

**Advanced System & products
for DTTB Network**

Ver.0.0

15th,June,2000

Toshiba (Member of DiBEG)
Digital Broadcasting Experts Group

Video quality is kept constant when signal strength is more than threshold level.(not suffered by ghost,noise,etc)

Transmission quality is defined by B.E.R

Threshold B.E.R= 2×10^{-4}

(after Viterbi)

Concatenated Forward Error Correction

**In case of
64QAM-(7/8)
HDTV available**

Before Viterbi(7/8)	1×10^{-2}
After Viterbi	2×10^{-4}



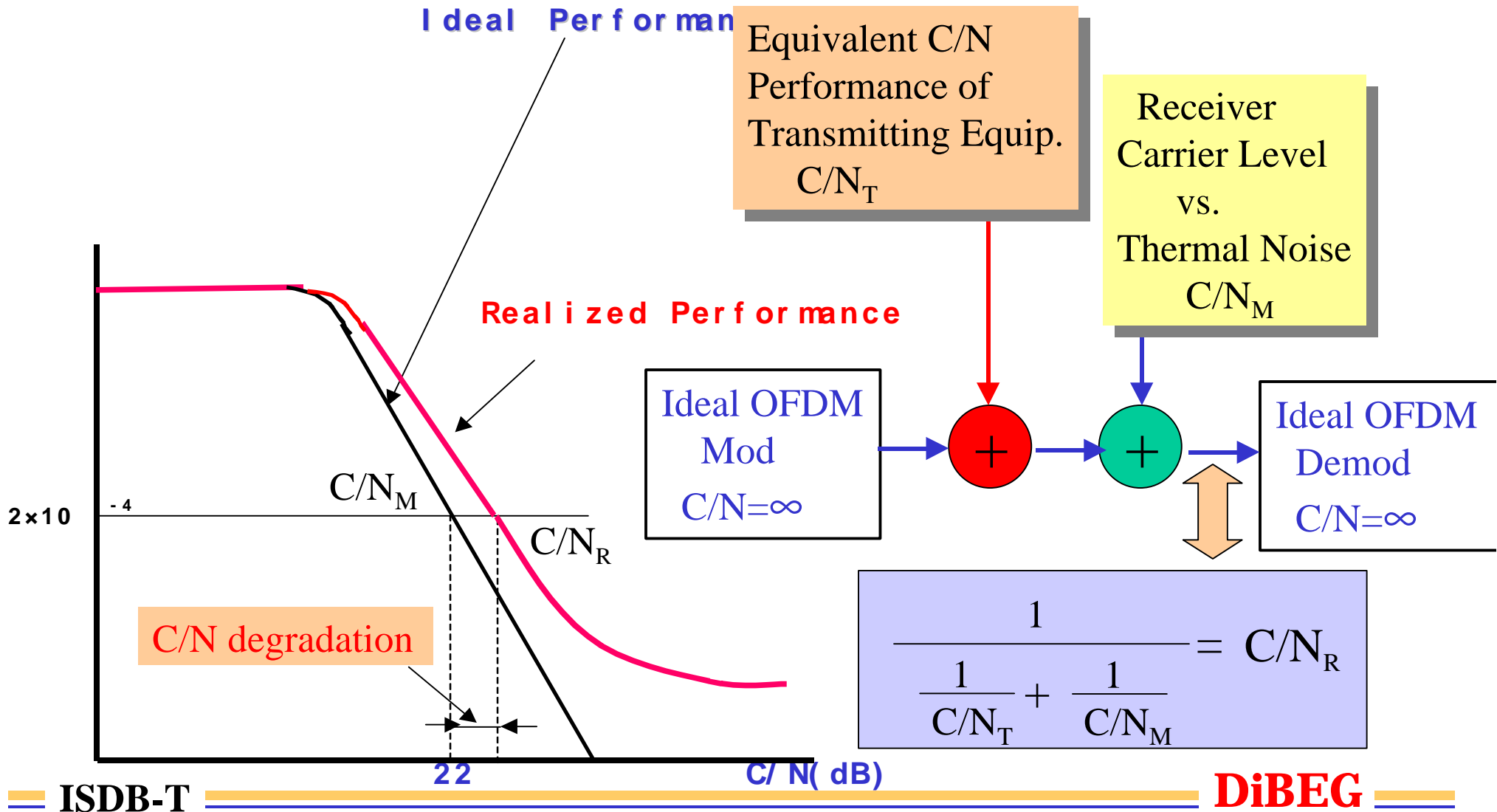
After Reed-Solomon	1×10^{-11}
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**Encoded in
MPEG-2 TS**

