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Australian DTTB Lab Tests, Methodology & Results Summary

http://www.commslab.gov.au/

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Overview

- Digital Television Objectives & Technology
- DTTB Transmission Technology
- The Australian Test Program
- Laboratory Tests - Test Rig
- Laboratory Tests - Main Results
- Field Test Objectives & Equipment
- Summary Field Test Results
- Selection Process & Criteria
- Selection Result & Future

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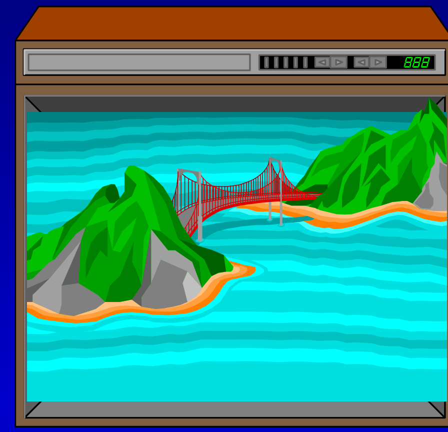
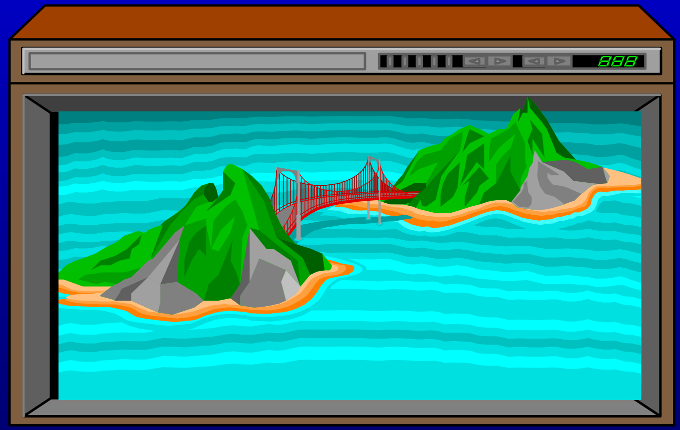
Digital Television

Why digital?

To Overcome Limitations of Analog Television

- Noise free pictures
- Higher resolution images Widescreen / HDTV
- No Ghosting
- Multi-channel, Enhanced Sound Services
- Other Data services.





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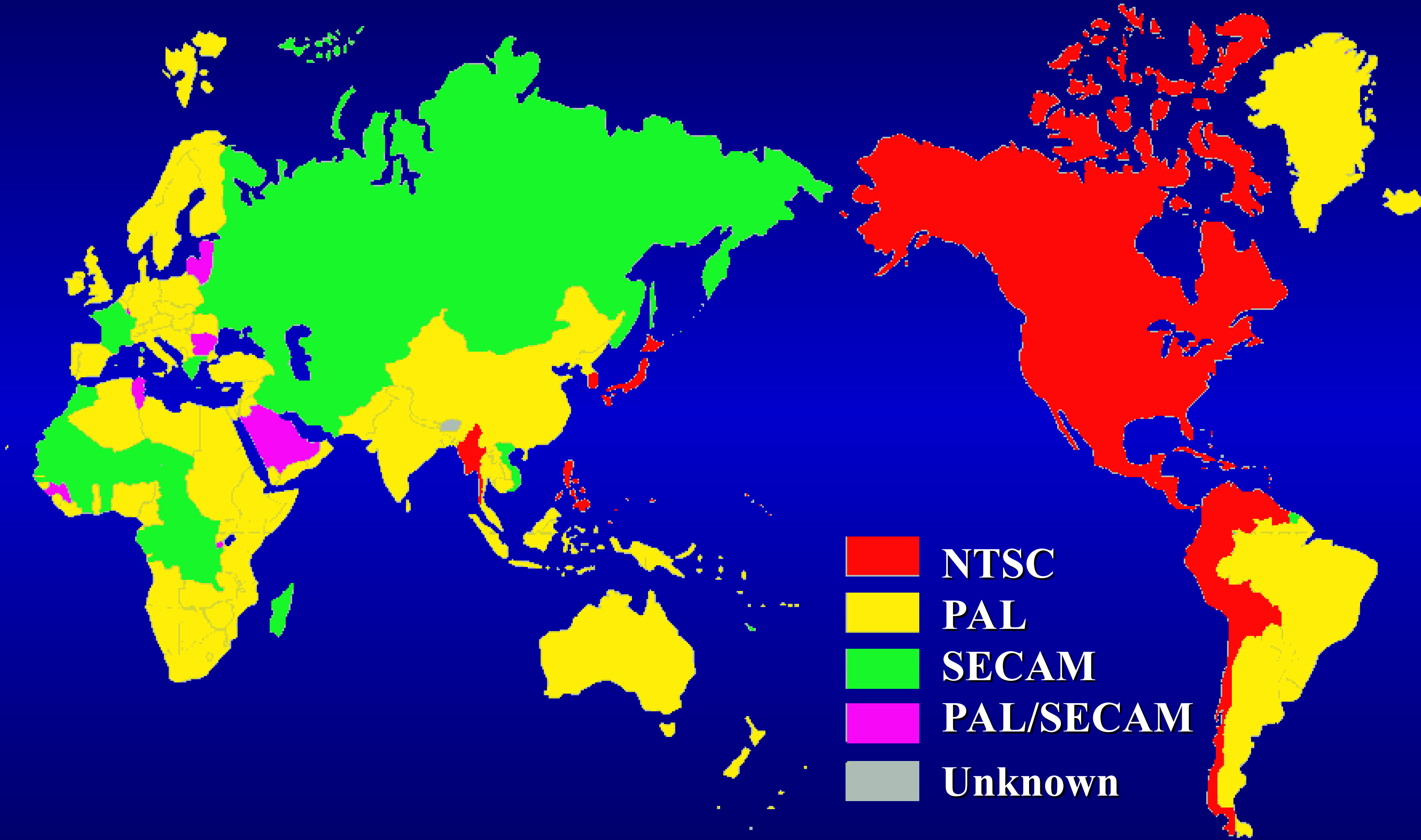
World TV Standards



Australia like China & Malaysia are PAL

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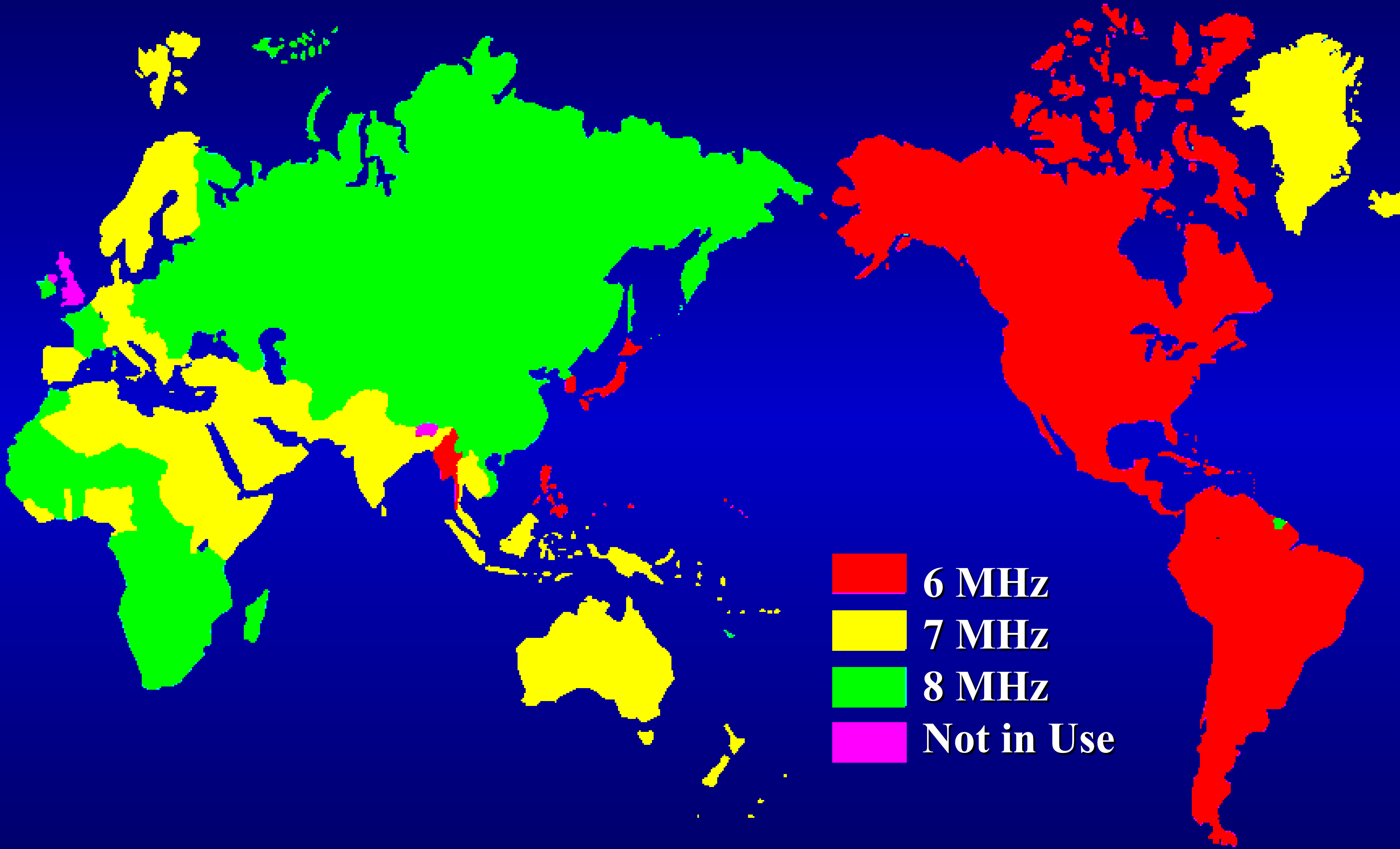
Transmission Bandwidth - VHF



**Australia & Malaysia are 7 MHz,
China is 8 MHz**

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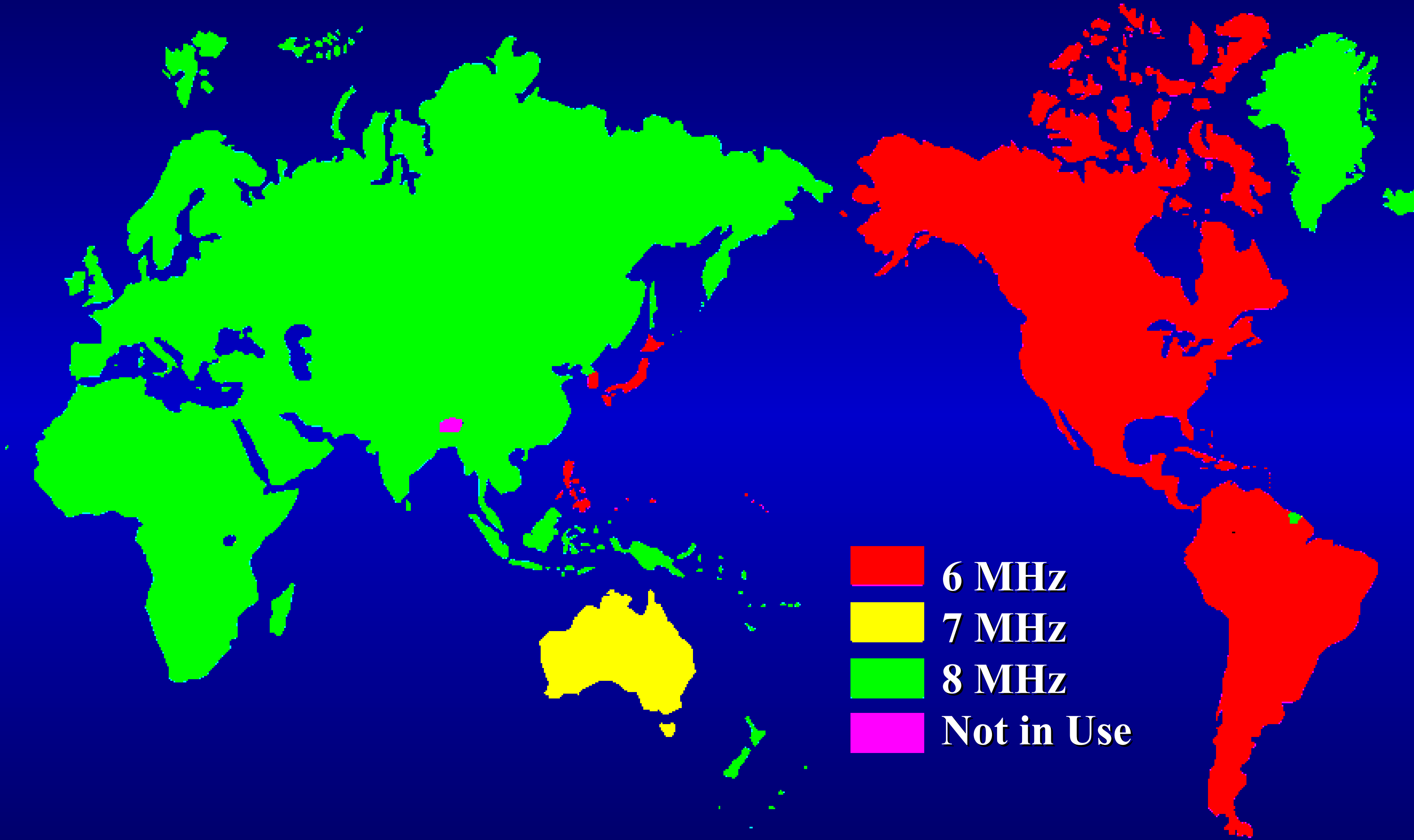
Transmission Bandwidth - UHF



Australia is Alone using 7 MHz on UHF

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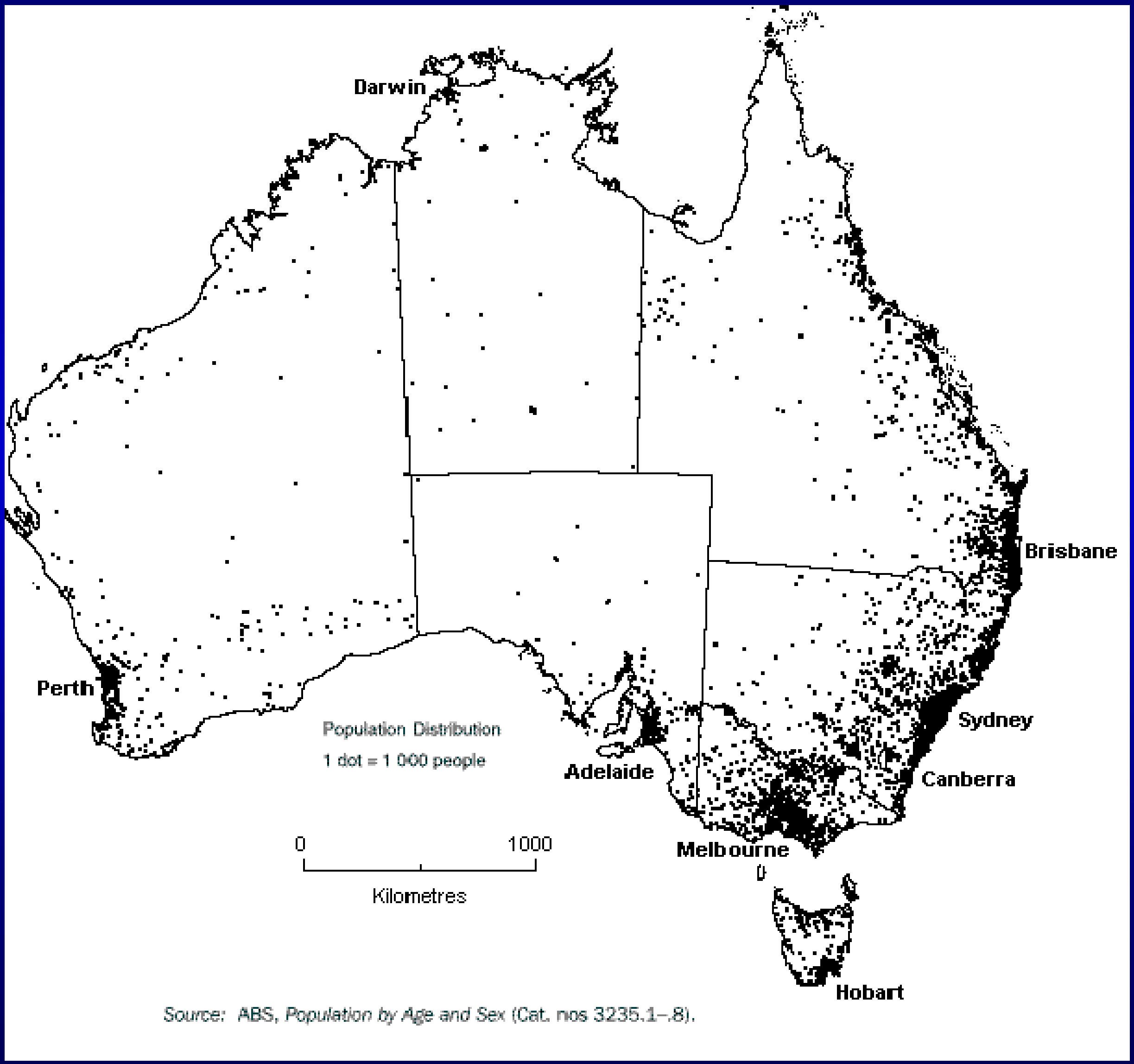
Australian Population Distribution



Uneven Population distribution

Wide areas where few people live

Noise Limited Transmission environment

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Free To Air Television (FTA)

- 5 Networks - 3 Commercial, 2 Government
- Important part of Australian entertainment
- Majority of Australian audience is watching
- No television receiving licences
- National broadcasters funded from taxation

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Pay TV - Cable, MDS & Satellite

- Only a small business in Australia
- Less then 400,000 subscribers
- Less than 7% of households

Indoor reception

- Around 30% of Australians watch FTA using indoor antennas

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Program Quality Vs Quantity

- Australians have a low number of available television channels
- Television program budget is spread between fewer programs
- Australians used to watching high quality programming at high technical quality.

MP@ML

MP@HL

All decoders sold in Australia will be MP@HL capable allowing all viewers access to HD resolution when it becomes available

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Enabling Technologies

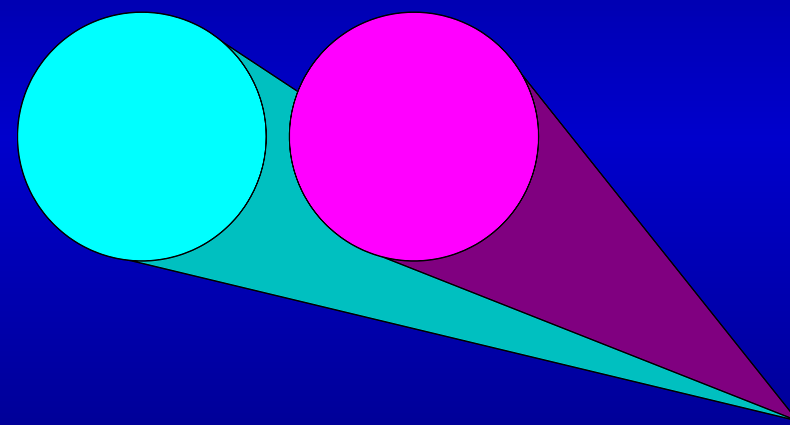
- Source digitisation (Rec 601 digital studio)
- Compression technology (MPEG, AC-3)
- Data multiplexing (MPEG)
- Display technology (large wide screens)
- Transmission technology (modulation)

Transmission Technology

- The transmission system is used to transport the information to the consumer.
- The system protects the information being carried from the transmission environment
- Current Australian analog television uses the PAL-B AM modulation system

Digital TV Transmission Technology

- The transmission system is a “data pipe”
- Transports data rates of around 20 Mb/s
- Transports data in individual containers called packets



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Digital TV Transmission Systems

Australia has been following Digital TV & HDTV

- Europeans - Digital SDTV
  - 8 MHz on UHF
  - DVB-T (COFDM)
- Americans - Digital HDTV
  - 6 MHz VHF/UHF
  - ATSC (8-VSB)
- Japanese - Integrated Broadcasting
  - ISDB (BST-OFDM)

8-VSB - USA

ADVANCED TELEVISION SYSTEMS COMMITTEE

- Developed by the advance television systems committee - ATSC
- Developed for use in a 6 MHz channel
  - A 7 MHz variant is possible.
- Uses a single carrier with pilot tone
- 8 level amplitude modulation system
- Single Payload data rate of 19.39 Mb/s
- Relies on adaptive equalisation
- Existing AM technology highly developed

COFDM - Europe

- Developed by the digital video broadcasting project group - DVB
- Uses similar technology to DRB
- Uses 1705 or 6817 carriers
- Variable carrier modulation types are defined allowing Payload data rates of 5-27 Mb/s in 7 MHz
- Developed for 8 MHz channels
  - A 7 MHz variant has been produced and tested
- Can use single frequency networks - SFNs
- New technology with scope for continued improvement & development

The Australian DTTB Test Program

- Australia is interested in a Digital HDTV Future
- Australia has a Unique Broadcasting Environment
- Overseas Digital TV Developments were interesting but the results could not be directly related to Australia.
- To make informed decisions we needed to collect information relevant to our situation.
- We had a few Questions.

