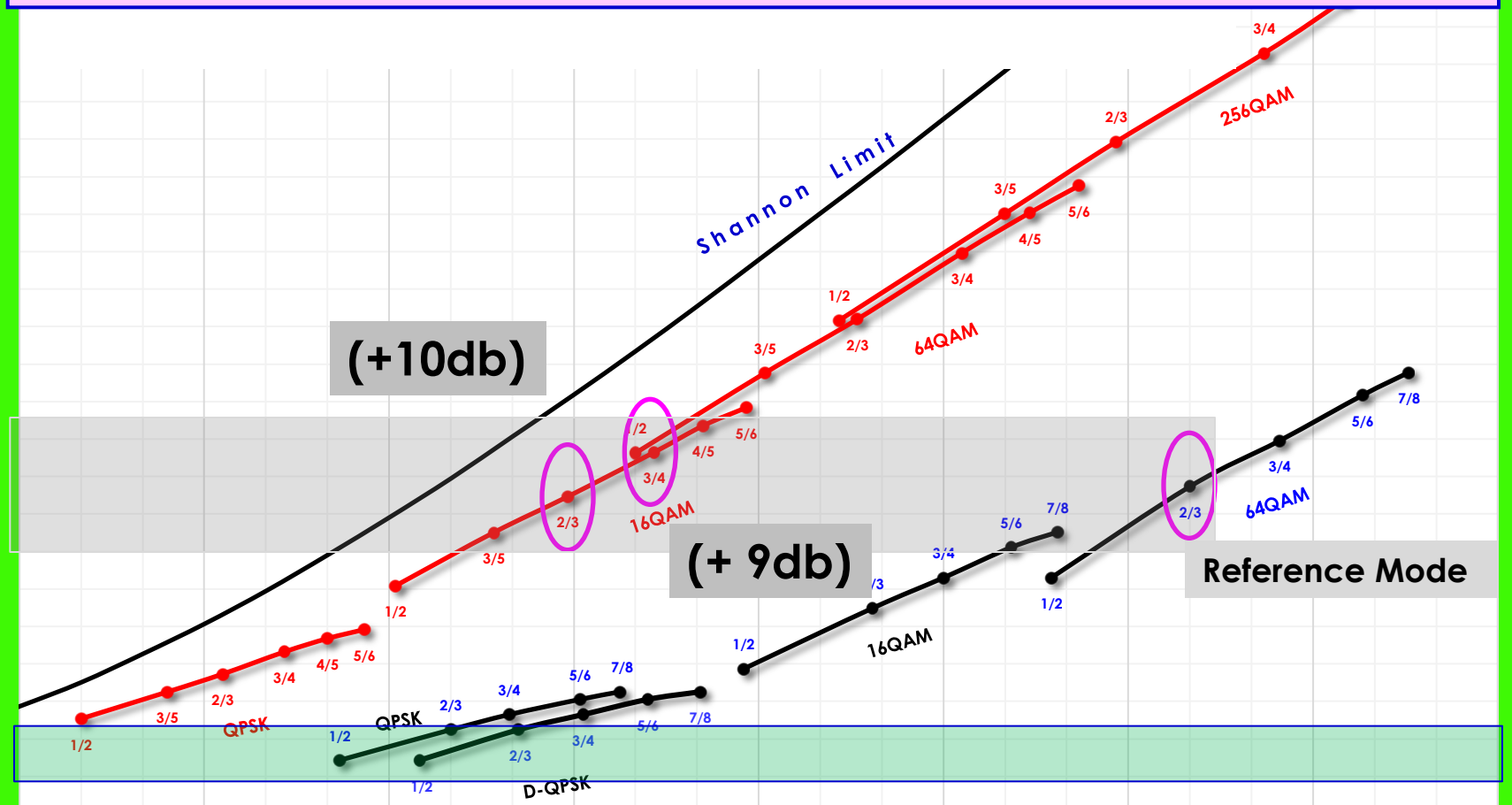
Net Capacity in 8MHz Stationnary channels

F1 : Fix Reception - LOS - Rice

Same Payload modes

ISDB-T

DVB-T2: FFT 32K GI 1/16 (224 µs) 16QAM 2/3 (18.93 Mbps) C/N = 8.9 dB (-10.1 dB)
DVB-T2: FFT 32K GI 1/16 (224 µs) 16QAM 3/4 (21.29 Mbps) C/N = 10.1 dB (-8.9 dB)



ISDB-T: FFT 8K GI 1/4 (224 µs) 64QAM 2/3 (19.47 Mbps) C/N = 19.3 dB (0.0 dB)

0 dB 3 dB 6 dB 9 dB 12 dB 15 dB 18 dB 21 dB 24 dB

System Comparison DVB-T2 / DVB-T / ISDB-T Summary			
System	**Transmission Mode**	**Data Rate (Payload) Mb/s**	**C/N Ricean Model dB**
DVB-T	**64 QAM, GI 1/4, 3/4, 8K**	**22.39 (ref)**	**18.9 (0)**
DVB-T2	256 QAM, GI 1/16, 2/3, 32k	**37.9 (+70%)**	17.8
DVB-T2	256 QAM, GI 1/16, 3/4, 32k	**42.7 (+91%)**	20.2
DVB-T2	16QAM, GI 1/16, 4/5, 32K	22.7	**11.1 (-7.8)**
DVB-T2	64QAM, GI 1/16, 1/2, 32K	21.3	**10.0 (-8.9)**
ISDB-T	**64 QAM, GI 1/4, 2/3, 8K**	**19.47 (ref)**	**19.3(0)**
DVB-T2	256 QAM, GI 1/16, 2/3, 32k	**37.9 (+94%)**	17.8
DVB-T2	256 QAM, GI 1/16, 3/4, 32k	**42.7 (+115%)**	20.2
DVB-T2	16QAM, GI 1/16, 3/4, 32K	21.29	**10.1 (-8.9)**
DVB-T2	16QAM, GI 1/16, 2/3, 32K	18.9	**8.9 (-10)**
Same Coverage			
Same Payload			

DVB-T2 RELATIVE PERFORMANCE

- Compared with DVB-T % ISDB –T 1st Generation standards
  - DVB-T2 can increase significantly the payload capacity for the same coverage (C/N ratio)
  - In the examples the increase ranges 70% - 115%
  - This increase can be translated into more services per RF Channel and increased spectrum productivity.
    - 4 – 6 HDTV services in one RF channel
    - 10 – 16 SDTV services
    - Effective Spectrum saving >70%

  OR

  - DVB-T2 can with the <u>same payload as ISDB-T or DVB-T</u>
    - Reduction of Transmitter power (same coverage) 1/4 - 1/10
    - Increase the coverage by 6 – 10 db (same Tx power)

Versatility of DVB-T2

Benefits can be realized in different ways

Payload gain:

- **Better quality**
- **More channels**
- **Less Spectrum**

C/N gain:

- **Transmission side:**
  - **Lower power (1/4 – 1/10 power of Tx)**
  - **Less transmitters/sites**
  - **High Spectrum saving**
- **Reception side:**
  - **extended coverage**
  - **Better indoor portable/mobile reception**
  - **lower antenna/receiver gain needed (indoor aerials)**

Thank You