Equivalent C/N of transmitting equipment

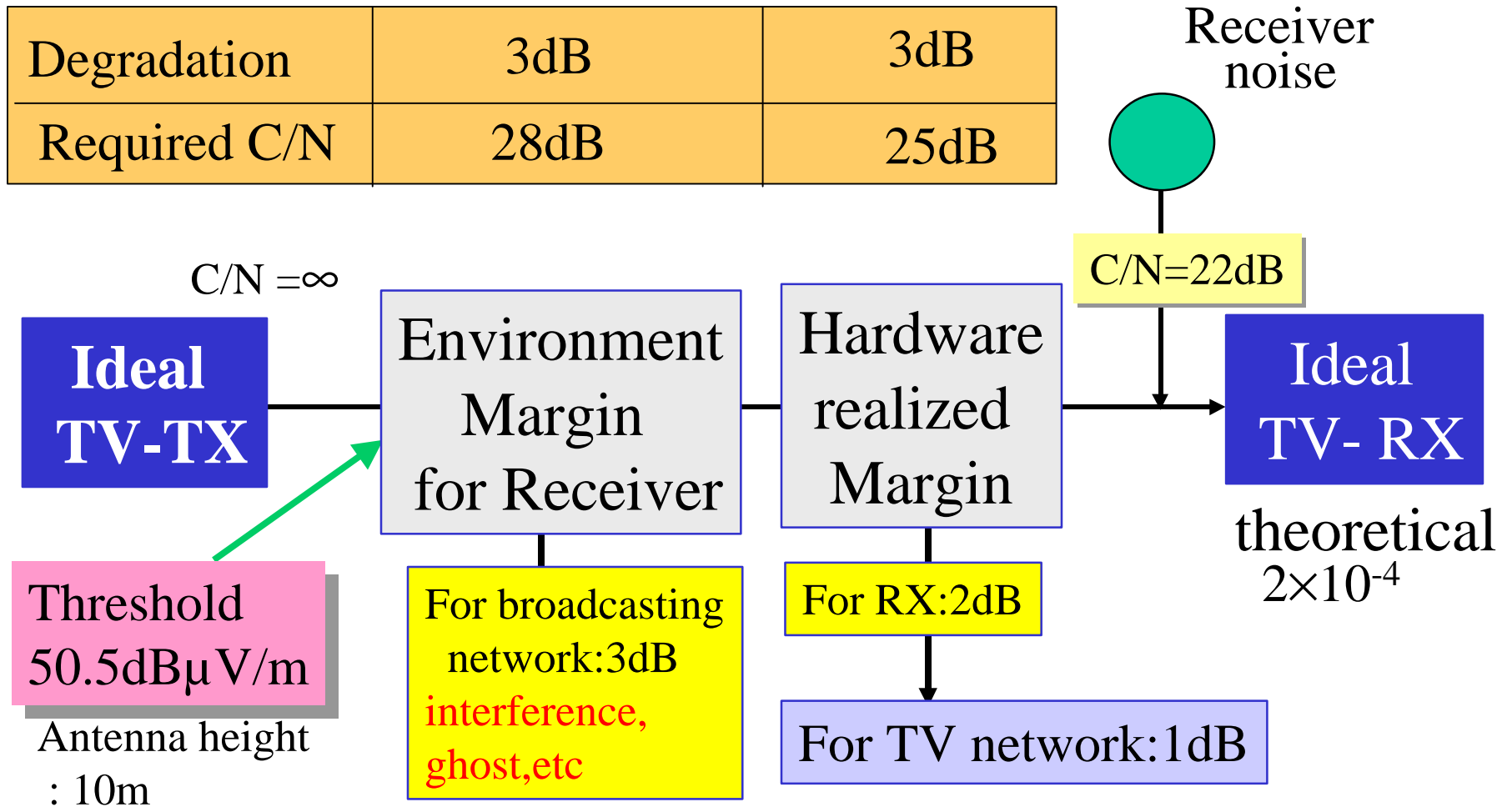
Digital Terrestrial Broadcasting