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Aims of Australian DTTB Testing-1

Australia needed to know:

- How does DTTB perform with VHF PAL-B?
- What Protection does PAL require from the DTTB service for:
  - Co-Channel?
  - Adjacent Channel?
  - Is Signal level a factor?

→ Subjective Assessment

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Aims of Australian DTTB Testing-2

- How Quickly does the system degrade?
- What are the real system thresholds?
  - Signal Level
  - Carrier to Noise
  - Payload Data Rate in 7 MHz
- How does DTTB cope with Interference?
- What is a typical Noise Figure for a DTTB Rx

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Aims of Australian DTTB Testing-3

- What Protection does DTTB require from the PAL-B service for:
  - Co-Channel?
  - Adjacent Channel?
  - Is Signal level a factor?
- What Protection does DTTB require from other DTTB services?

Aims of Australian DTTB Testing-4

- How does DTTB perform in a 7 MHz Channel Environment?
- How sensitive is DTTB to practical Transmission Equipment?

How important is:

- Transmitter Linearity?
- Transmitter Precorrection?
- Transmitter Output Filtering?
- Combined Feeder/Antenna Systems?

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Aims of Australian DTTB Testing-5

- Is DTTB affected by Multipath Echoes?
  - Are Pre-Echoes a Problem?
  - What happens past the Guard interval?
- Is DTTB affected by Doppler Shift?
- Is DTTB affected by Dynamic Flutter?
- Is DTTB affected by Impulsive Interference?
- How does DTTB perform in the Field cw PAL

Lots of Questions but
Few Definitive Answers!

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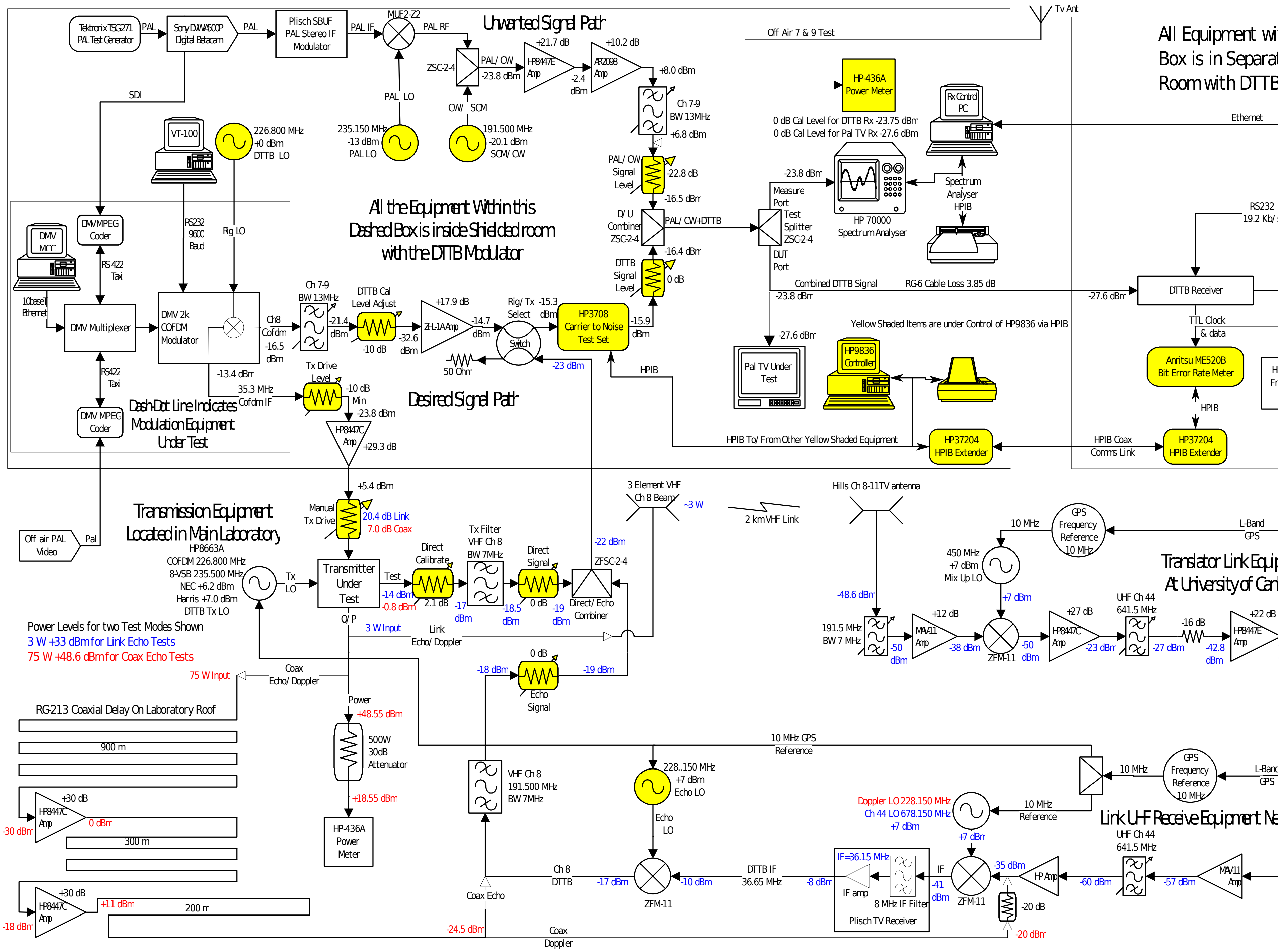
Scope of Tests

- The test program began with the aim of answering these questions for DVB-T
- During the early stages of testing ATSC was floated as a Candidate Digital TV System
- The test program's scope was increased and a comparative focus adopted.
- All tests were designed to be as generally applicable as possible to any Digital TV Modulation System.

Order of Measurements

- FACTS Advanced TV Specialists Group directed the priority of Testing
- Laboratory Tests First
  1. DTTB into PAL protection
  2. DTTB System Parameters
  3. PAL into DTTB protection
  4. Other Interferers & Degradations
- Field Tests Later



Unwanted Signal Path
Tektronix TSG271 PAL Test Generator
PAL
Sony DVW-A500P Digital Betacam
PAL
Plisch SBUF PAL Stereo IF Modulator
PAL IF
MUF2-Z2
PAL RF
ZSC-2-4
PAL/ CW
-23.8 dBm
+21.7 dB
HP8447E Amp
-2.4 dBm
+10.2 dB
AR2098 Amp
+8.0 dBm
Ch 7-9 BW 13MHz
+6.8 dBm
PAL LO
CW/ SCM
SDI
226.800 MHz +0 dBm DTTB LO
235.150 MHz -13 dBm PAL LO
191.500 MHz -20.1 dBm SCM/ CW
VT-100
Tv Ant
Off Air 7 & 9 Test
HP-436A Power Meter
0 dB Cal Level for DTTB Rx -23.75 dBm
0 dB Cal Level for Pal TV Rx -27.6 dBm
Rx Control PC
Ethernet
All Equipment wi
Box is in Separat
Room with DTTB
PAL/ CW Signal Level
-22.8 dB
-16.5 dBm
-23.8 dBm
Measure Port
HP 70000 Spectrum Analyser
Spectrum Analyser HPIB
D/ U Combiner ZSC-2-4
PAL/ CW+DTTB
Test Splitter ZSC-2-4
DUT Port
RS232
19.2 Kb/ s
-16.4 dBm
DTTB Signal Level
0 dB
Combined DTTB Signal
RG6 Cable Loss 3.85 dB
-23.8 dBm
-27.6 dBm
DTTB Receiver
All the Equipment Within this Dashed Box is inside Shielded room with the DTTB Modulator
DMV MCC
DMV/MPEG Coder
RS232 9600 Baud
Rig LO
RS 422 Taxi
10baseT Ethernet
DMV Multiplexer
DMV 2k COFDM Modulator
Ch8 Cofdm -16.5 dBm
Ch 7-9 BW 13MHz
-21.4 dBm
DTTB Cal Level Adjust
-10 dB
-32.6 dBm
+17.9 dB
ZHL-1A Amp
-14.7 dBm
Rig/ Tx Select
-15.3 dBm
Switch
HP3708 Carrier to Noise Test Set
-15.9 dBm
50 Ohm
-23 dBm
Yellow Shaded Items are under Control of HP9836 via HPIB
TTL Clock & data
-27.6 dBm
Pal TV Under Test
HP9836 Controller
Anritsu ME520B Bit Error Rate Meter
HPIB
-13.4 dBm
35.3 MHz Cofdm IF
Tx Drive Level
-10 dB Min
-23.8 dBm
RS422 Taxi
DMV MPEG Coder
Dash-Dot Line Indicates Modulation Equipment Under Test
Desired Signal Path
HP8447C Amp
+29.3 dB
HPIB To/ From Other Yellow Shaded Equipment
HP37204 HPIB Extender
HPIB Coax Comms Link
HP37204 HPIB Extender
+5.4 dBm
Transmission Equipment Located in Main Laboratory
Manual Tx Drive
20.4 dB Link
7.0 dB Coax
3 Element VHF Ch 8 Beam
~3 W
2 km VHF Link
Hills Ch 8-11 TV antenna
10 MHz
GPS Frequency Reference 10 MHz
L-Band GPS
Off air PAL Video
Pal
HP8663A COFDM 226.800 MHz 8-VSB 235.500 MHz NEC +6.2 dBm Harris +7.0 dBm DTTB Tx LO
Tx LO
Transmitter Under Test
Test
-14 dBm
-0.8 dBm
Direct Calibrate
2.1 dB
Tx Filter VHF Ch 8 BW 7MHz
-17 dBm
Direct Signal
-18.5 dBm
0 dB
-19 dBm
-22 dBm
ZFSC-2-4
Direct/ Echo Combiner
450 MHz +7 dBm Mix Up LO
Translator Link Equi
At University of Can
-48.6 dBm
+7 dBm
191.5 MHz BW 7 MHz
-50 dBm
MAV11 Amp
+12 dB
-38 dBm
ZFM-11
-50 dBm
HP8447C Amp
+27 dB
-23 dBm
UHF Ch 44 641.5 MHz
-27 dBm
-16 dB
-42.8 dBm
HP8447E Amp
+22 dB
O/ P
Power Levels for two Test Modes Shown
3 W +33 dBm for Link Echo Tests
75 W +48.6 dBm for Coax Echo Tests
3 W Input
Link Echo/ Doppler
75 W Input
Coax Echo/ Doppler
0 dB
-18 dBm
-19 dBm
Echo Signal
Power
+48.55 dBm
RG-213 Coaxial Delay On Laboratory Roof
900 m
500W 30dB Attenuator
10 MHz GPS Reference
228..150 MHz +7 dBm Echo LO
VHF Ch 8 191.500 MHz BW 7MHz
10 MHz
GPS Frequency Reference 10 MHz
L-Band GPS
+30 dB
HP8447C Amp
-30 dBm
0 dBm
300 m
+18.55 dBm
HP-436A Power Meter
Doppler LO 228.150 MHz
Ch 44 LO 678.150 MHz
+7 dBm
10 MHz Reference
Link UHF Receive Equipment Ne
+7 dBm
UHF Ch 44 641.5 MHz
+30 dB
HP8447C Amp
-18 dBm
+11 dBm
200 m
Echo LO
Ch 8 DTTB
-17 dBm
ZFM-11
-10 dBm
DTTB IF 36.65 MHz
-8 dBm
IF=36.15 MHz
IF amp
8 MHz IF Filter
Plisch TV Receiver
IF
-41 dBm
ZFM-11
-35 dBm
HP Amp
-60 dBm
-57 dBm
MAV11 Amp
-20 dB
-20 dBm
-24.5 dBm
Coax Echo
Coax Doppler

Laboratory Tests - Test Rig

C/N Set & Attenuators   EUT   PAL & CW

Control Computer   Domestic Television Receiver   Modulator Control Computers   Spectrum Analysers   Plot & Printing

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Test Rig - Modulation Equipment

Power Meter

RF LO

COFDM Modulator

MPEG Mux

MPEG Mux

MPEG Encoder

MPEG Encoder

PAL & CW Interference Generators

8-VSB Modulator

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Laboratory Tests - Transmitters

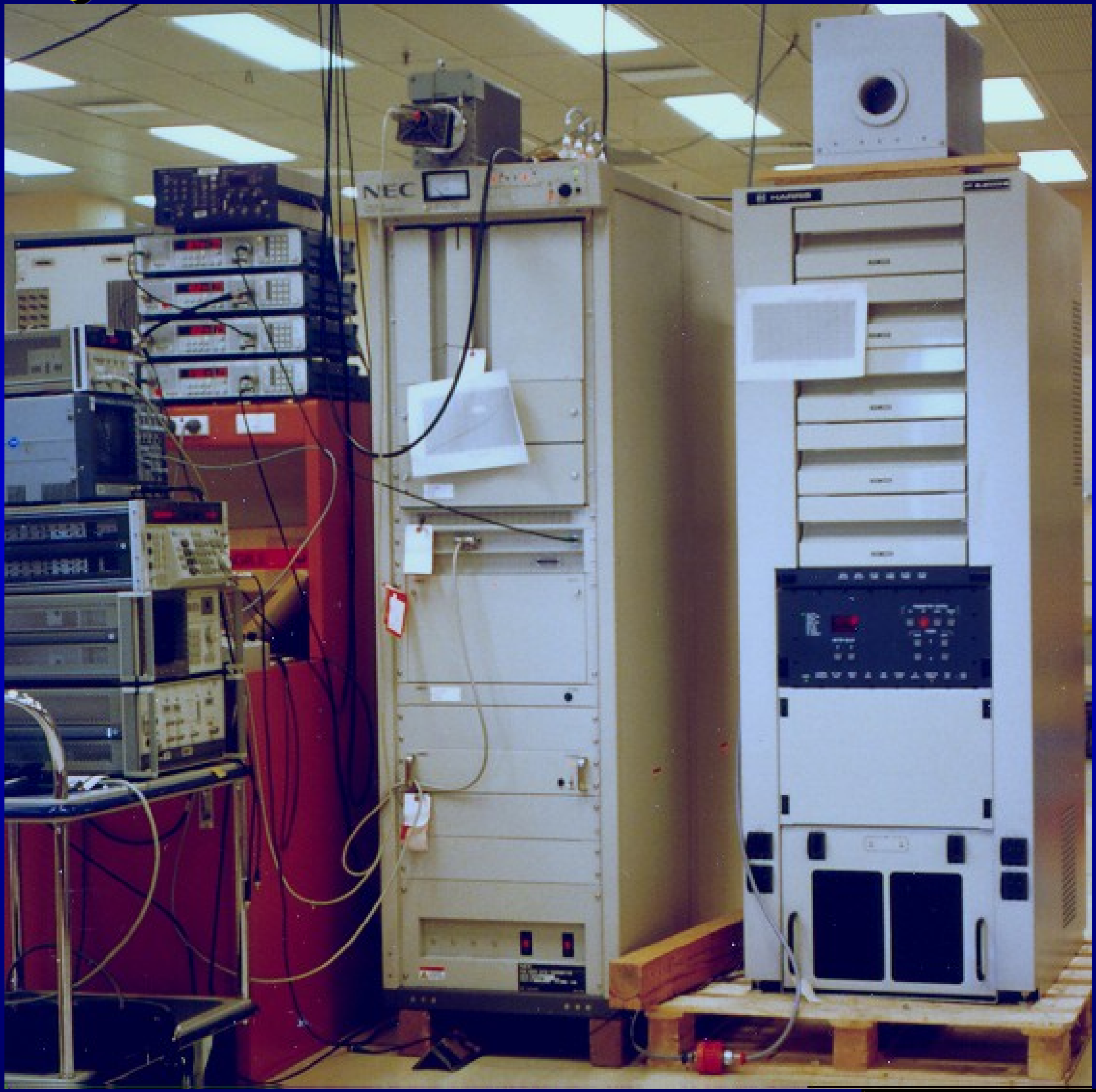
Echo Combiner

Power Meter

Digital CRO

Tx LO

Spectrum Analyser



Loads

Harris 1 kW Tx

Harris Exciter

NEC 200 W Tx

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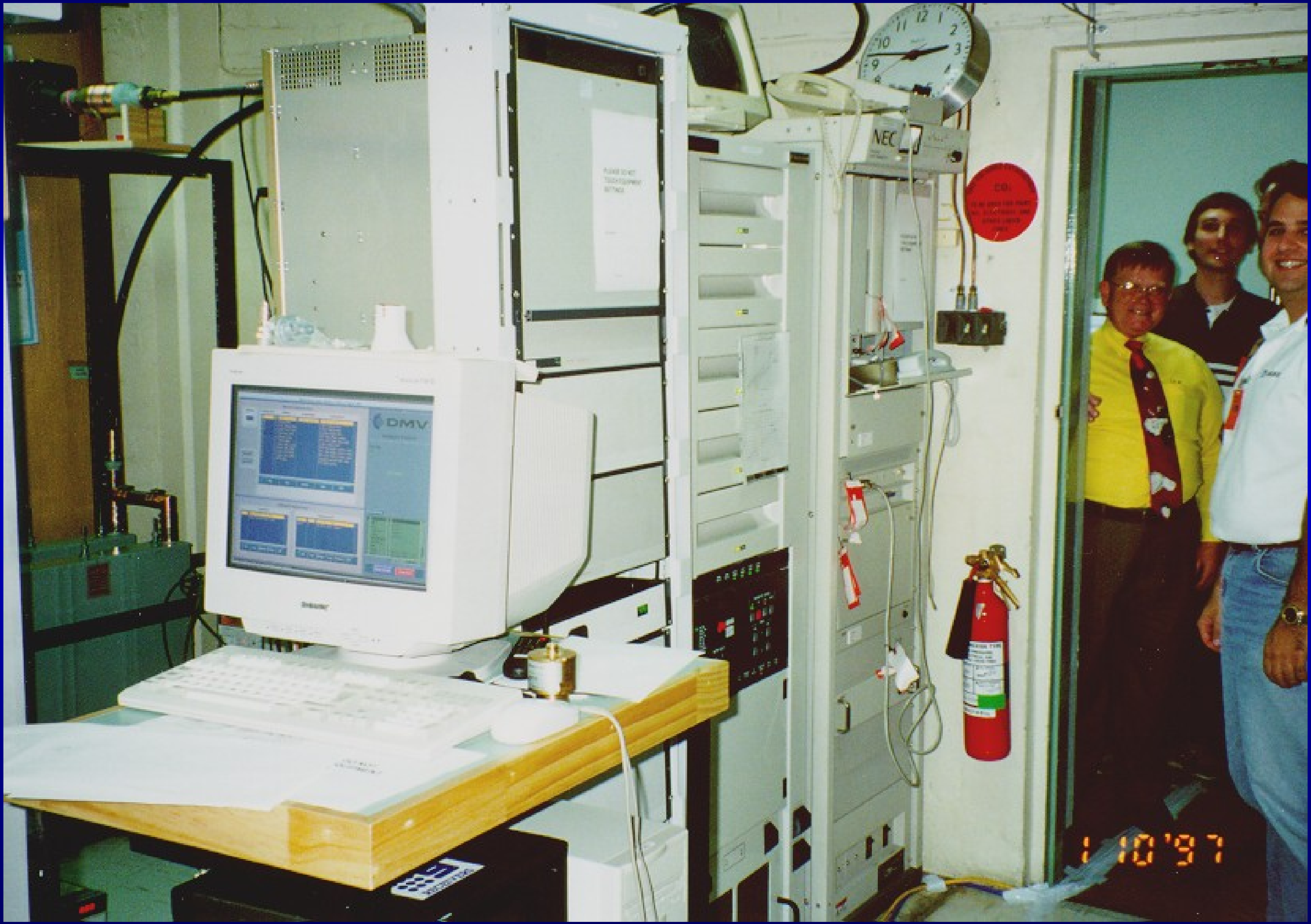
Digital Transmitters TCN-9 Sydney