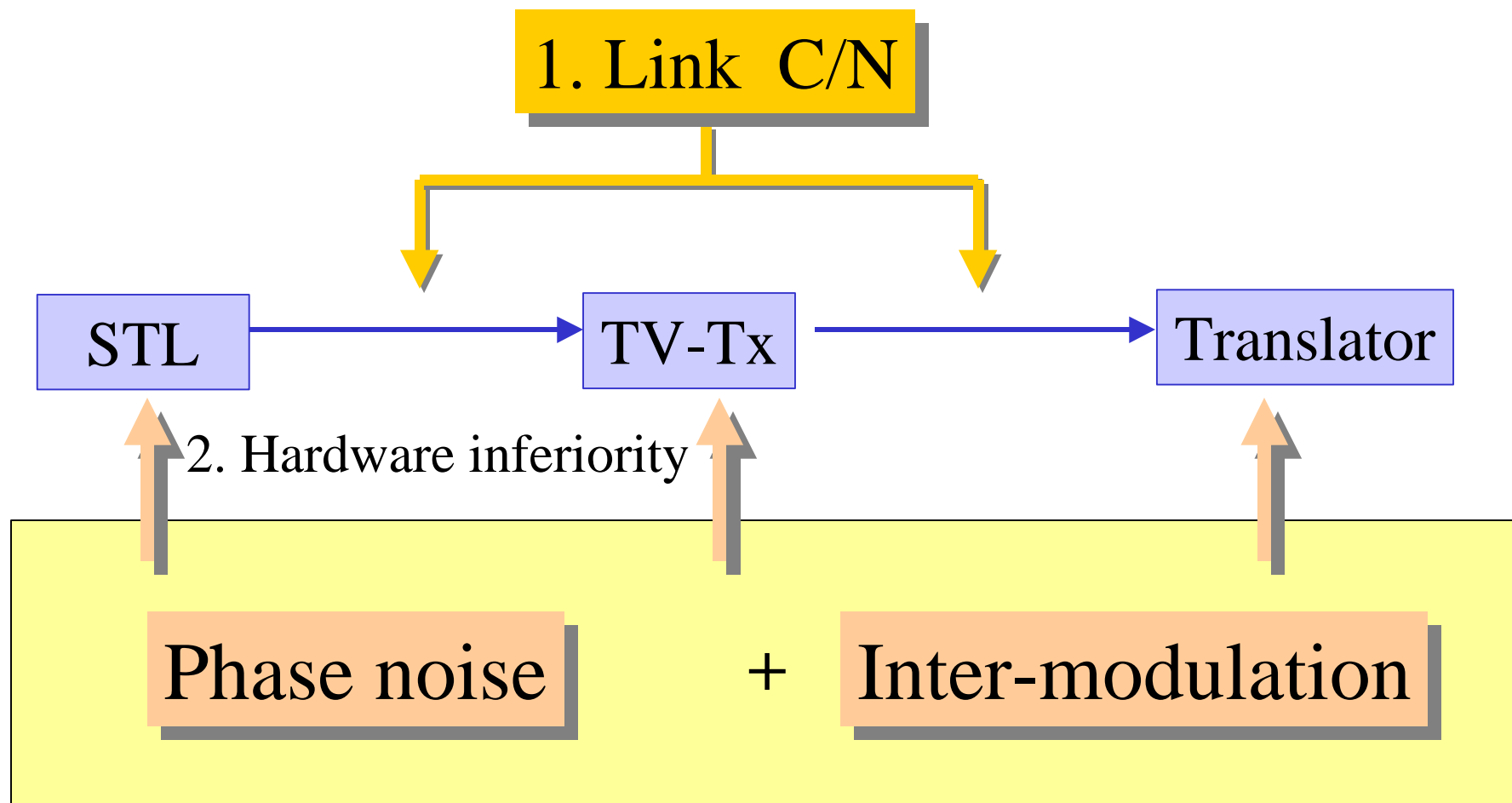
$$C/N \text{ degradation} = (C/N)_M \text{ dB} - (C/N)_R \text{ dB}$$



Ideal link model

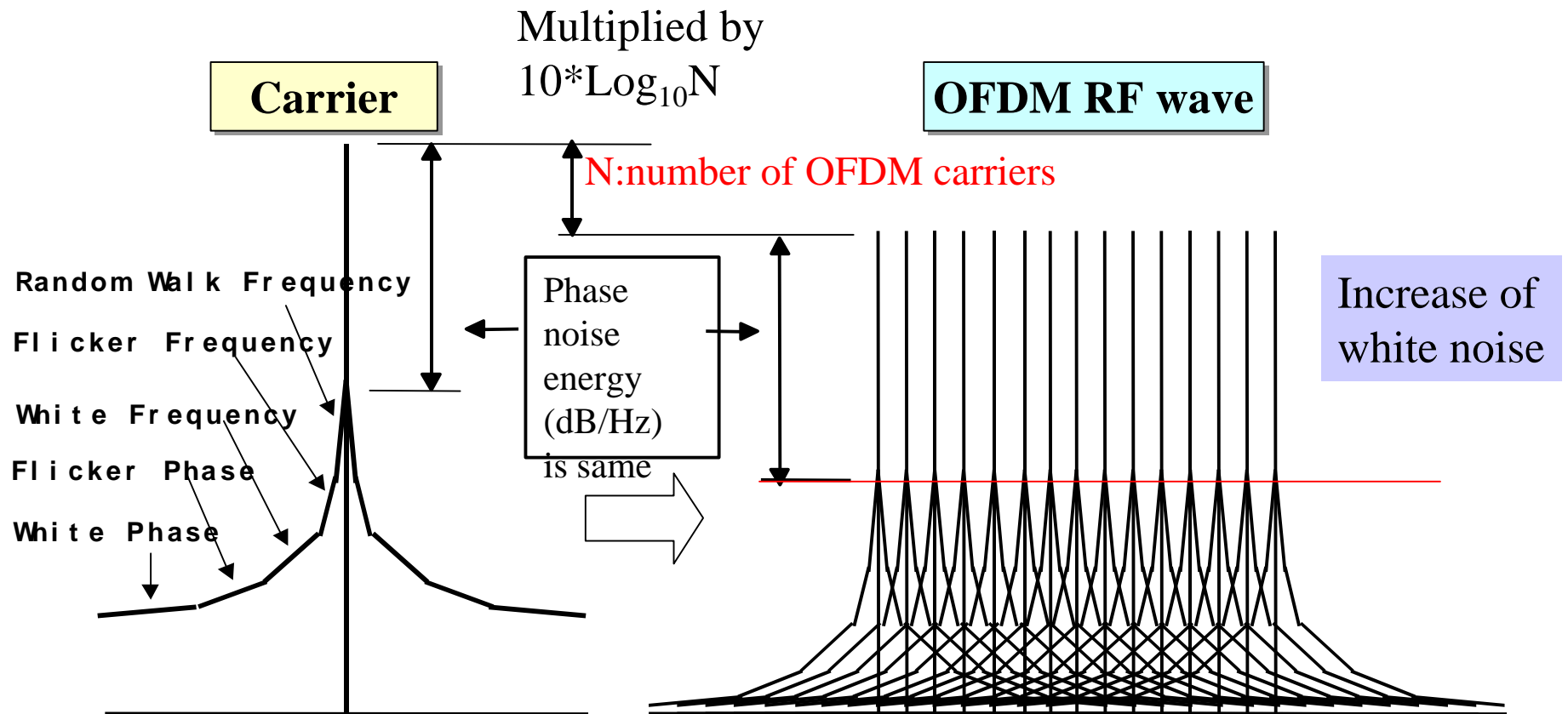
Degradation	3dB	3dB
Required C/N	28dB	25dB