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Lab Tests - VHF/UHF Transposer

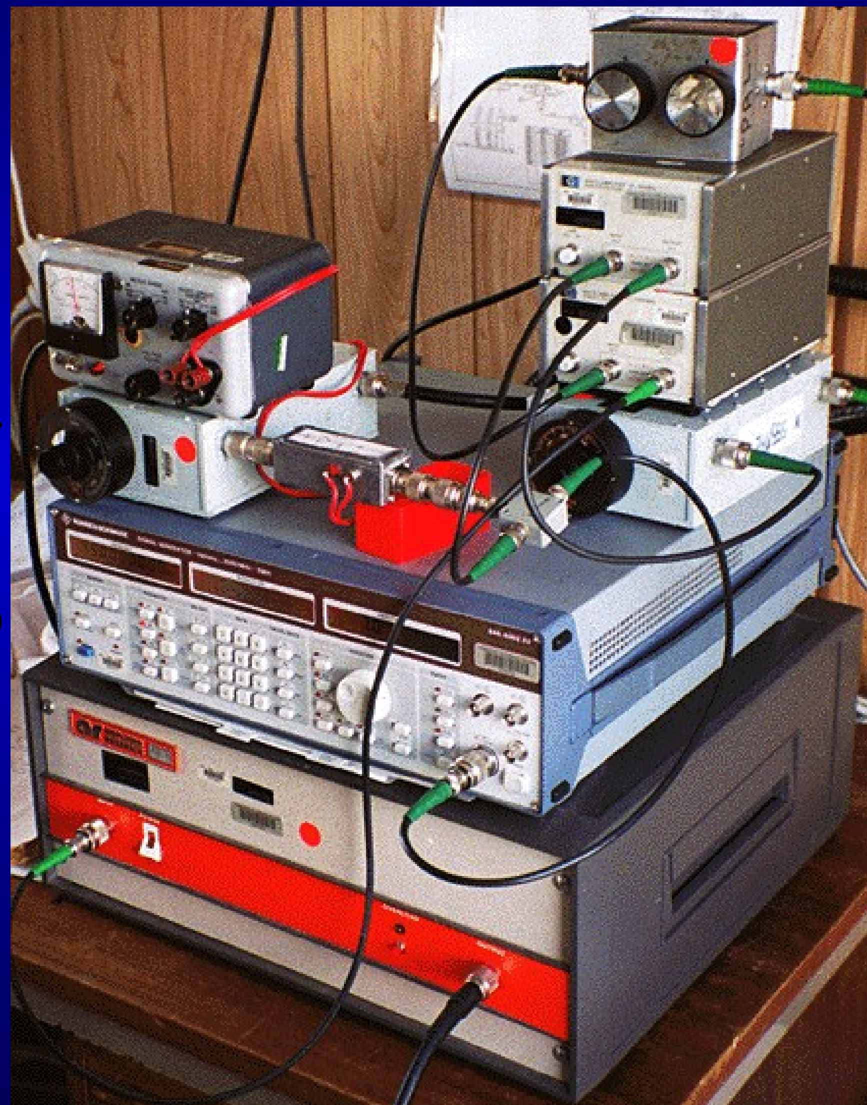
Power Supply

VHF Input Filter

RF Amp

RF LO

10 Watt UHF Amplifier



Level Adjust

UHF Amps

UHF BPF Filter

Mixer

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COFDM - Commercial Receiver

- News Data Systems - System 3000

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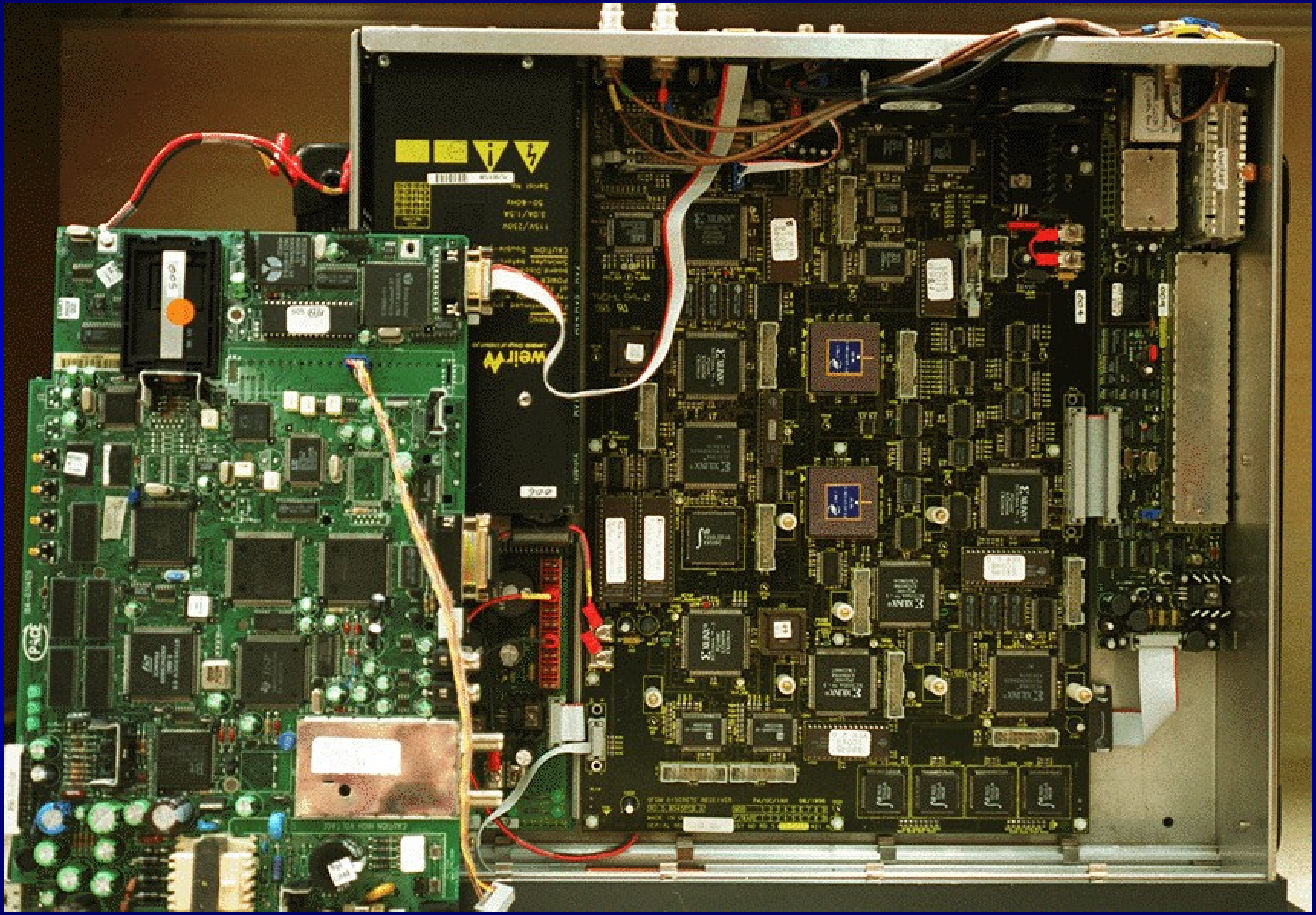
COFDM - Test Rx Hardware



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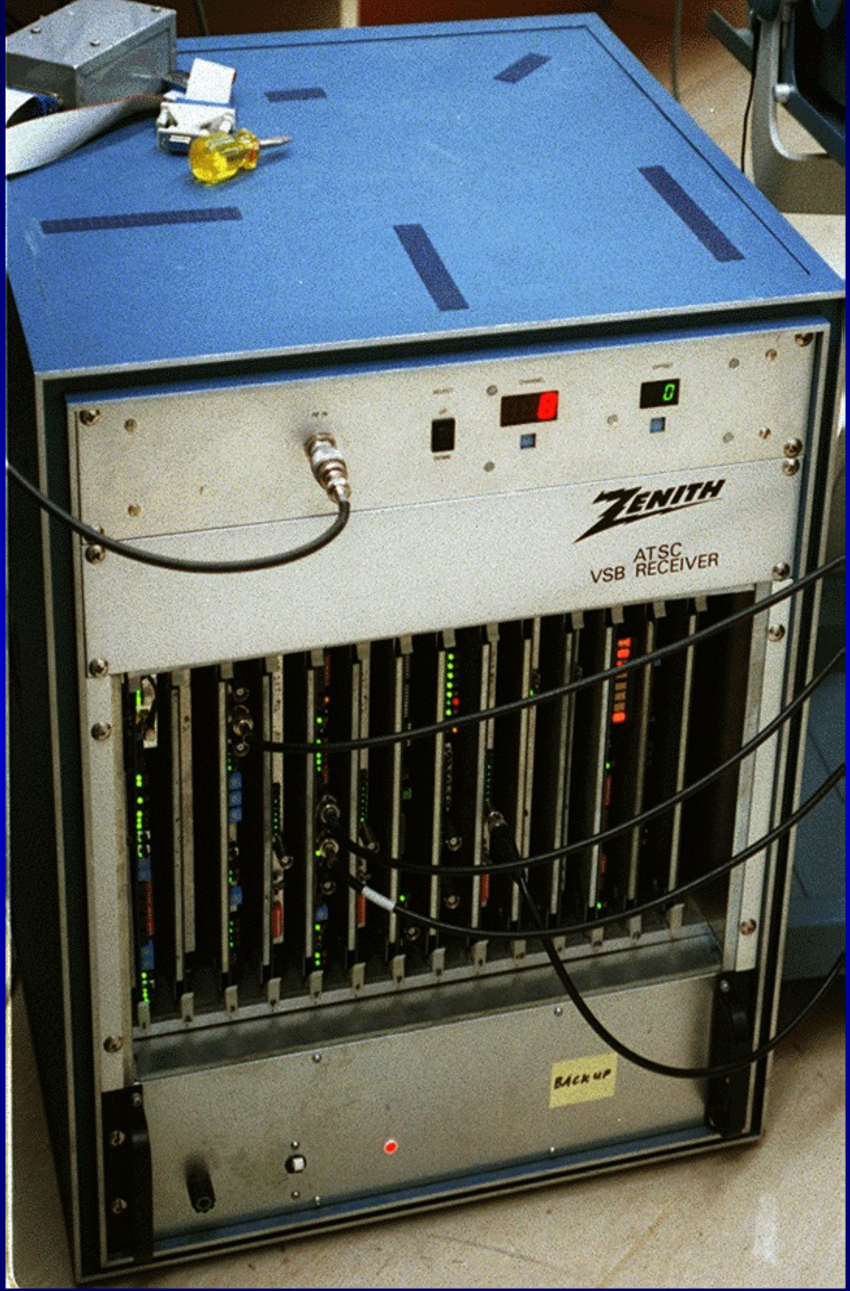

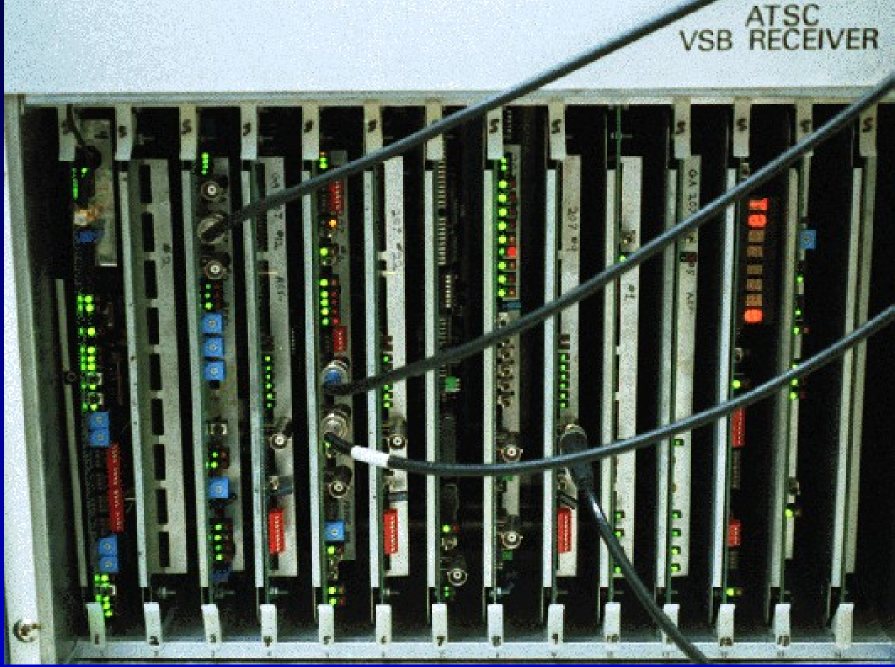

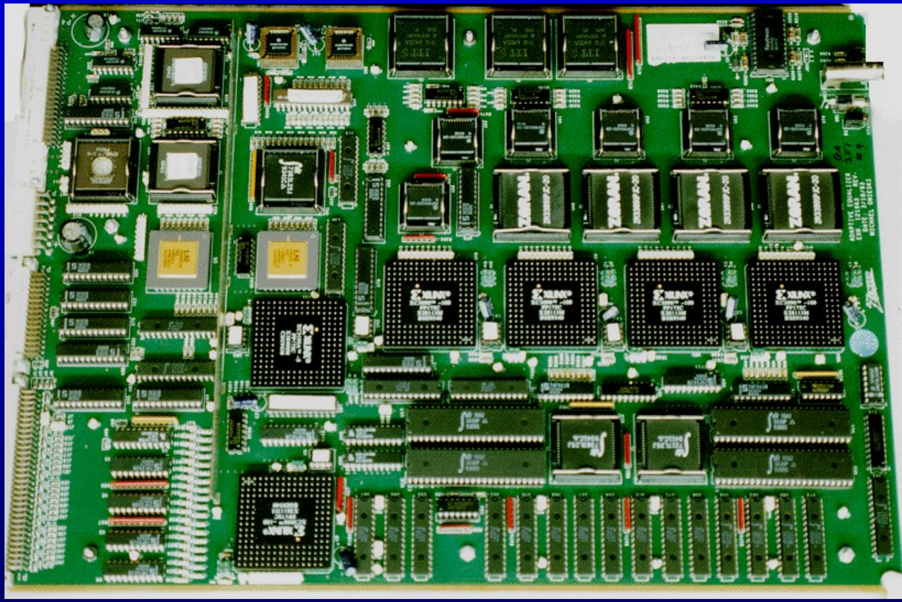

8-VSB - Test Receiver Hardware

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Main Results - Lab Tests

- C/N ATSC 4 dB better than DVB-T.
  This Advantage offset by Poor Noise Figure
- DVB-T is better than ATSC for Multipath
- ATSC is better than DVB-T for Impulse Noise
- ATSC cannot handle Flutter or Doppler Echoes
- ATSC is very sensitive to Transmission system impairments and IF translation
- DVB-T is better at handling Co-channel PAL
- DVB-T is better rejecting on channel interference (CW)

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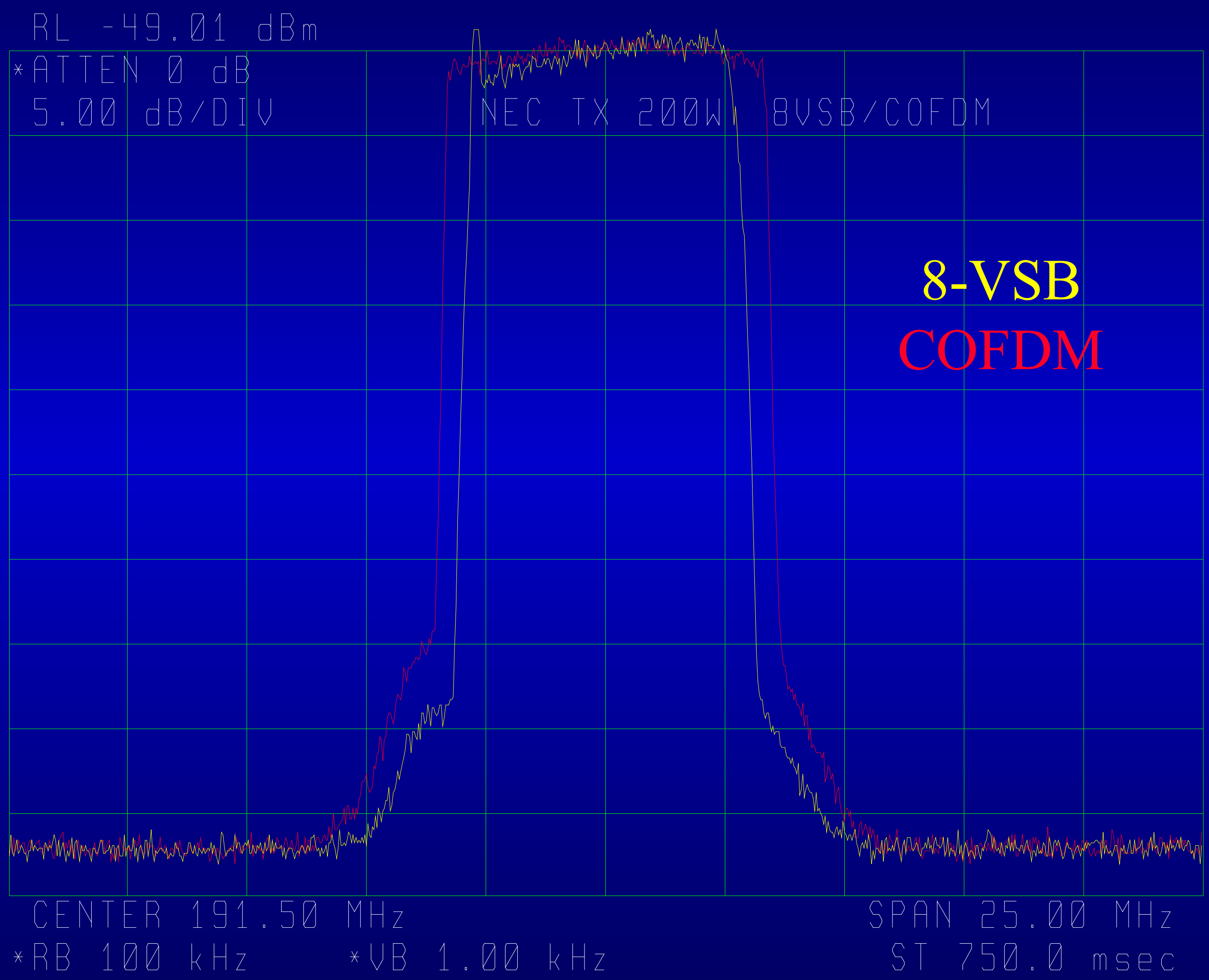
8-VSB & COFDM - Spectrum