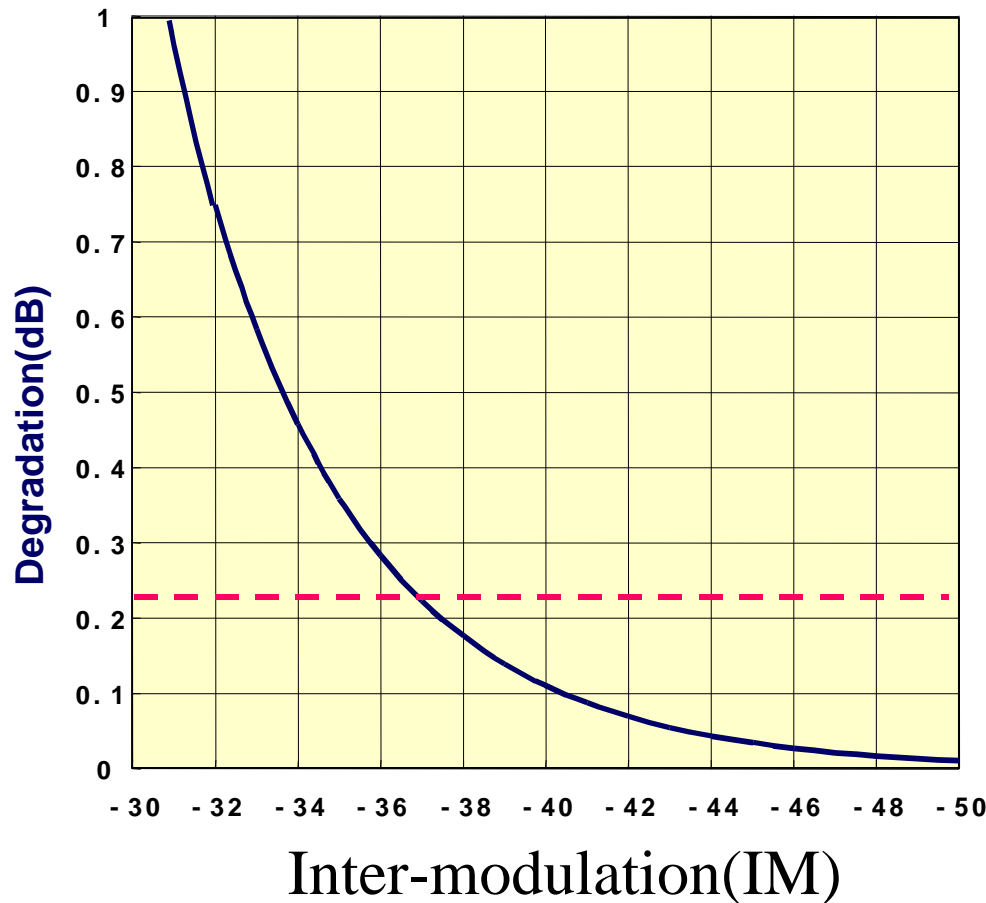


Contribution of phase noise

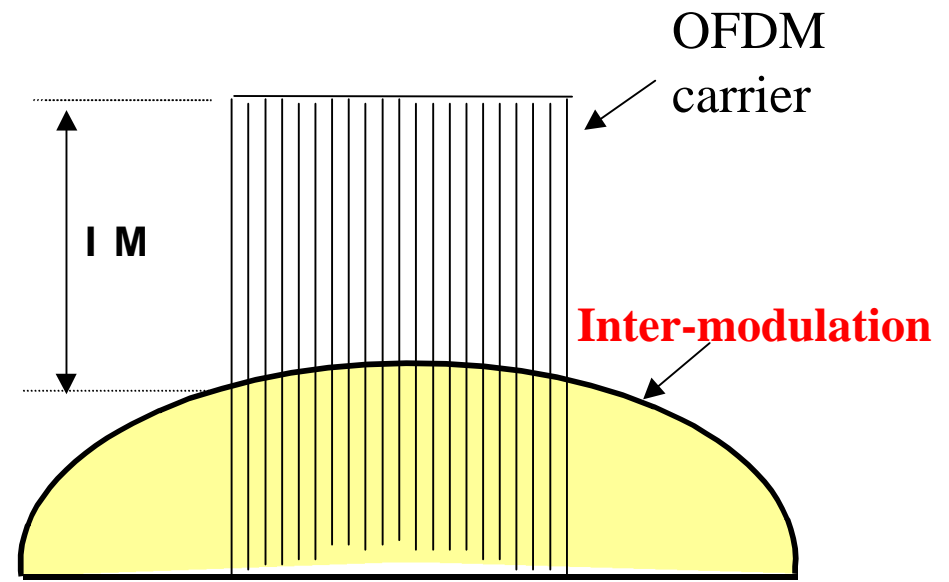
Phase noise of carrier oscillator is converted to each OFDM carrier and spread over in-band of OFDM