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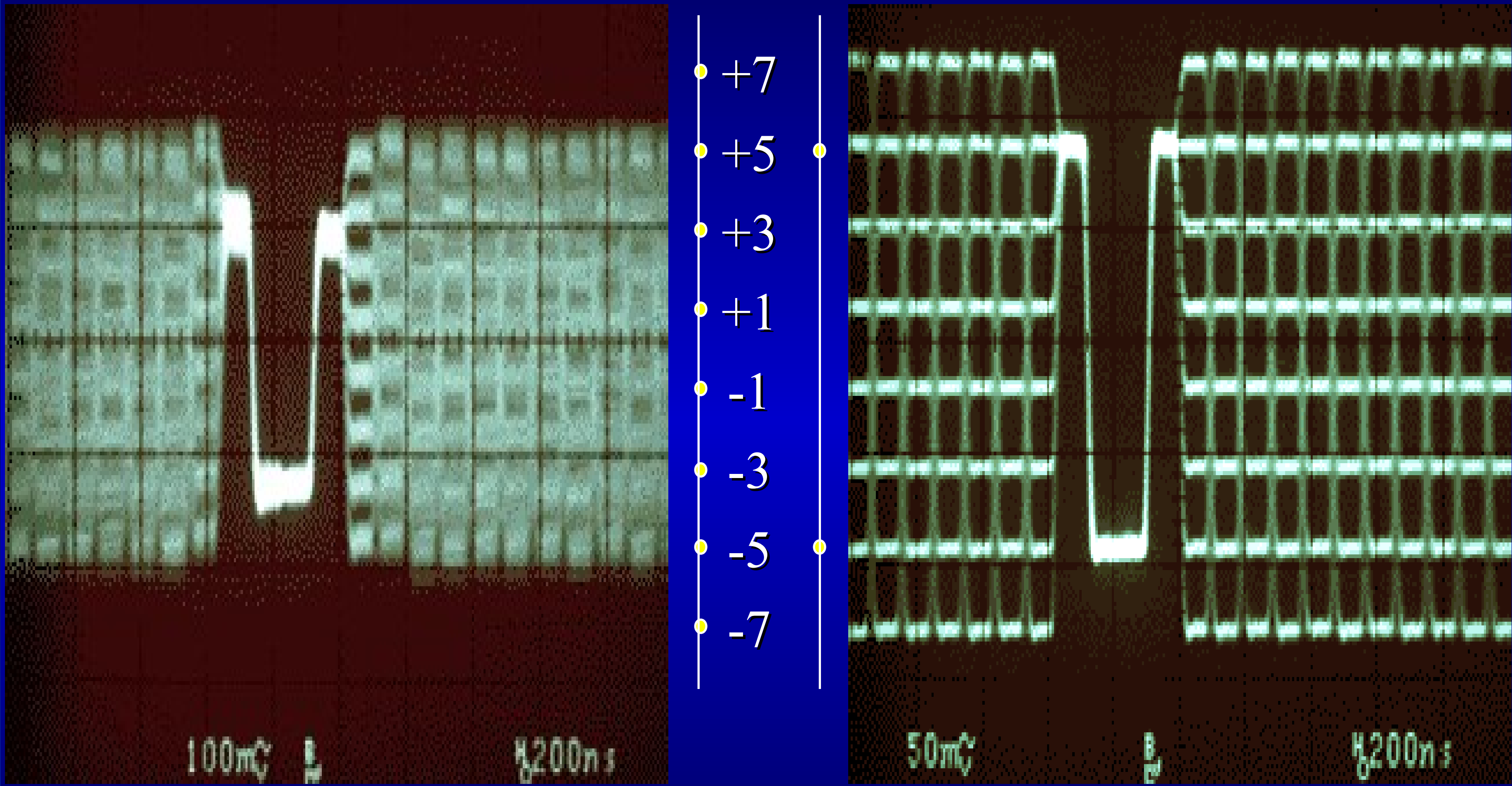
Digital Modulation - 8-AM



Before Equaliser   After Equaliser

8-VSB - Coaxial Direct Feed through Tuner on Channel 8 VHF

3 Bits/Symbol

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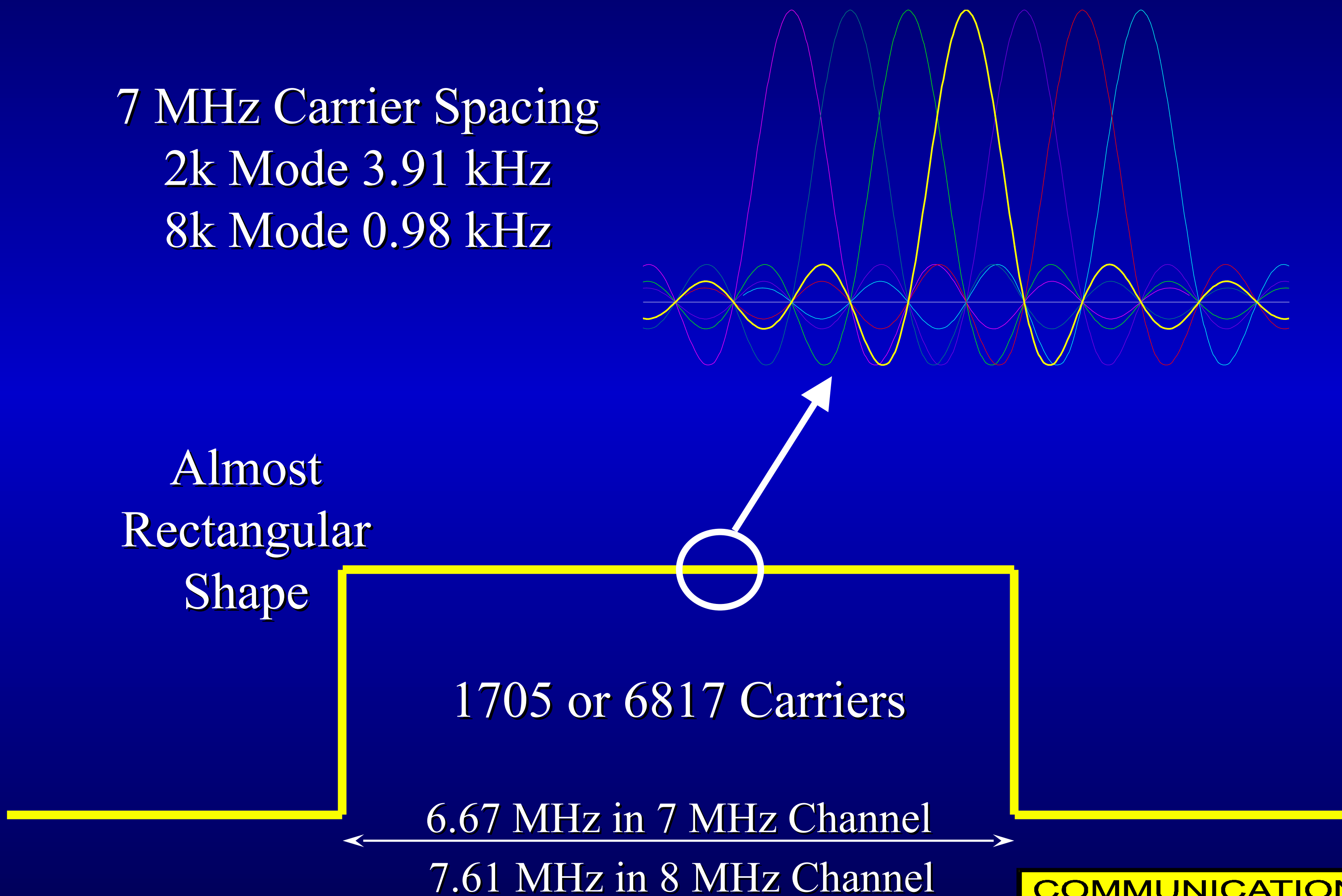
Spectrum of COFDM DTTB



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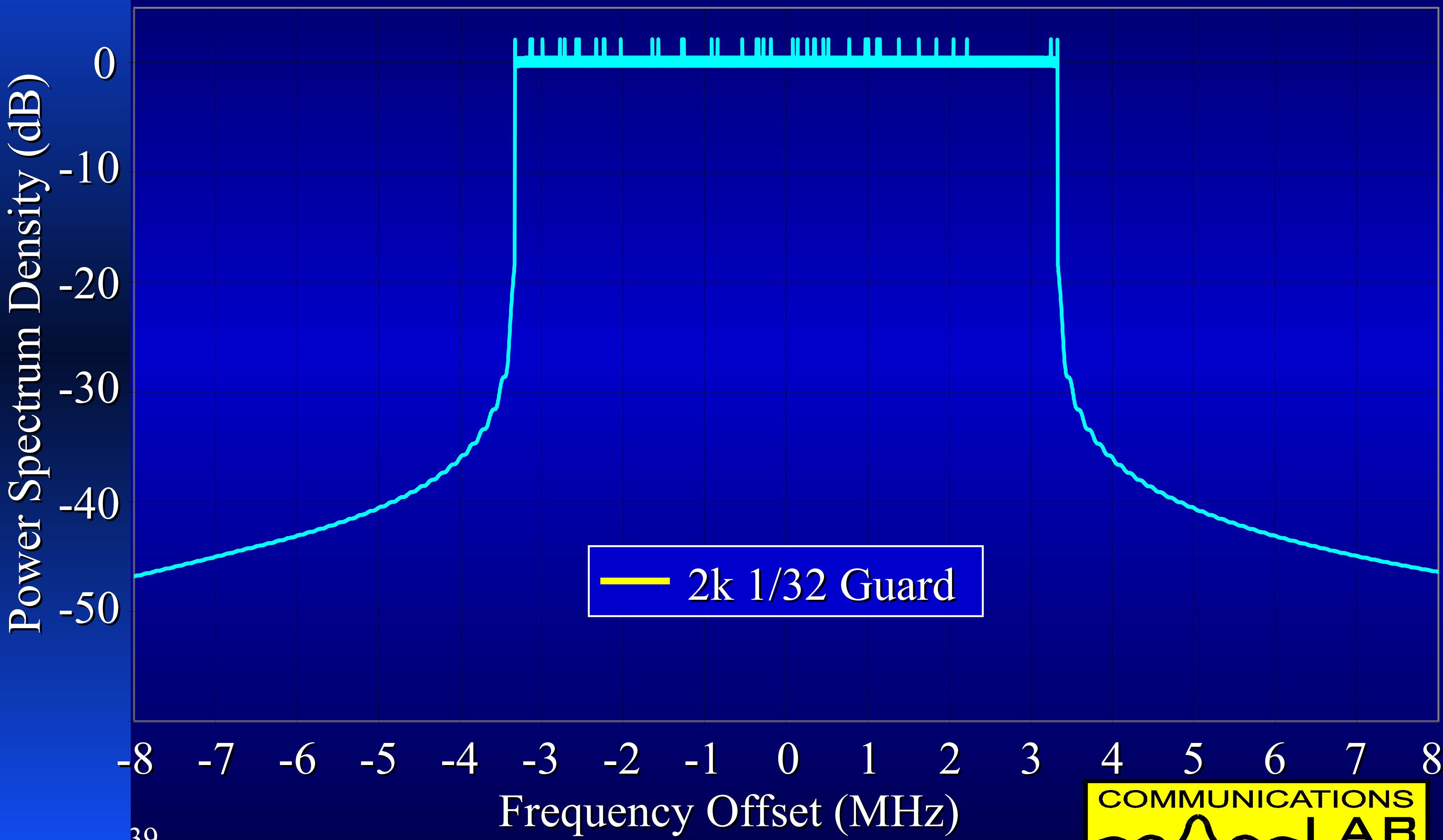
7 MHz COFDM Modulator Spectrum



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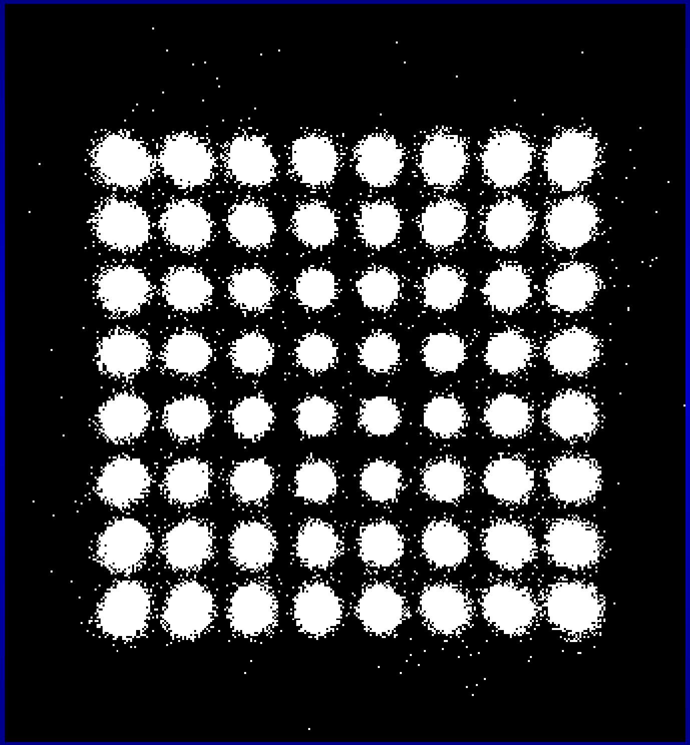
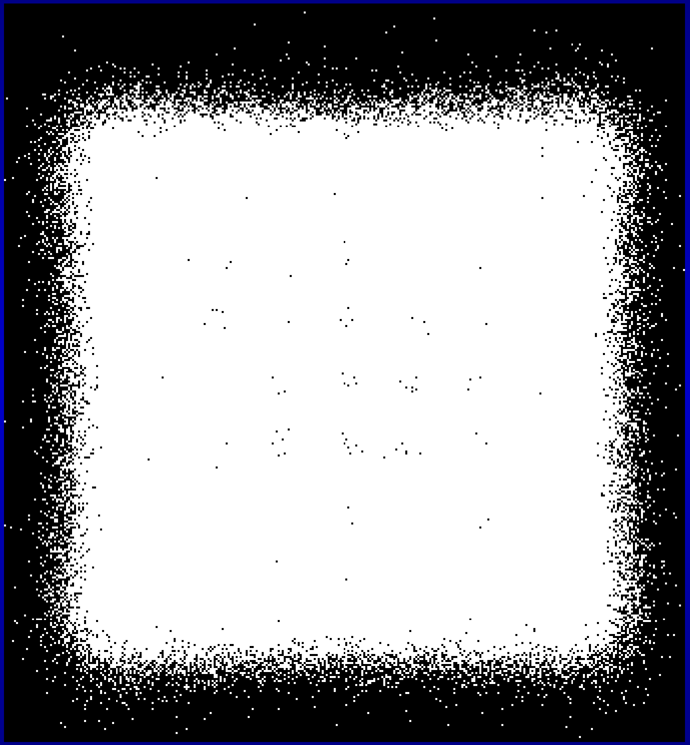
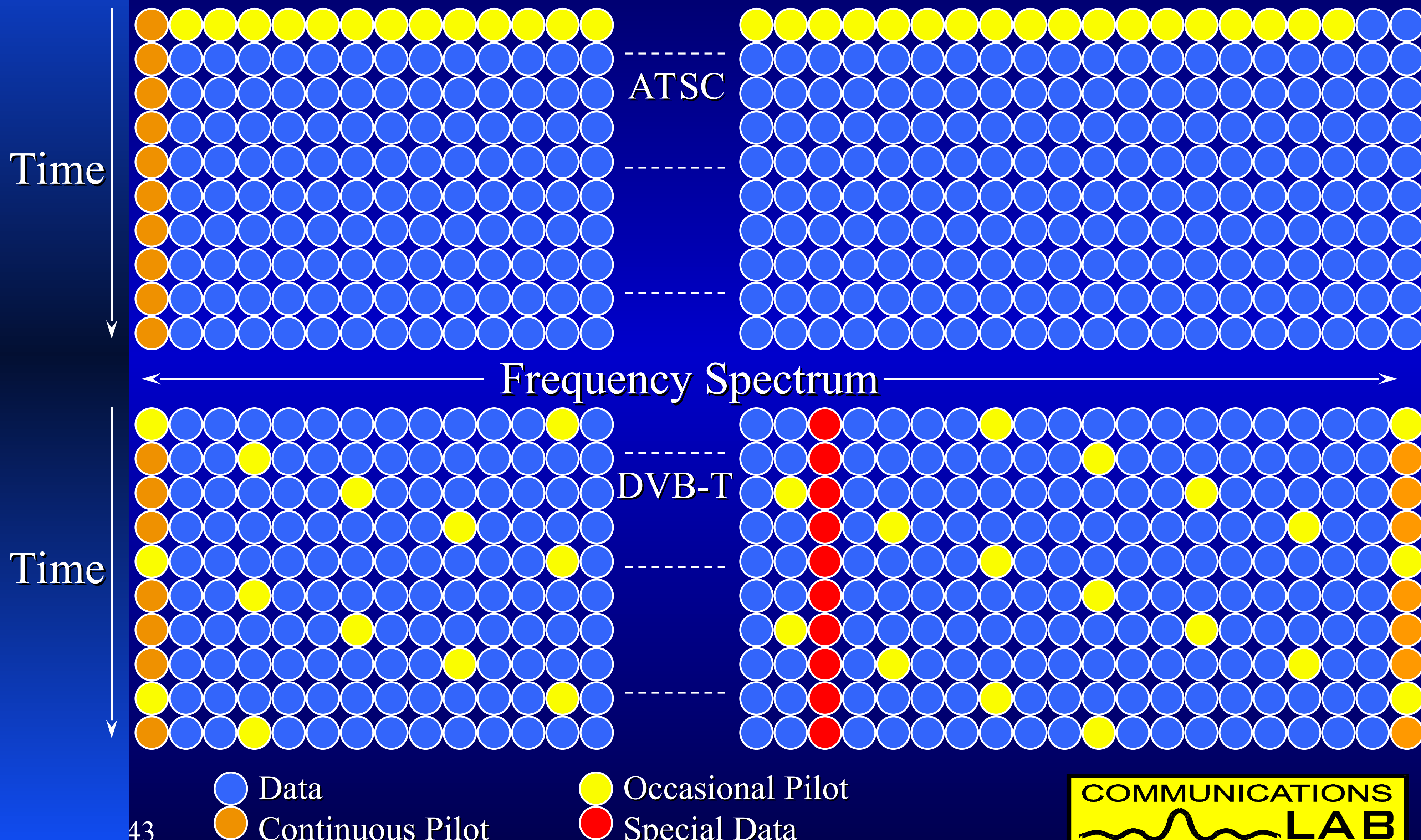
64-QAM - Perfect & Failure





Channel Estimation & Equalisation



General Parameters - Aust Tests

Parameter	DVB-T	ATSC
Data Payload	19.35 Mb/s	19.39 Mb/s
Carriers	1705	1
Symbol Time	256 us	93 ns
Time Interleaving	1 Symbol	4 ms
Reed Solomon code rate	188/204	187/207
IF Bandwidth (3 dB)	6.67 MHz	5.38 MHz

General Parameters

Parameter	DVB-T	ATSC
IF centre Frequency MHz	35.3 MHz	44.0
Receiver AFC range	11.5 kHz	359 kHz
Latency including MPEG coding SDTV 8 Mb/s	37 Frames	

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COFDM MOD TYPE	FEC Code Rate	Sys C/N (dB)	Min Sig Level (dBuV)	Calc Rx NF (dB)	Payload Bitrate Mb/s Guard 1/4 (Mb/s)	Guard 1/8 (Mb/s)	Guard 1/16 (Mb/s)	Guard 1/32 (Mb/s)
QPSK	1/2	5.4	11.7	4.8	4.35	4.84	5.12	5.28
QPSK	2/3	6.6	13.2	5.1	5.81	6.45	6.83	7.04
QPSK	3/4	7.6	14.8	5.7	6.53	7.26	7.68	7.92
QPSK	5/6	8.7	16.8	6.6	7.26	8.06	8.54	8.80
QPSK	7/8	9.5	19.2	8.2	7.62	8.47	8.96	9.24
16-QAM	1/2	11.2	17.7	5.0	8.71	9.68	10.25	10.56
16-QAM	2/3	13.0	19.6	5.1	11.61	12.90	13.66	14.07
16-QAM	3/4	14.1	20.9	5.3	13.06	14.51	15.37	15.83
16-QAM	5/6	15.5	22.9	5.9	14.51	16.13	17.08	17.59
16-QAM	7/8	16.3	24.9	7.1	15.24	16.93	17.93	18.47
64-QAM	1/2	16.8	23.3	5.0	13.06	14.51	15.37	15.83
64-QAM	2/3	19.1	25.2	4.6	17.42	19.35	20.49	21.11
64-QAM	3/4	20.6	27.5	5.4	19.59	21.77	23.05	23.75
64-QAM	5/6	22.2	30.0	6.3	21.77	24.19	25.61	26.39
64-QAM	7/8	23.7	32.4	7.2	22.86	25.40	26.89	27.71
8-VSB	2/3	15.1	27.2	11.2	-	-	-	19.39

Blue Payload Figures are 188/204 scaled from actual measurement

Red Figures are calculated from the 1/32 Guard interval data

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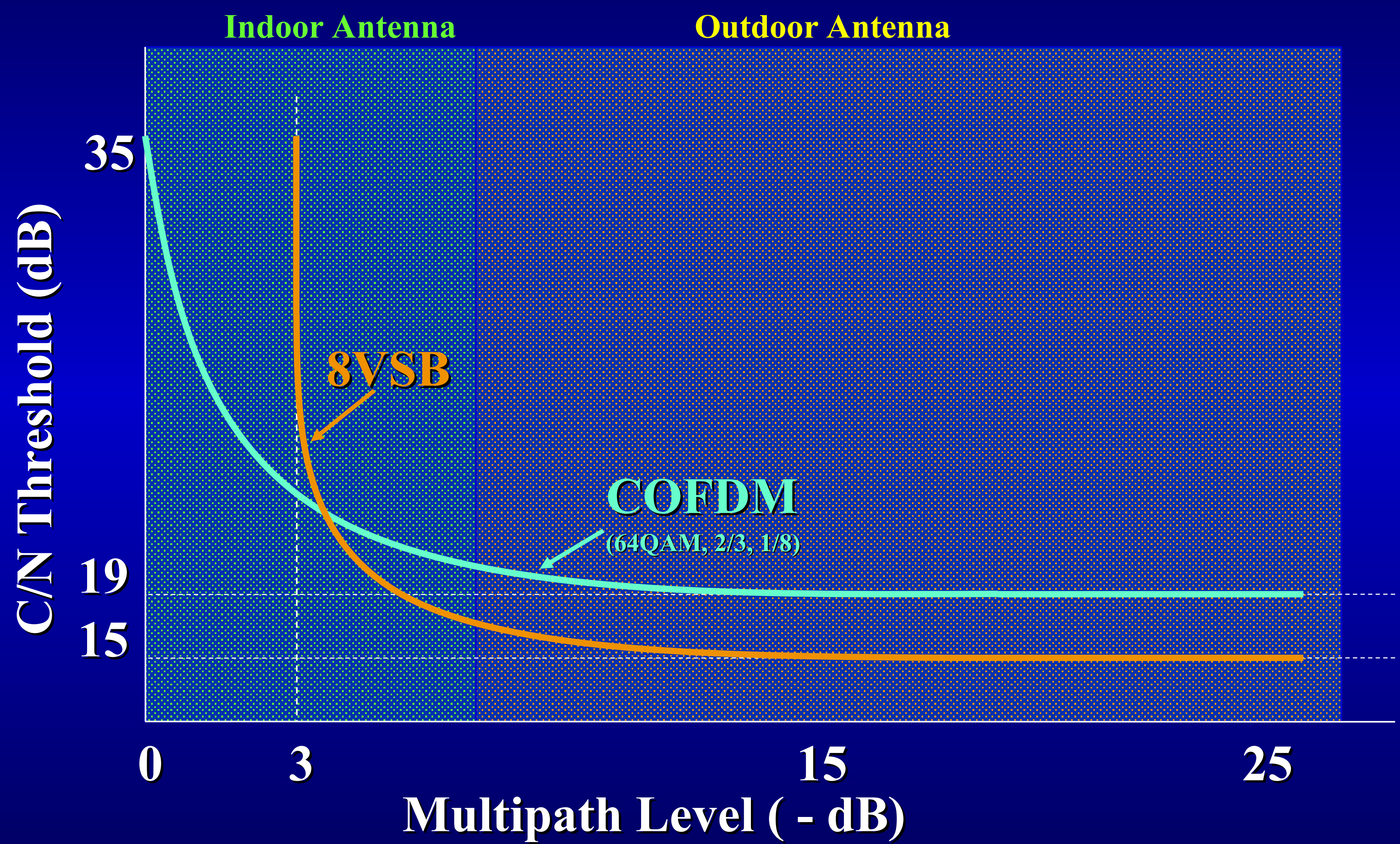
AWGN Receiver Performance

Parameter	DVB-T	ATSC
Carrier to Noise Threshold (in native system BW)	19.1 dB	15.1 dB
Simulated Theoretical C/N for optimum system	16.5 dB	14.9 dB
Minimum Signal Level	25.2 dBuV	27.2 dBuV
Receiver noise figure	4.6 dB	11.2 dB
Rx Level for 1 dB C/N Loss	34 dBuV	35 dBuV

Receiver Parameters

- Guard interval
  - Affects payload data rate and echo performance
  - No impact on general receiver parameters such as C/N & Signal level.
- COFDM Transmission Parameter Signalling (TPS) - receiver automatically determines the modulation type, FEC & Guard Interval

DTTB System Multipath Character



(Conditions: Static multipath, Equal Rx NF,
No Co-channel or impulse interference)

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AWGN Performance

- C/N 4 dB more power required for DVB-T to achieve the same coverage as ATSC.
- Better C/N performance ATSC offset by poor receiver noise figure
- ATSC C/N is very close to the theoretical DVB-T implementation is still over 2.5 dB higher than the simulated margin.
- Other DVB-T modes have different C/N Thresholds and Data Rates

Multipath & Flutter Measurements

Parameter	DVB-T	ATSC
7.2 us Coax pre ghost	0 dB	-13.5 dB
7.2 us Coax post ghost	0 dB	-2.2 dB
Echo correction range	32 us	+3 to -20 us
Doppler single echo performance (-3 dB echoes)	140 Hz	1 Hz

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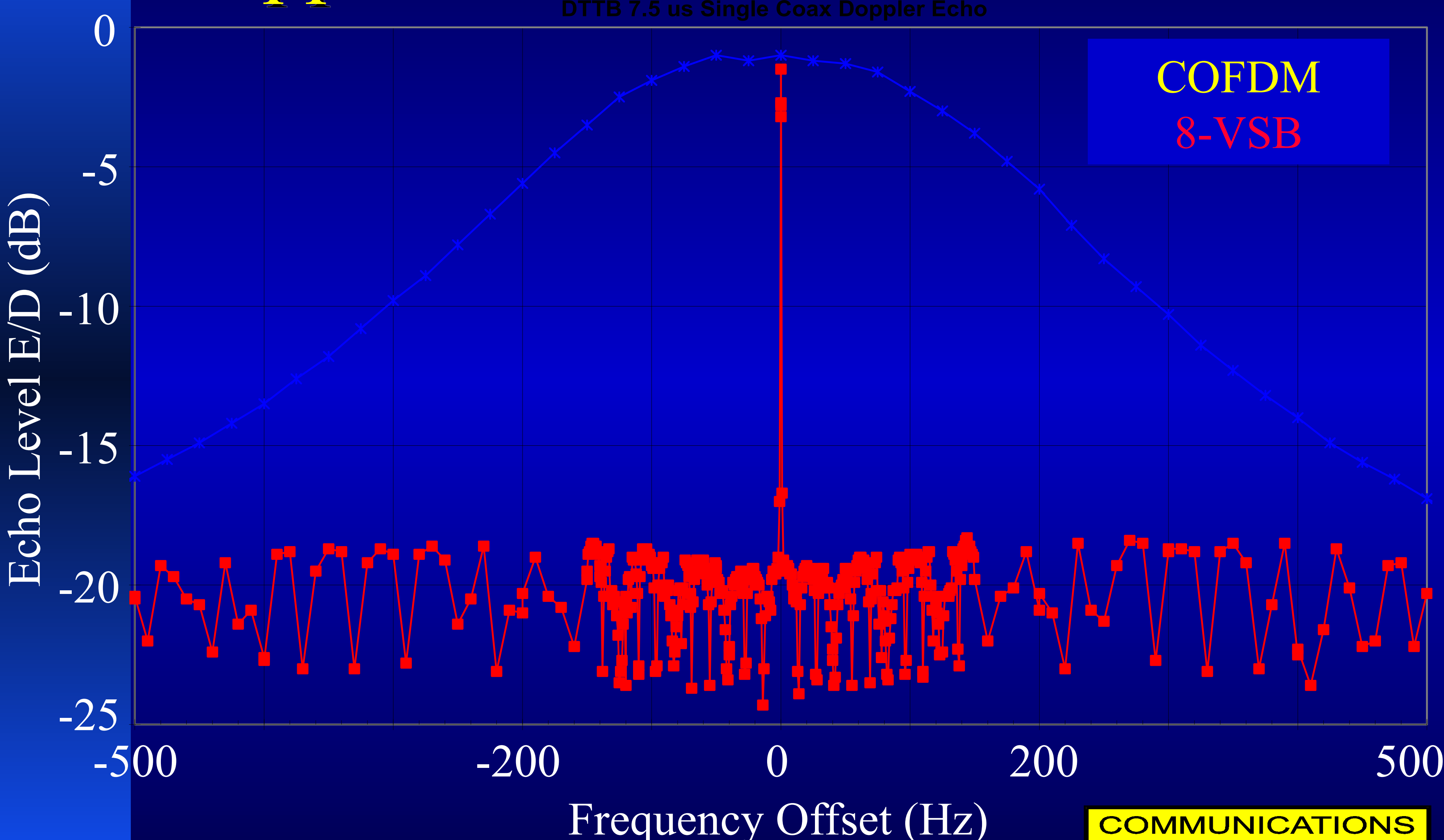
Doppler Echo - 7.5 us Coax



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Multipath & Flutter - Overview

- ATSC system 2 Equaliser modes
  - Rx Eq switches to fast mode when short variable echoes are detected.
  - Lab Tests - slow equalisation mode.
- 8 VSB degrades more rapidly when multipath echo exceeds -7 dB
- COFDM works up to 0 dB in a white noise environment but in this condition is very fragile.

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Transmitter Performance Sensitivity

Parameter	DVB-T	ATSC
Transmitter/Translator Linearity & Inter-mod Sensitivity	Low	High
Group Delay / Combiner / Filter Sensitivity	Low	< 50 ns

Transmission Strategies - 1

Suggested Transmission System performance maintenance strategy

- DVB-T - Manual Maintenance and static pre-correction - same as PAL
- ATSC - Automatic Dynamic pre-corrector Measures performance and makes pre-correction adjustments on-line

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Transmission Strategies - 2

Gap Fill coverage - System Strategy

- DVB-T -
  - IF Translator
  - Non Regenerative On Channel Repeater (OCR)
  - Digital Repeater
  - Single Frequency Network
- ATSC -
  - Digital Repeater
  - Non Regenerative OCR (Low Signal Environs)

Transmission Performance - 1

- ATSC very sensitive to transmission impairments as it uses up correction capacity in the receiver equaliser.
- ATSC equaliser has to correct the response characteristic of the whole channel.
- DVB-T equaliser uses pilot carriers spread throughout the spectrum to equalise the channel in small 16-50 kHz sections.

Transmission Performance - 2

- ATSC Dynamic Pre-corrector will be difficult to apply in the combined antenna systems used in Australia
- Zenith suggest transmission without using a transmitter output filter to avoid group delay problems with 8-VSB.
- ATSC 6 MHz system operating in a 7 MHz channel helps this situation.

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Impulse Noise - Results

- Impulse Sensitivity (Differential to PAL grade 4)
  - **DVB-T** 9 -14 dB
  - **ATSC** 17-25 dB
- Difficult to measure & characterise.
- Mainly affects the lower VHF frequencies
- ATSC is 8 to 11 dB better at handling impulsive noise than DVB-T

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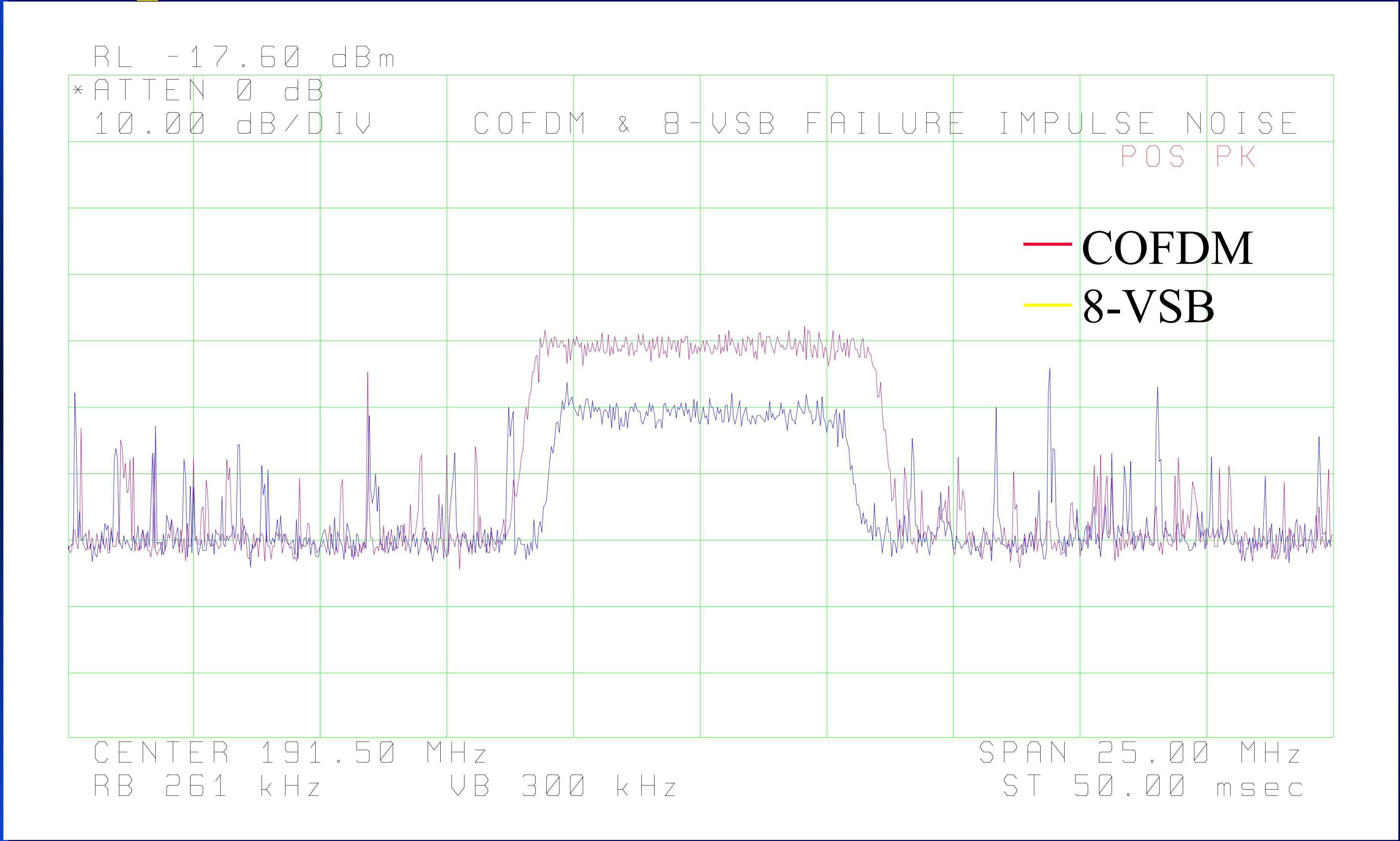
Impulse Noise - Plot



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Impulse Noise - Overview

- ATSC only has a few data symbols affected by any normal impulsive phenomenon
- The DVB-T COFDM demodulation (FFT) spreads the energy from a broad spectrum impulse across all carriers leading to massive data loss when the impulse is large enough.

DTTB into PAL - Subjective

Grade

3

4

-9.5
35.8
-10.6
-5.3
41.1
-6.4
3.5
50.4
5.1

3

4

-7.0
38.7
-7.1
-0.9
45.5
-0.3
5.0
51.4
5.4

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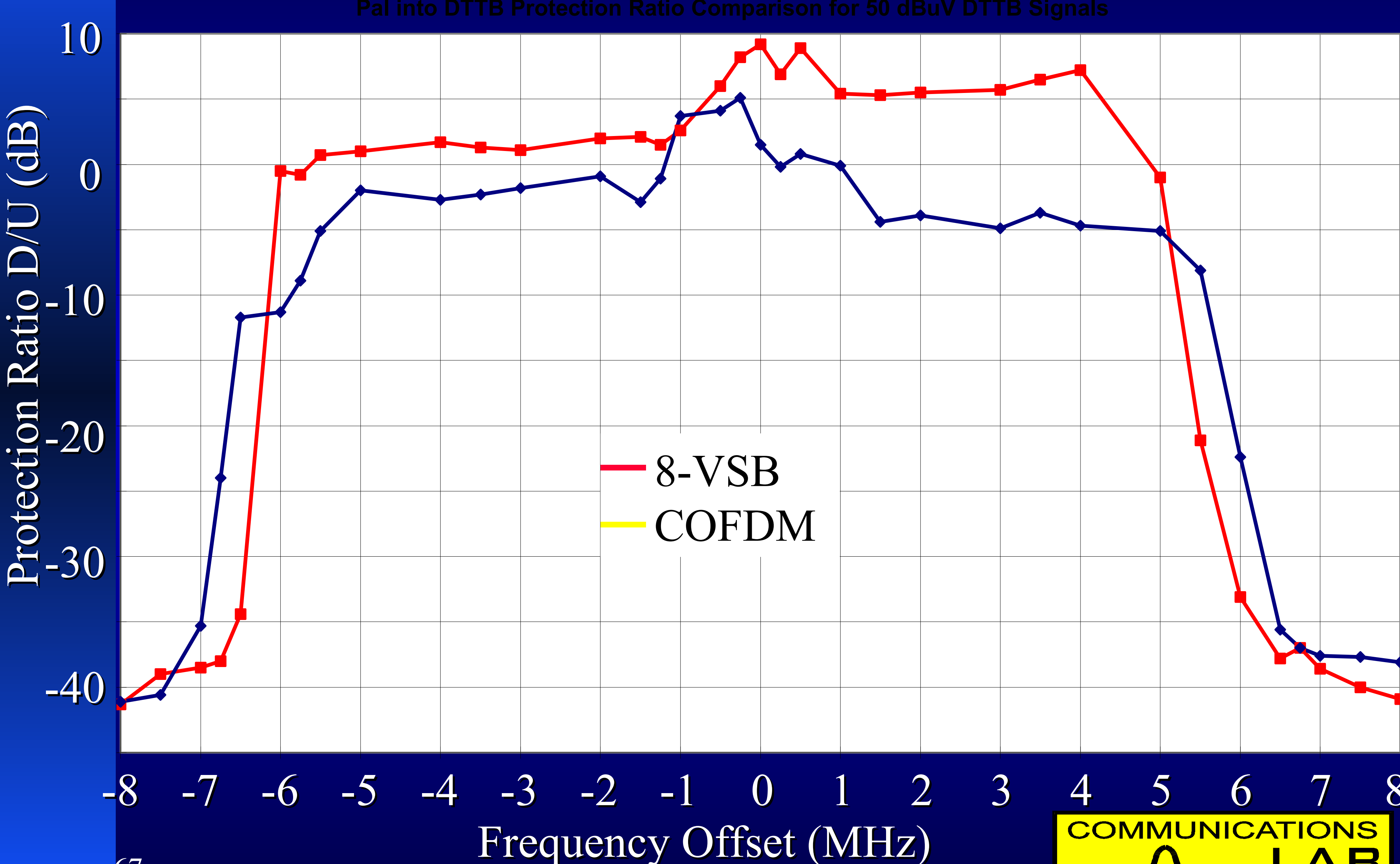
DTTB into PAL - Overview

- DVB-T marginally less interference to PAL
- DTTB Co channel signals need to be kept at least 46 dB on average below the Wanted PAL level to ensure Grade 4 reception
- DTTB Adjacent channel signals need to be kept on average at or below the Wanted PAL level to ensure Grade 4 reception

PAL into DTTB - Results

DVB-T-7	COFDM 64-QAM	2/3	-35.4	1.4	-37.5
ATSC-6	8-VSB 8-AM	2/3	-38.6	9.1	-38.7

PAL into DTTB - Protection Plot



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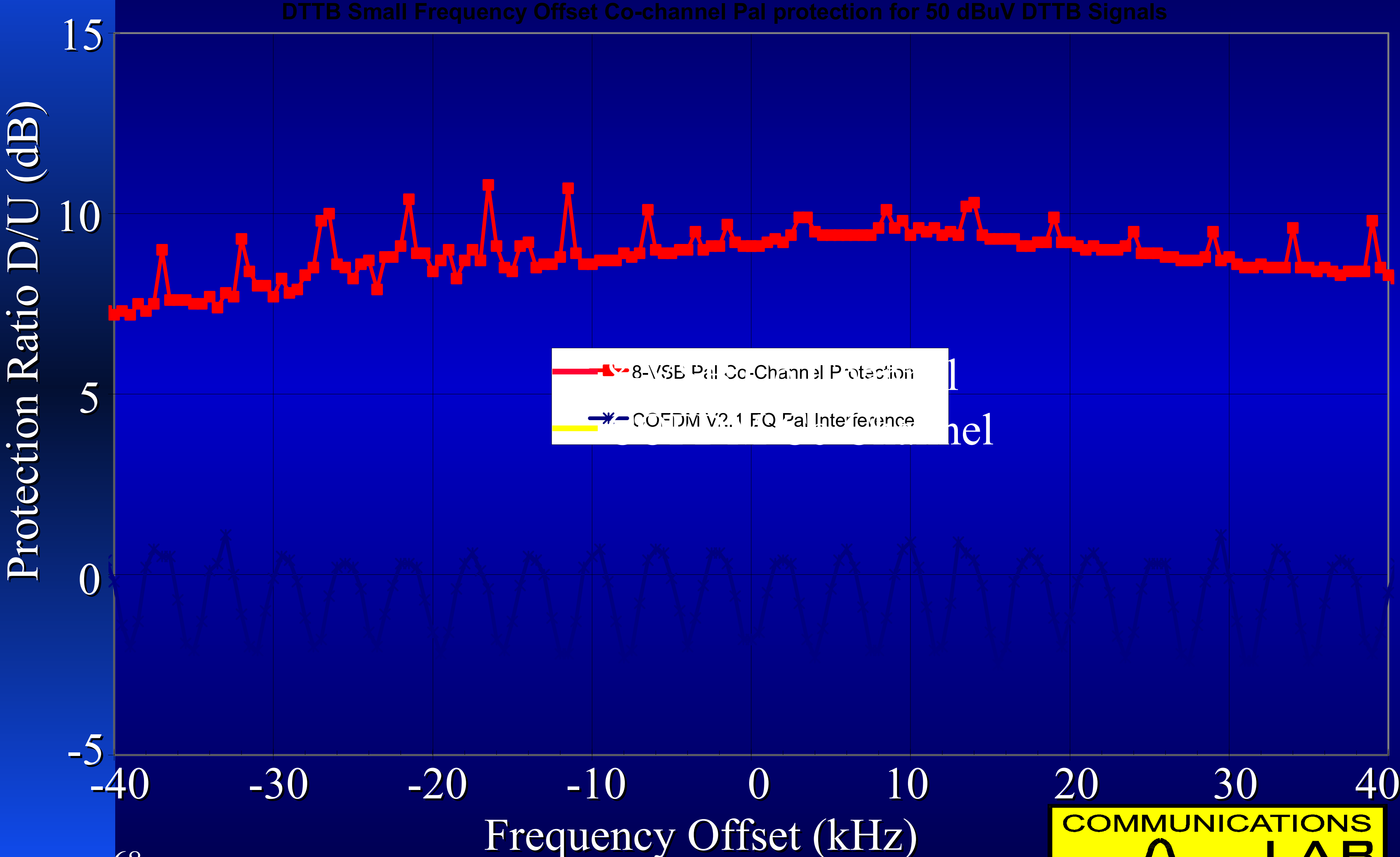
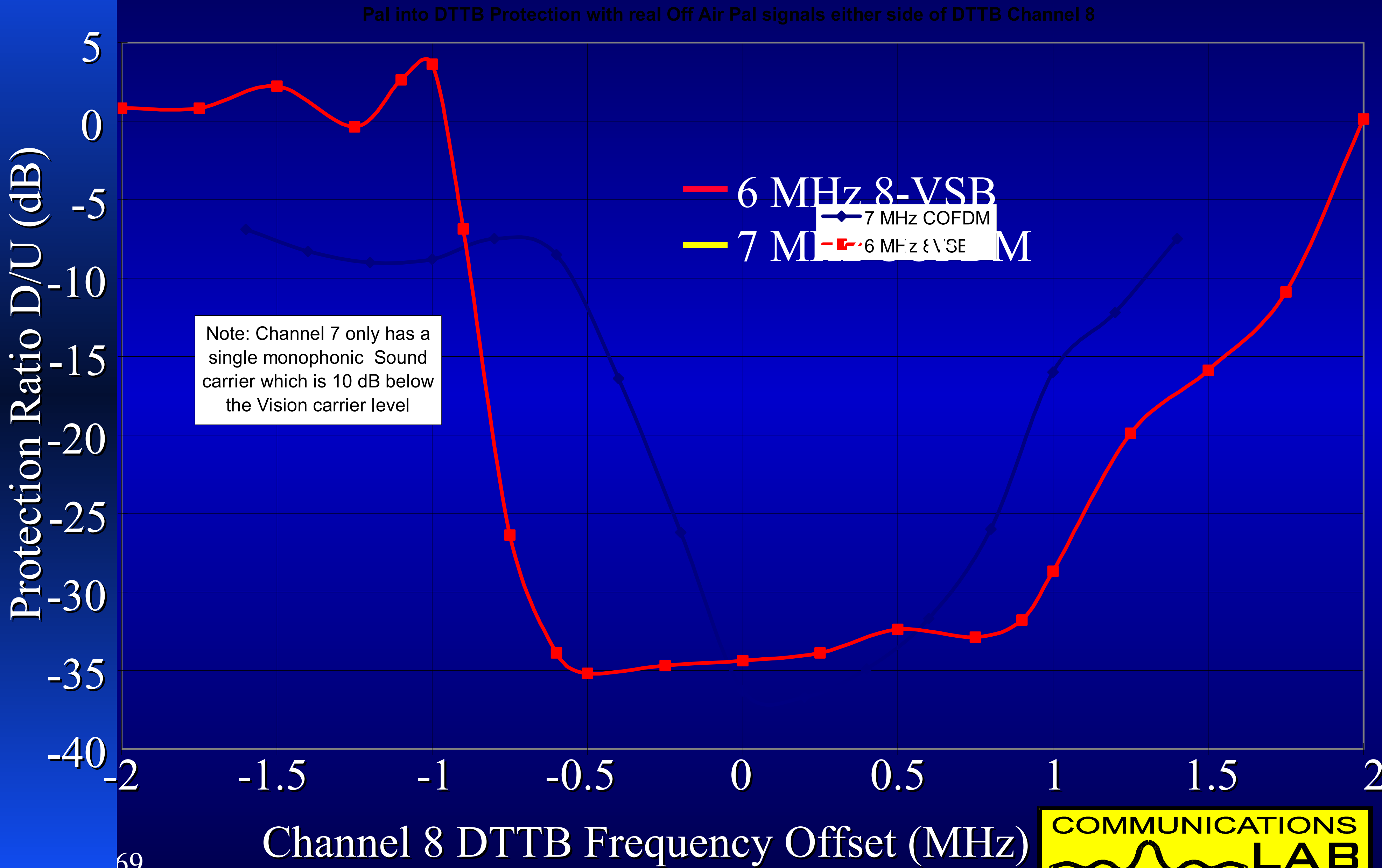
Co Channel PAL into DTTB - Plot



Off Air PAL into DTTB - Plot



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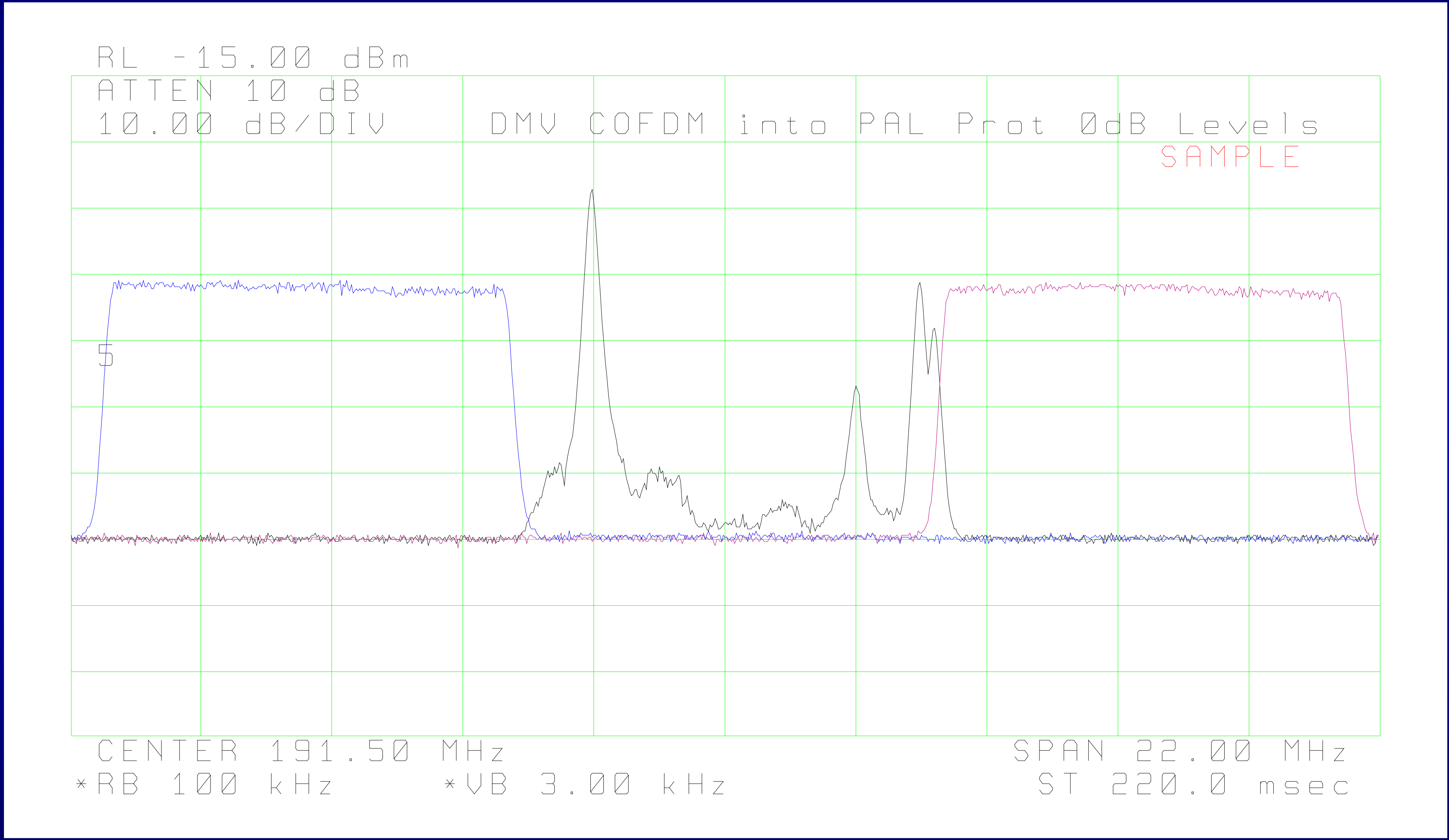
DTTB & PAL in Adjacent Channels



0 dB Relative Levels - PAL/DTTB

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PAL into DTTB - Overview 1

- The narrower ATSC system achieves very similar out of band / adjacent channel performance to DVB-T.
- ATSC is nearly 8 dB worse than DVB-T when subjected to interference from Co-Channel PAL transmissions

PAL into DTTB - Overview 2

- In situations where Co-Channel DTTB and PAL signals exist the DTTB into PAL interference will be the dominant factor, providing directional antennas are used.
- If a DTTB frequency offset was being considered for use, the data indicates that moving up in frequency is preferable to moving down.

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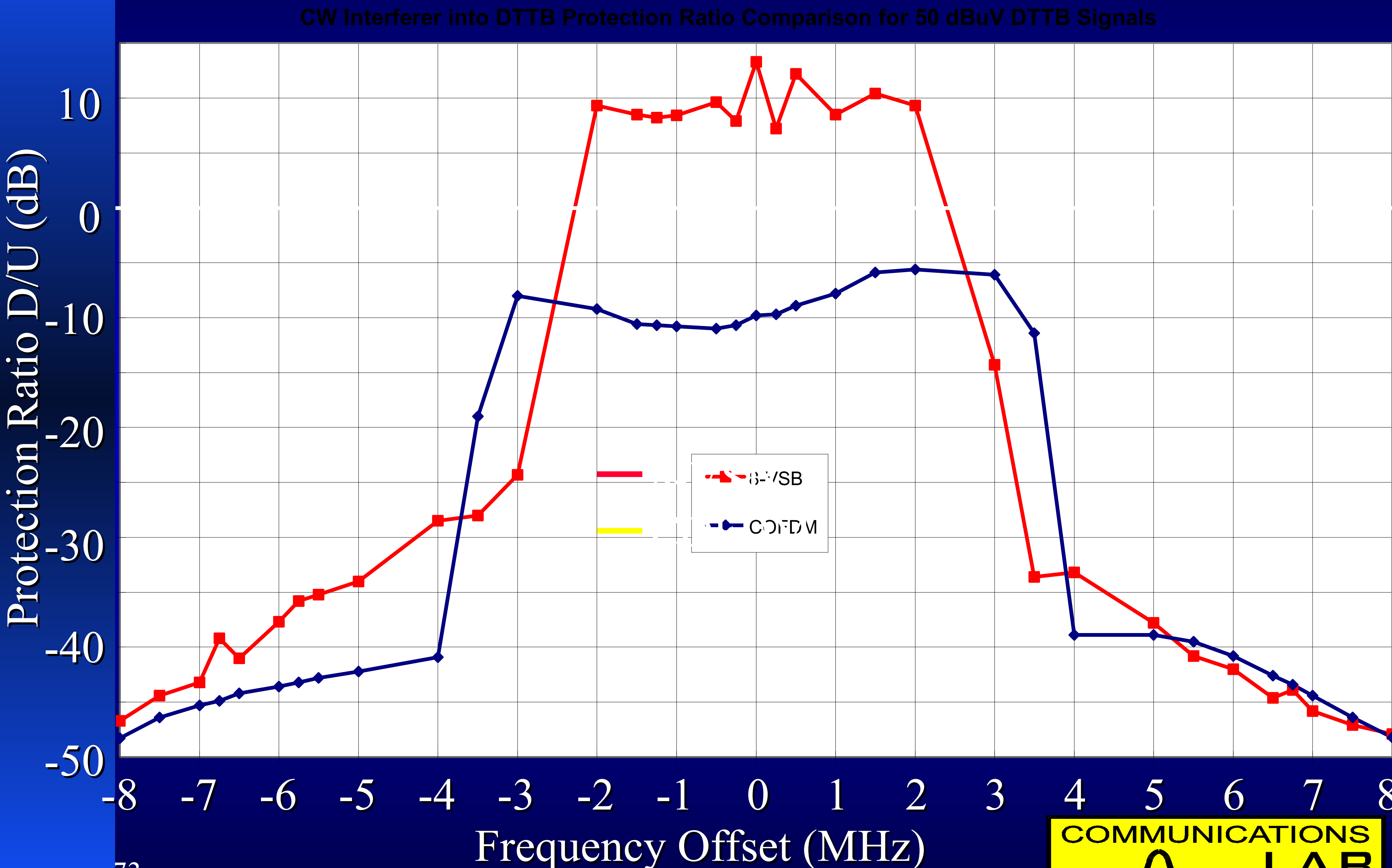
CW into DTTB - Protection Plot



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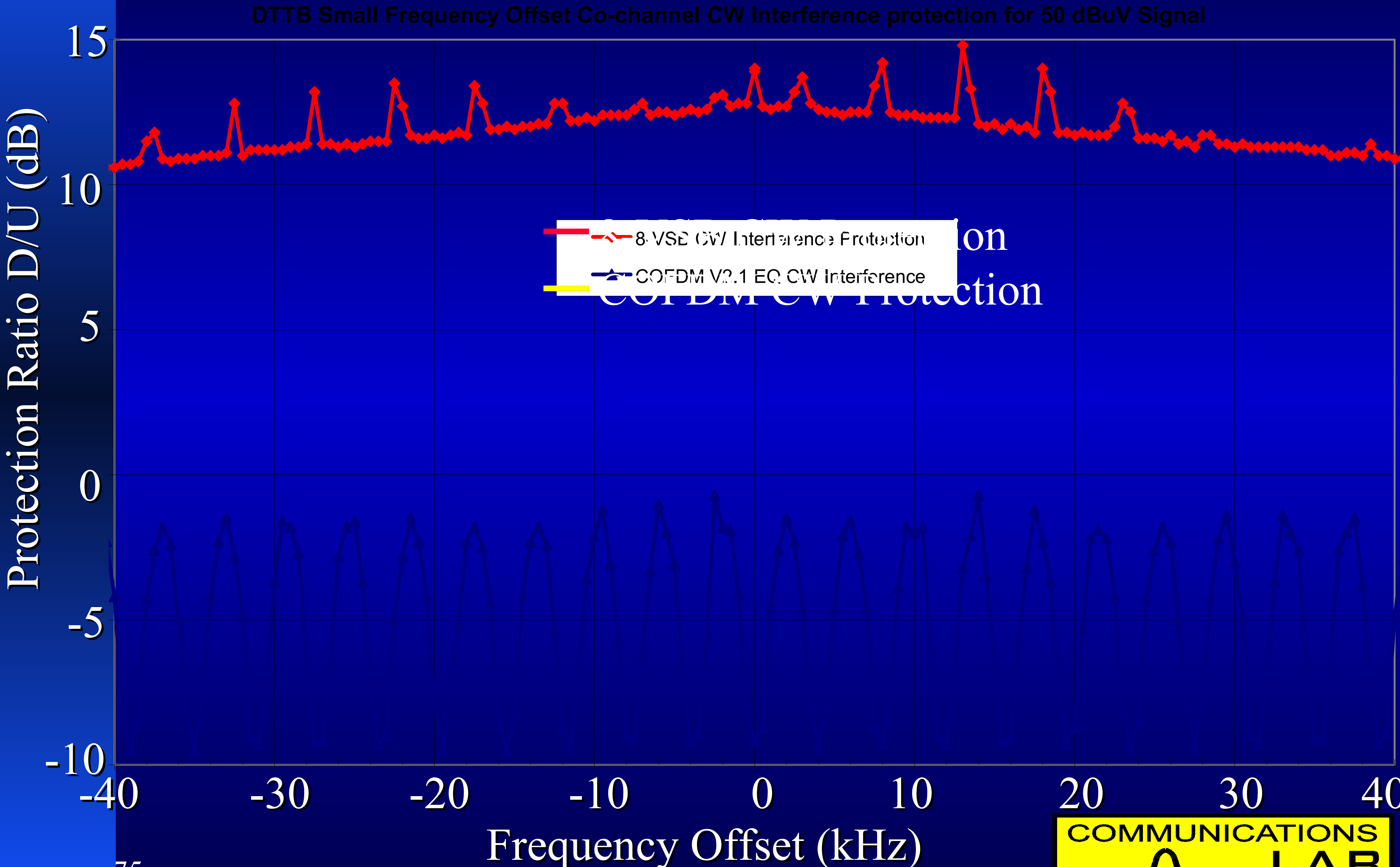
CW into DTTB - Summary

- DVB-T is on average 15.5 dB less sensitive across the channel to general CW type interferers than ATSC
- The DVB-T orthogonal carrier spacing is evident for DVB-T in this measurement with a variation of over 8 dB. If known CW interferers are likely then a frequency offset of less than 4 kHz may assist system performance.

CW into DTTB centre channel



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CW into DTTB - Comment

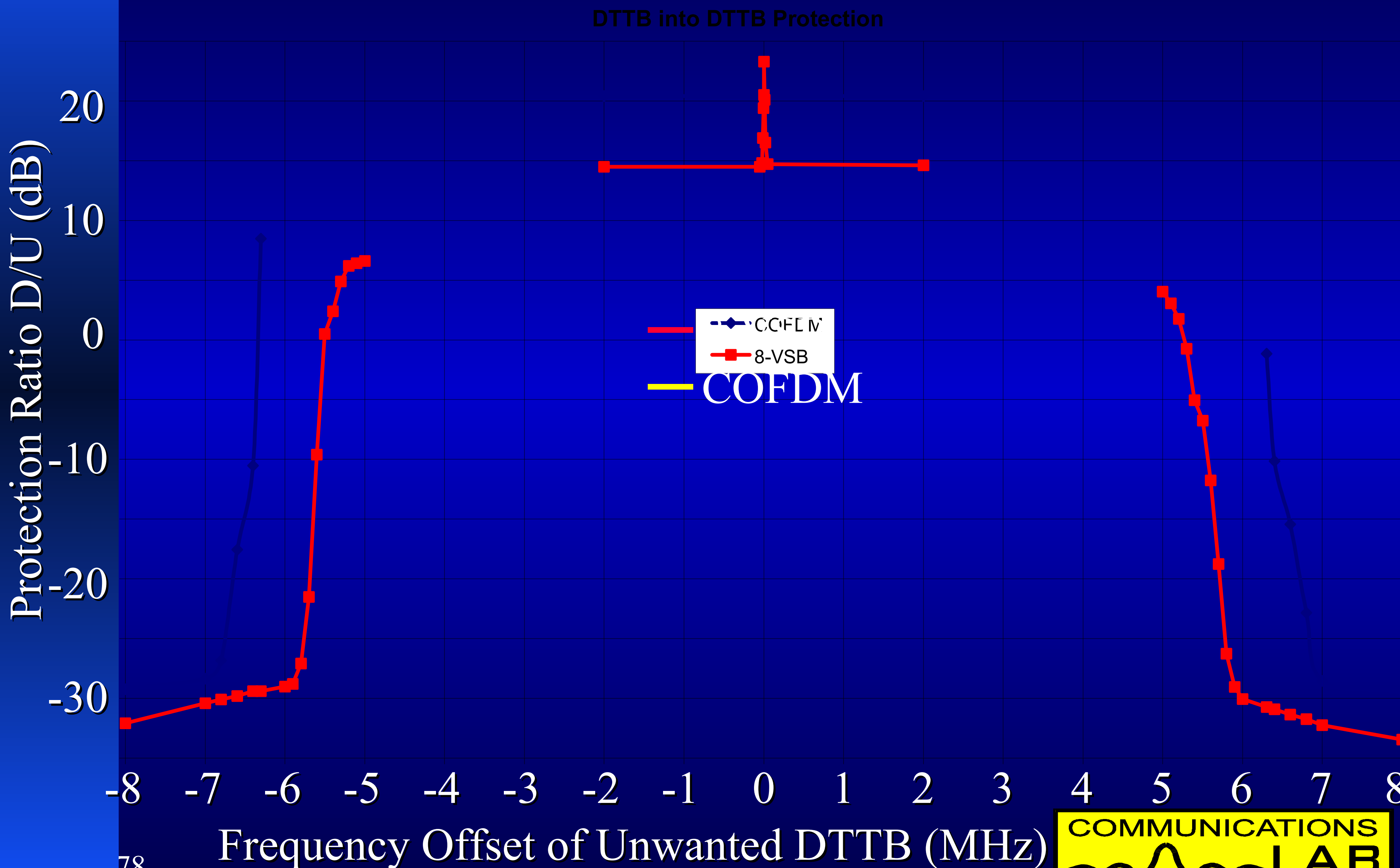
- ATSC has occasional peaks due to critical equaliser responses.
- The DVB-T response above was obtained from the improved equaliser which was provided near the end of the tests.

DTTB into DTTB - Overview

DTTB TYPE	Ch 7 Lower Adj Ch (dB)	Co Channel (dB)	Ch 9 Upper Adj Ch (dB)
DVB-T-7	-28.3	20	-28.5
ATSC-6	-30.4	14.6	-32.2

- Adjacent channel performance of ATSC is better than DVB-T
- The Co-channel protection of both digital systems approximates to the system carrier to noise threshold.

DTTB into DTTB - Protection Plot



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DTTB Field Testing Objectives

A DTTB Field Trial is study of Failure !!

In comparison with current PAL television

In various reception conditions :

- Investigate the difference in reception character for the two DTTB modulation systems.
- Provide information to DTTB system planners
- To provide Credible data.

Field Testing - Van

- A field test vehicle was built in a small van.

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Field Testing - On the Streets

- Over 115 sites were measured

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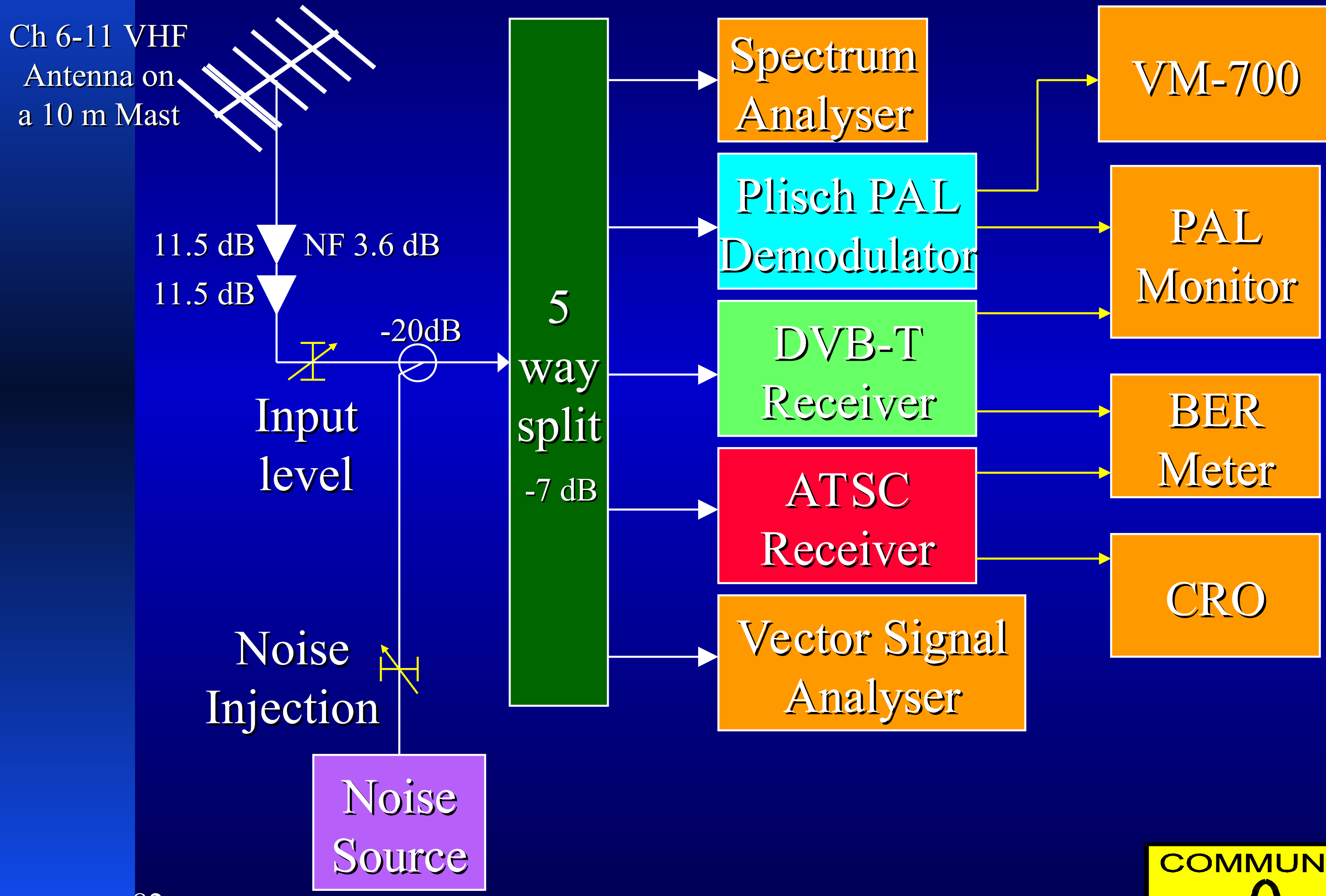
Field Test Vehicle Block Diagram



Field Testing - Method

- Field tests were conducted in Sydney over a 1 month period on VHF channel 8.
- Some simultaneous tests were conducted on VHF channel 6
- Power level for the field test was 14 dB below adjacent analog television channels 7 & 9
- Analog and digital television performance for both systems were evaluated at each site.
- Conducted by Independent Consultant & Mr Wayne Dickson of TEN

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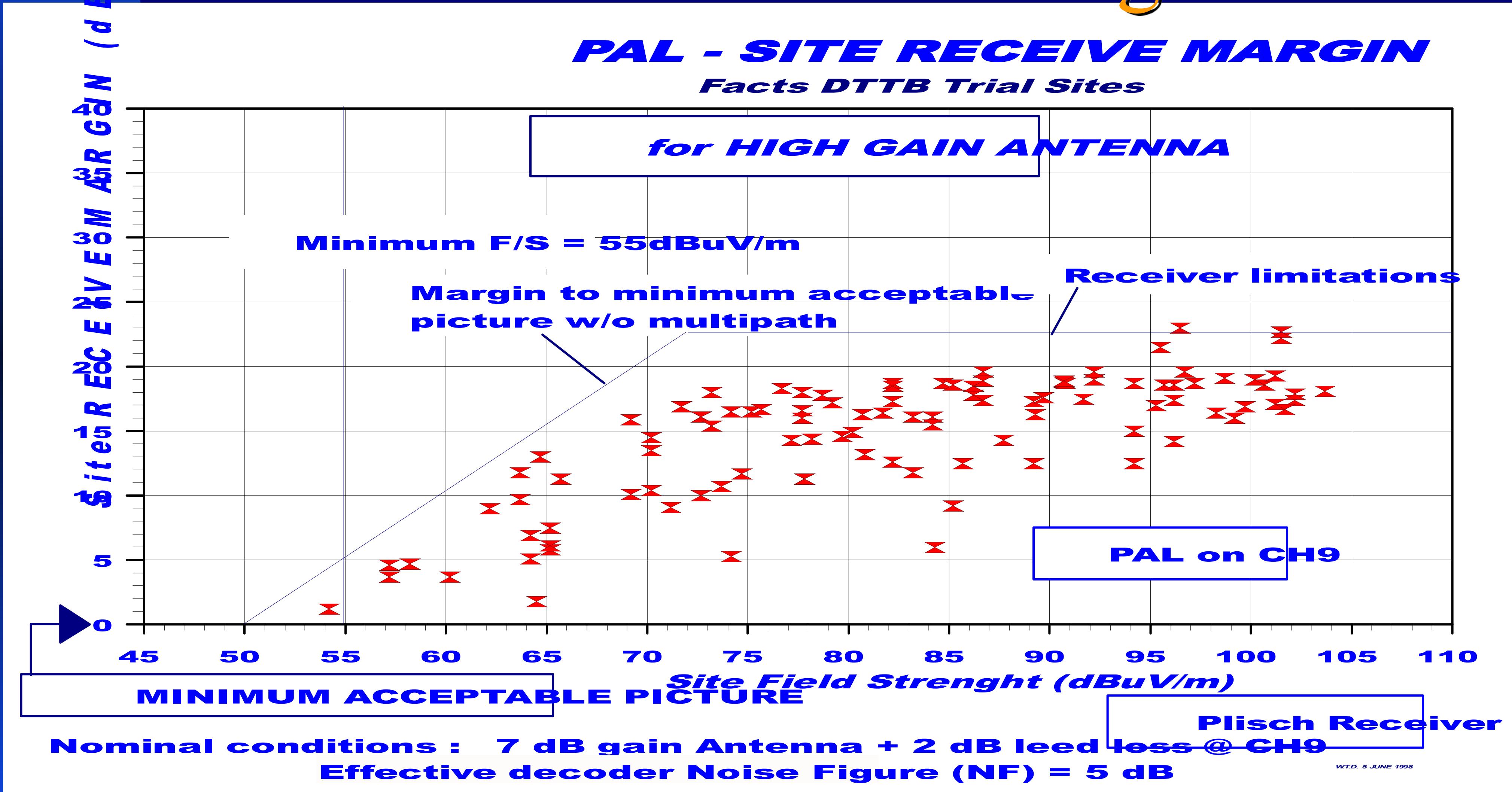
Field Test - Data Collected each Site

- Common Masthead Amp used (NF ~ 3.6 dB)
- Analog PAL transmission character (7,9 & 10)
- Measure level, multipath, quality & Video S/N
- Measure DVB & ATSC reception (Ch 8)
- Record DTTB & Analog Spectrum
- Measure Noise Margin (C/N Margin)
- Measure Level Threshold (Signal Margin)
- Measure antenna off pointing sensitivity

Australian DTTB Field Trial
PAL Receive Margin



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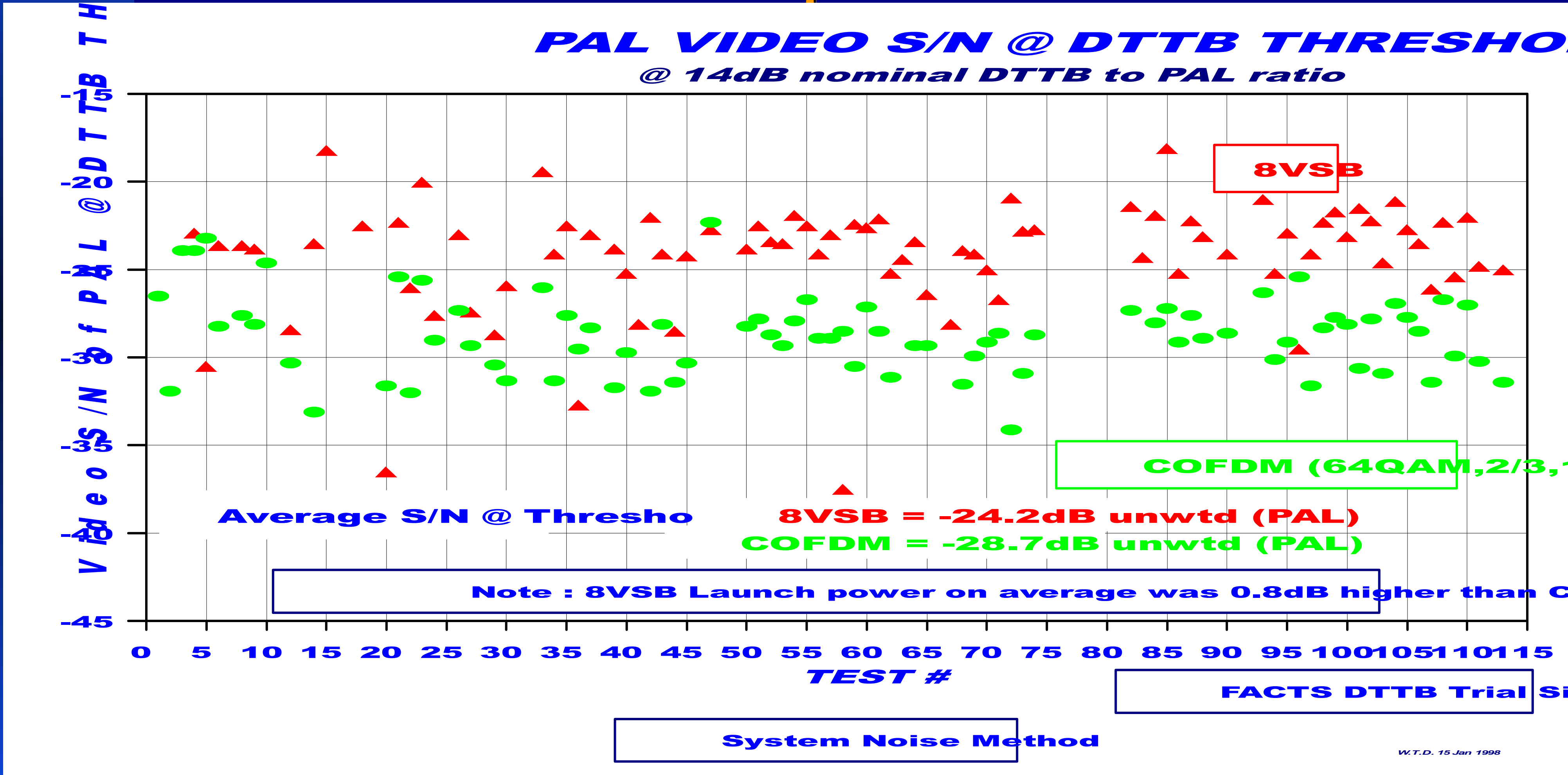
Australian DTTB Field Trial

DTTB compared to PAL



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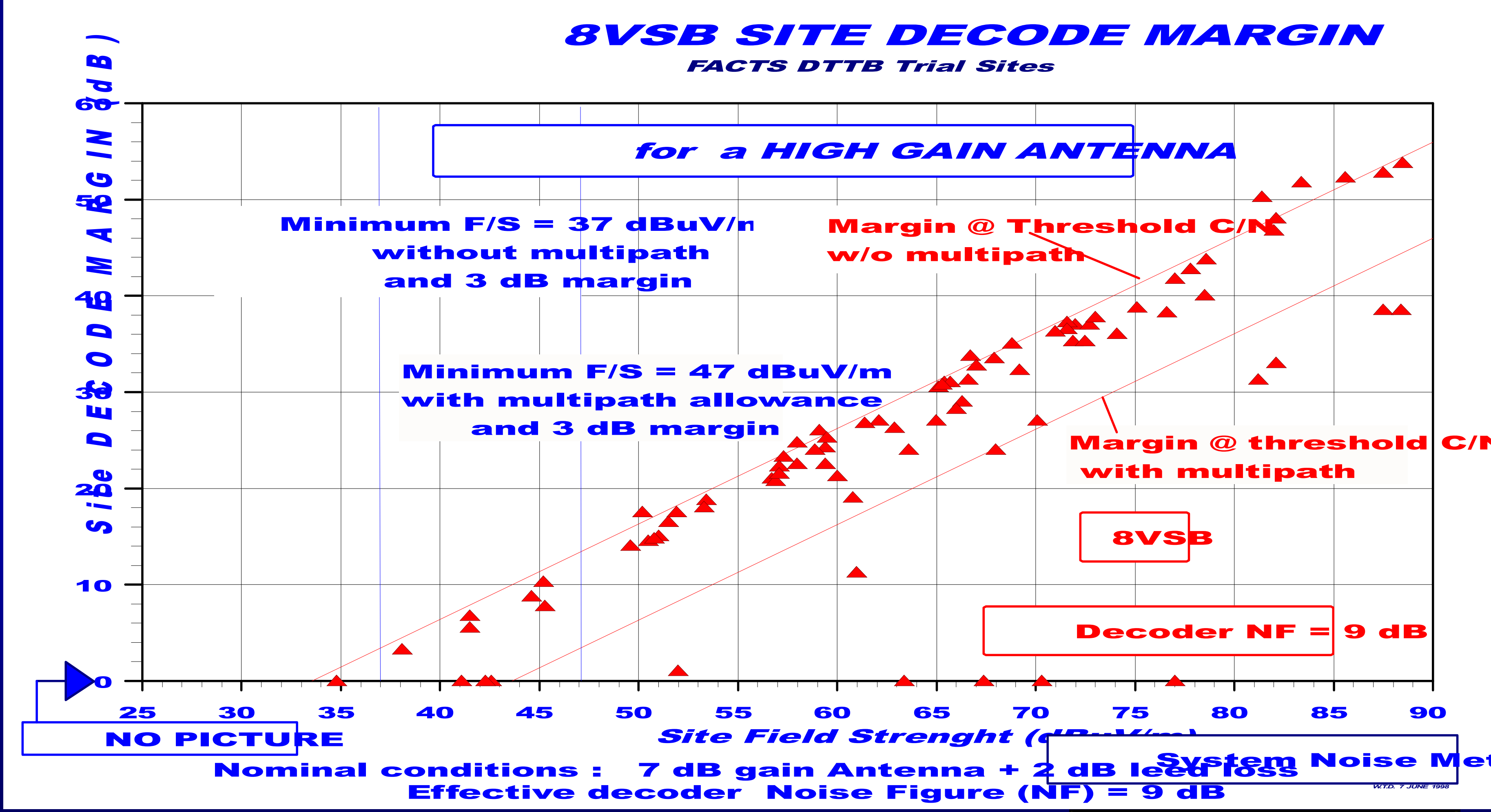
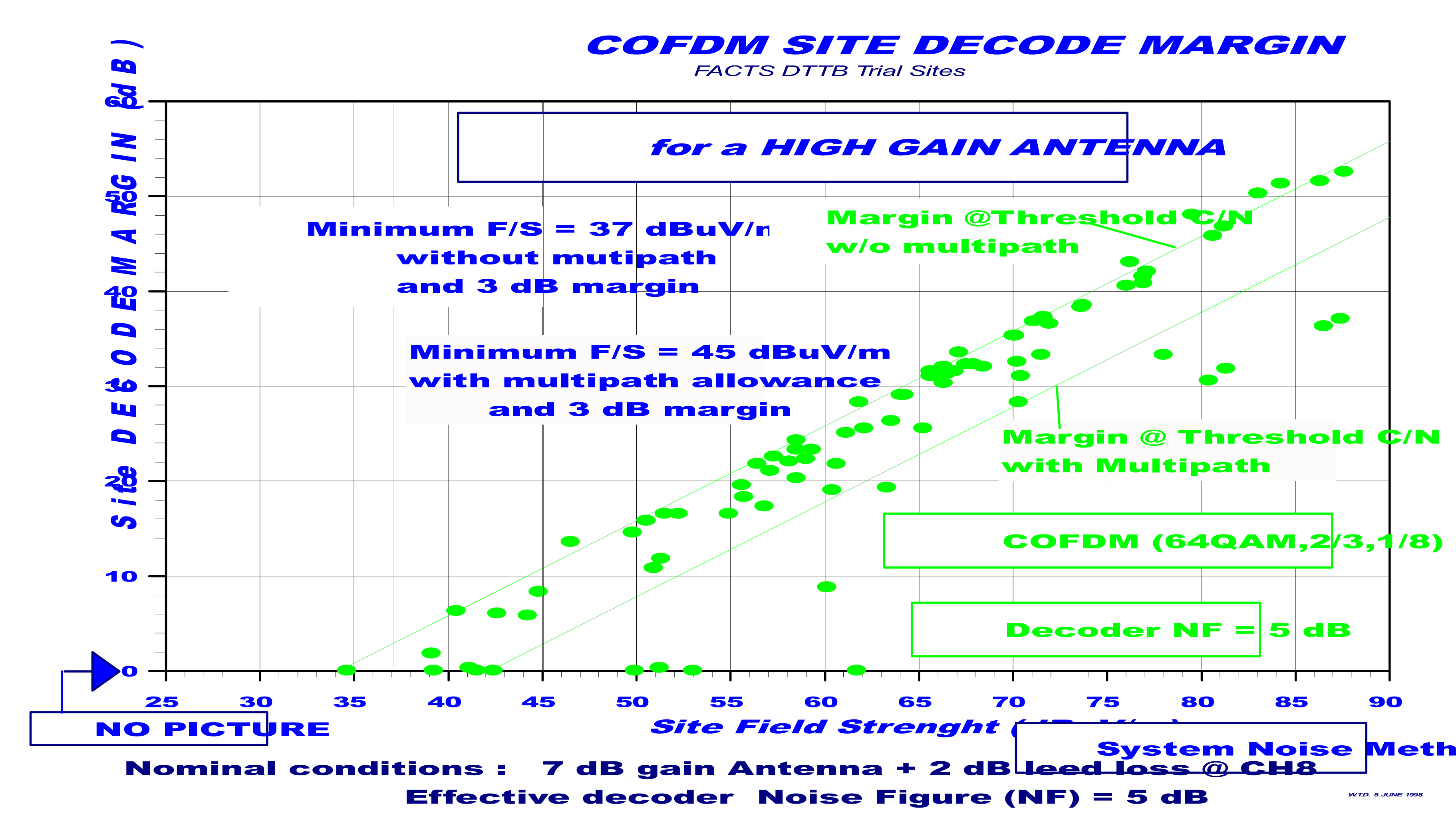
Australian DTTB Field Trial
8VSB Decoder Margin



Australian DTTB Field Trial
COFDM Decoder Margin



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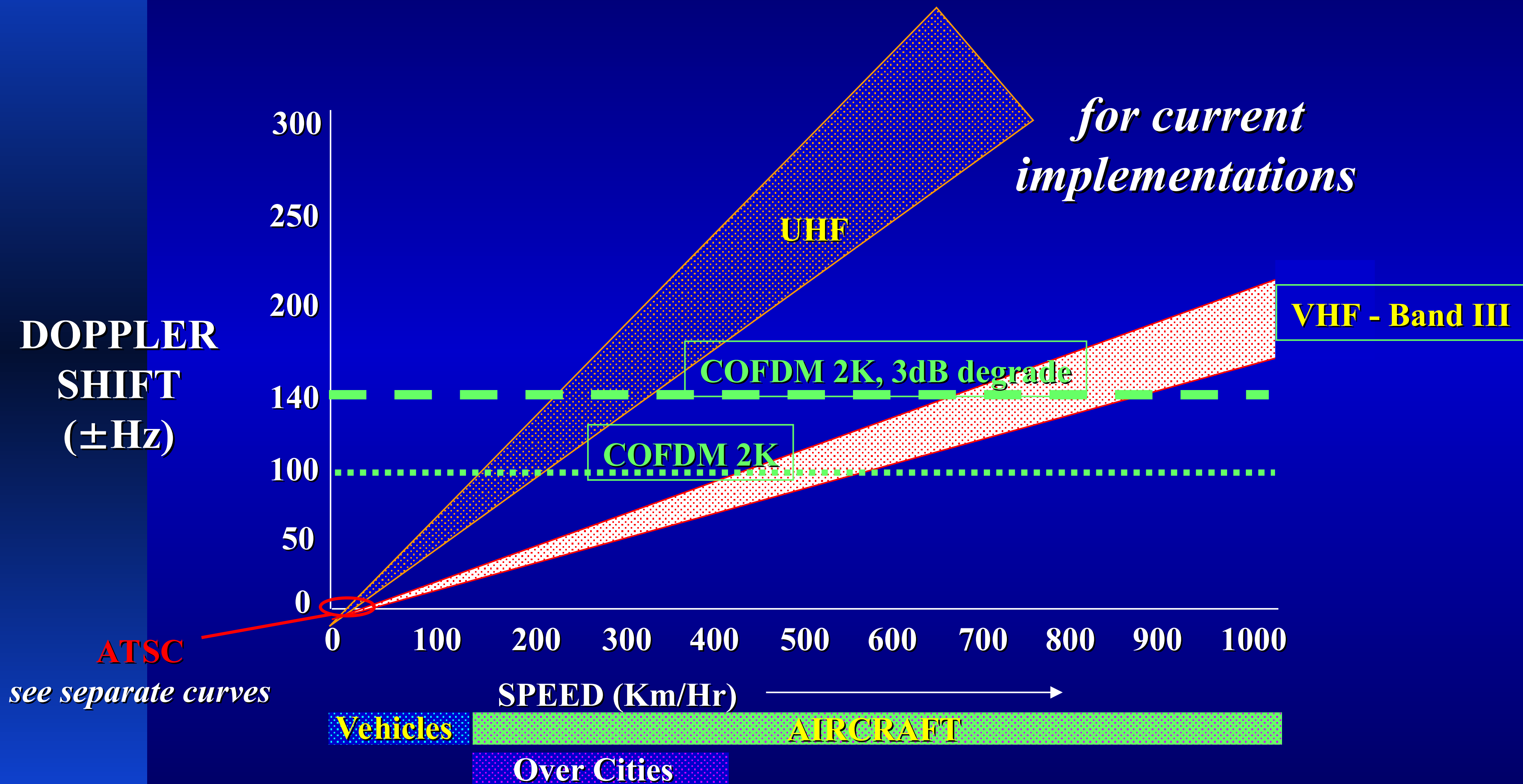
DTTB Systems Doppler Performance Limits



COFDM implementations will inherently handle post and pre-ghosts equally within the selected guard interval.

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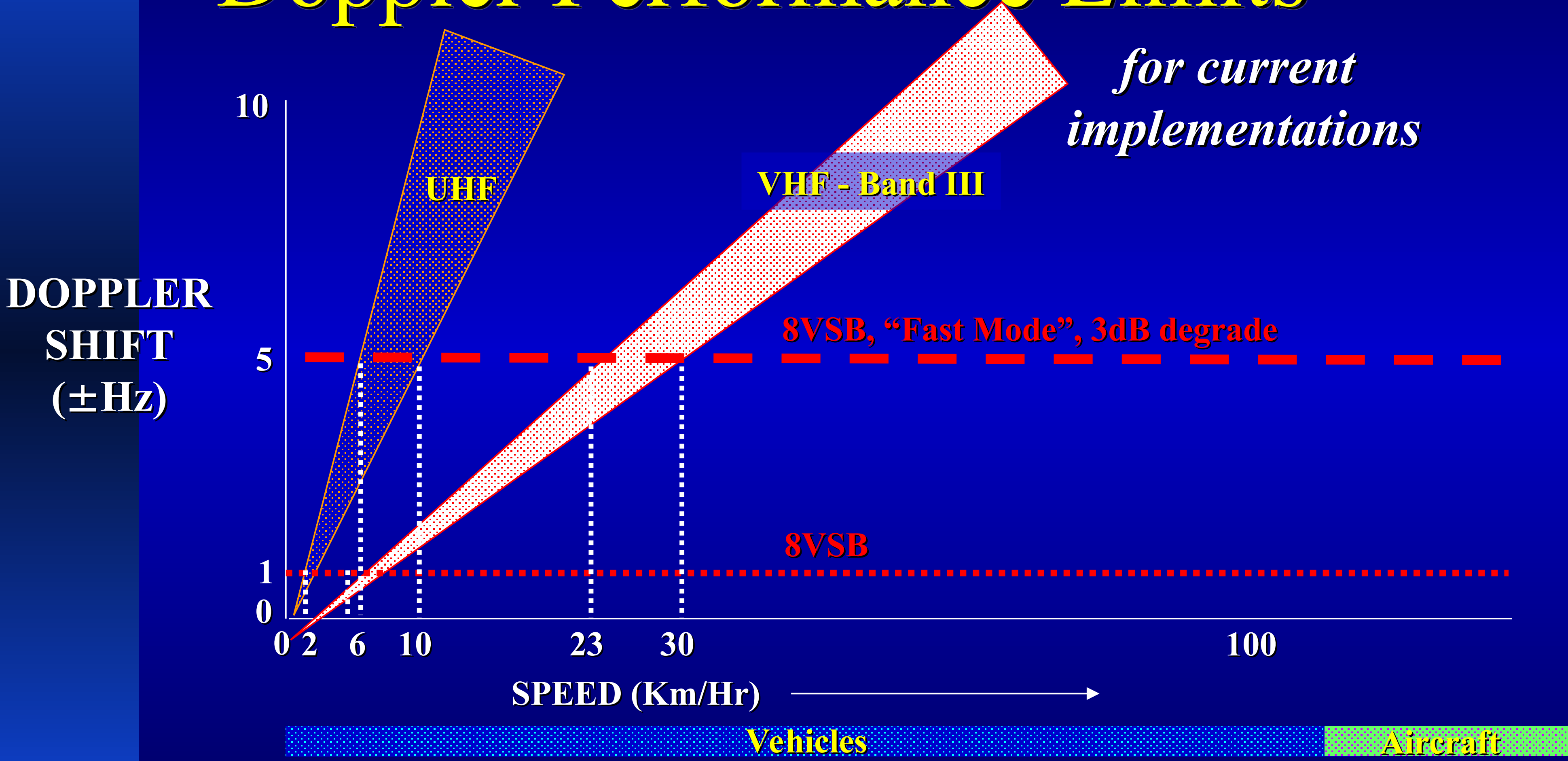
ATSC 8-VSB
Doppler Performance Limits

for current implementations



8VSB implementations of equalisers are likely to cater for post ghosts up to 30 uSec and pre-ghosts up to 3 uSec only.

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Field Test - Observations

- At -14 dB DTTB power when there was a reasonable PAL picture both 8-VSB & COFDM worked at the vast majority of Sites
- When PAL had:
  - Grain (noise) and some echoes (multipath), both 8-VSB & COFDM failed
  - Flutter, caused by aircraft or vehicles, 8-VSB failed
  - Impulsive noise & some grain, COFDM failed

Results Conclusion

- The assessment of the results presented in this summary depends largely on the SPECIFIC system REQUIREMENTS of the broadcaster and the viewers.
- The implementation and performance of both digital terrestrial transmission systems are still being improved, however the DVB-T system shows more scope for achieving future advances.

The Selection Committee

- A selection committee was formed from FACTS ATV specialists group Representing:
  - National broadcasters (ABC and SBS)
  - The commercial networks (7,9 & 10)
  - The regional commercial broadcasters
  - The Department of Communications and the Arts
  - The Australian Broadcasting Authority

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Selection Panel - Responsibility

- Analysing the comparative tests and other available factual information
- Establishing the relevance of the performance differences to Australian broadcasting
- Recommending the system to be used

Selection Criteria

- Derived a set of 50 selection criteria relevant to the Australian transmission environment
- Criteria were reduced to final 29 which could impact on the final decision
- The criteria were weighted and an overall average used to rank the selection criteria

Selection Criteria - Groups

- Most Important Criteria Groupings
  - Coverage
  - System Design Elements
  - Operational Modes Supported
  - Overall System
  - Receivers

Selection Criteria - Analysis

- Assessed each of the selection criteria elements for each modulation system
  - Some criteria were put aside as it was felt there was not enough information to factually score those criteria

Criteria - Coverage

- Inner and outer service areas
- Performance with Roof top antennas
- Performance with Set top antennas *
- Co-channel & Adjacent channel protection
- Mobile Reception
- Multipath (Ghosting, Doppler & Flutter)
- Immunity to impulse noise

Criteria - System Design Elements

- Combining & use of common Tx Antenna
- Requirements for implementing translators
- Suitability for co-channel translators
- Ability to use existing transmitters

Criteria - Operational Modes Support

- HDTV Support
- Support for closed captioning
- Multiple languages Audio
- Surround Sound Audio System

Criteria - Overall System

- Accepted HDTV system
- Performance within 7 MHz channel
- Number useful Mb/s in 7 MHz
- Ability to fit in existing infrastructure
- Overall Modulation System Delay
- System Flexibility, Upgrade Capacity & Future Development Capacity

Selection Criteria - Receivers

- Availability (for HDTV) MP@HL
- Receiver Features & Cost
- PAL and DTTB capability
- Degree of customizing for Australia
- Receiver Applications Software
- Lock up time
- Australian channel selection

DTTB Choice Assessment Sheet

	GROUP1 – COVERAGE	ATSC	DVB	IMPORTANCE	
				Element	Group
Element	Group 1				
1.1	Percentage of A coverage pop. served				
1.2	Percentage of B coverage pop. served				
1.3	Set top antennas				
1.4	Mobile reception				
1.5	Co-channel performance				
1.6	Adjacent channel performance				
1.7	Multipath Performance				
1.8	Immunity to electrical interference				
1.9	Ability to be conveyed in MATV and cabled systems				

	GROUP 2 - SYSTEM DESIGN ELEMENTS	ATSC	DVB	IMPORTANCE	
				Element	Group
Element	Group 2				
2.1	Combining to use common transmit antennas				
2.2	Ease of use and cost of implementing translators				
2.3	Common channel translator capability				
2.4	Ability to use existing transmitters				

	GROUP3 - OPERATIONAL MODES SUPPORTED	ATSC	DVB	IMPORTANCE	
				Element	Group
Element	Group 3				
3.1	HDTV support				
3.2	Support for closed captions				
3.3	Support for multilingual audio				
3.4	Audio System				

	GROUP 4 - OVERALL SYSTEM	ATSC	DVB	IMPORTANCE	
				Element	Group
Element	Group 4				
4.1	Adoption of an accepted rather than unique (HDTV) system				
4.2	Performance within 7 MHz channel				
4.3	Number of useful Mbs/7MHz				
4.4	Overall encode/decode delay				
4.5	System upgrade & further development capability				

	GROUP 5 - RECEIVER ELEMENTS	ATSC	DVB	IMPORTANCE	
				Element	Group
Element	Group 5				
5.1	Receiver availability, features & cost				
5.2	Receiver and STB MP @ HL				
5.3	Receivers with both PAL and DTTB capability				
5.4	Receivers not specific design for Australia				
5.5	Receiver applications software				
5.6	Receiver lock-up time				
5.7	Ability to provide automatic channel selection for Australian channelling				

DTTB Choice Assessment Sheet

	GROUP1 – COVERAGE	ATSC	DVB	IMPORTANCE	
				Element	Group
Element	Group 1				
1.1	Percentage of A coverage pop. served				
1.2	Percentage of B coverage pop. served				
1.3	Set top antennas				
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1.7	Multipath Performance				
1.8	Immunity to electrical interference				
1.9	Ability to be conveyed in MATV and cabled systems				

	GROUP 2 - SYSTEM DESIGN ELEMENTS	ATSC	DVB	IMPORTANCE	
				Element	Group
Element	Group 2				
2.1	Combining to use common transmit antennas				
2.2	Ease of use and cost of implementing translators				
2.3	Common channel translator capability				
2.4	Ability to use existing transmitters				

Selection Result - June 1998

- The selection committee unanimously selected the 7 MHz DVB-T modulation system for use in Australia
- The criteria that were set aside would, however, not have changed the selection decision

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Overall Selection Influences

- A single system for All Free to Air Broadcasters
- Ability to meet Governments objectives for coverage
- Able to deliver the HDTV quality objective
- Availability of consumer products at acceptable costs
- Solid support from proponent
- Interoperability with other digital video platforms
- Confidence in the system meeting the business objectives

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More Selections

- Sub-committees formed to investigate:
  - Service information data standard
  - Multichannel audio system
  - HDTV video production format
- July 1998 3 further recommendations
  - SI data standard be based on DVB-SI
  - AC3 multichannel audio is the preferred audio encoding format
  - 1920/1080/50 Hz interlaced 1125 lines is the preferred video production format

Frame Rate Video Format Decision

- Examined 50 or 60 Hz based video formats
- Decided to stay with 25/50 Hz system:
  - 40+ years of 50 Hz Archive program material
  - Overseas production available in 50 or 60 Hz
  - Down-conversion is required for Legacy Rx
  - Inappropriate to use incompatible frame rates in the FTA broadcast community
  - Production problems associated with 60 Hz image capture in a 50 Hz power environment
  - Broadcast / Consumer Manufacturers assurance 50 Hz equipment will be available

Australian Video Formats

- Use of Progressive and Interlace video formats
- The Format selected to suit program content.
- Likely Video Formats MP@HL,
  - **1920x1080/25P ⇨ Film Material**
  - **1920x1080/50I ⇨ General Entertainment**
  - **720x576/50P ⇨ Sports Coverage**
  - **720x576/50I ⇨ SDTV Program**

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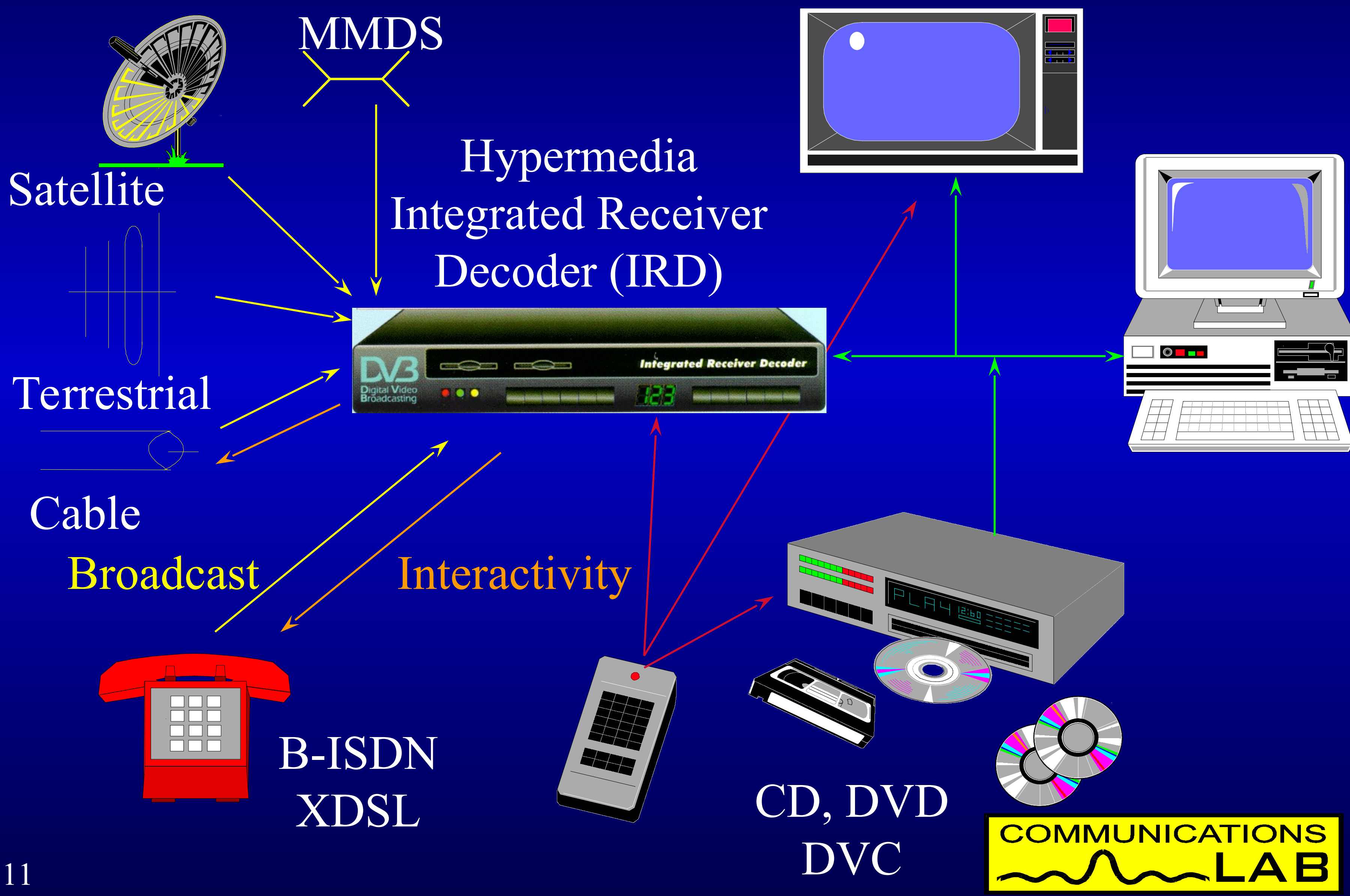
DTTB Implementation Notes:

- Although SFNs are of interest in Australia they will be of little use during the simulcast period.
- Use may be made of Dual Frequency Networks to increase spectrum efficiency
- The channel frequency matrix will be adjusted when Analog TV services cease.
- Digital TV provides the capacity to repack the television spectrum.

A Future Digital System Concept



The End

Thank you for your attention

Any questions?

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