IM vs. C/N degradation



OFDM Spectrum caused by Inter-modulation



Equals to white noise increasing

Networking

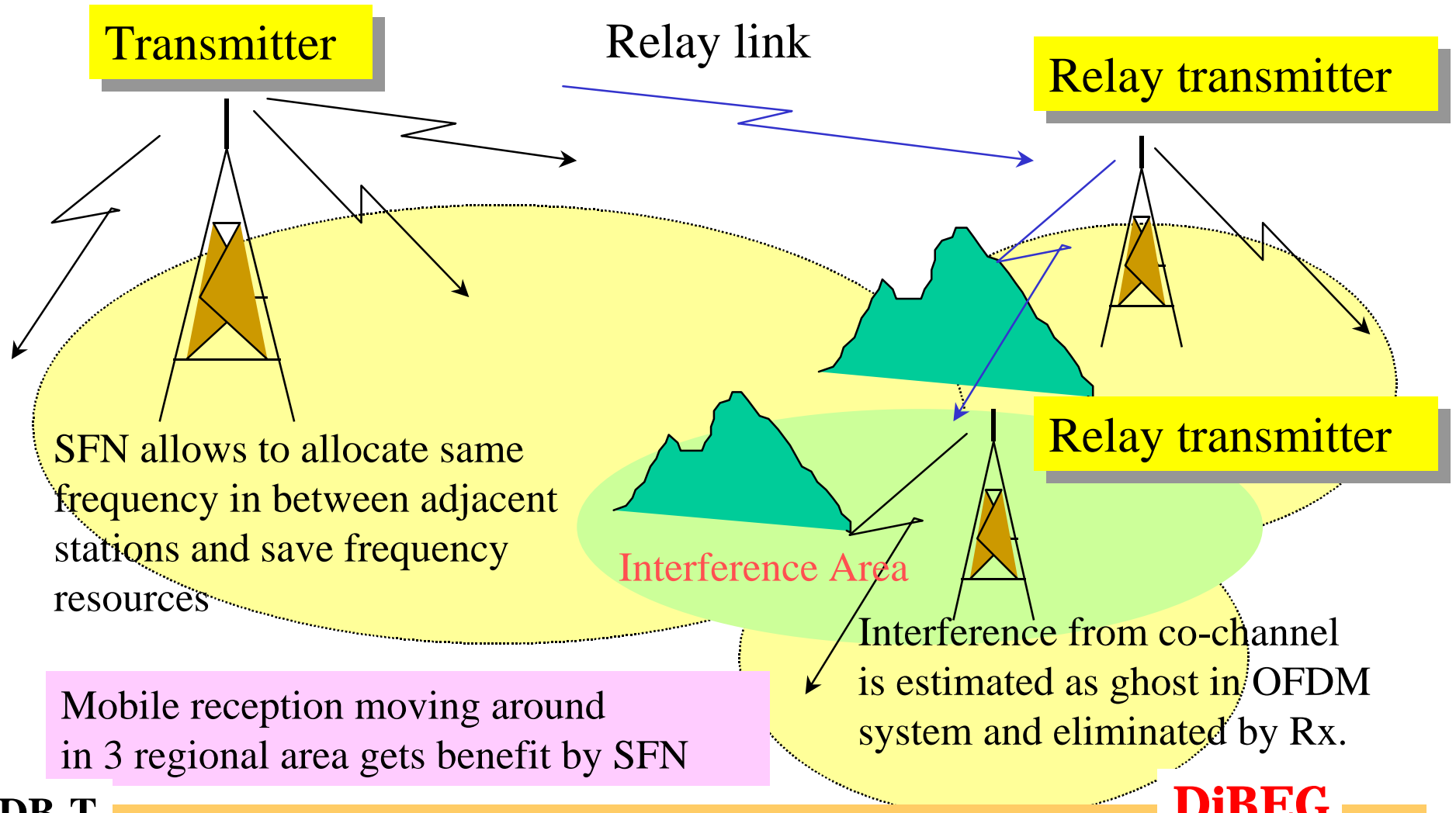
Effective coexistence with analog channel

SFN can make it easy to allocate digital channel

Effective allocation plan of transmitter station
and relay station

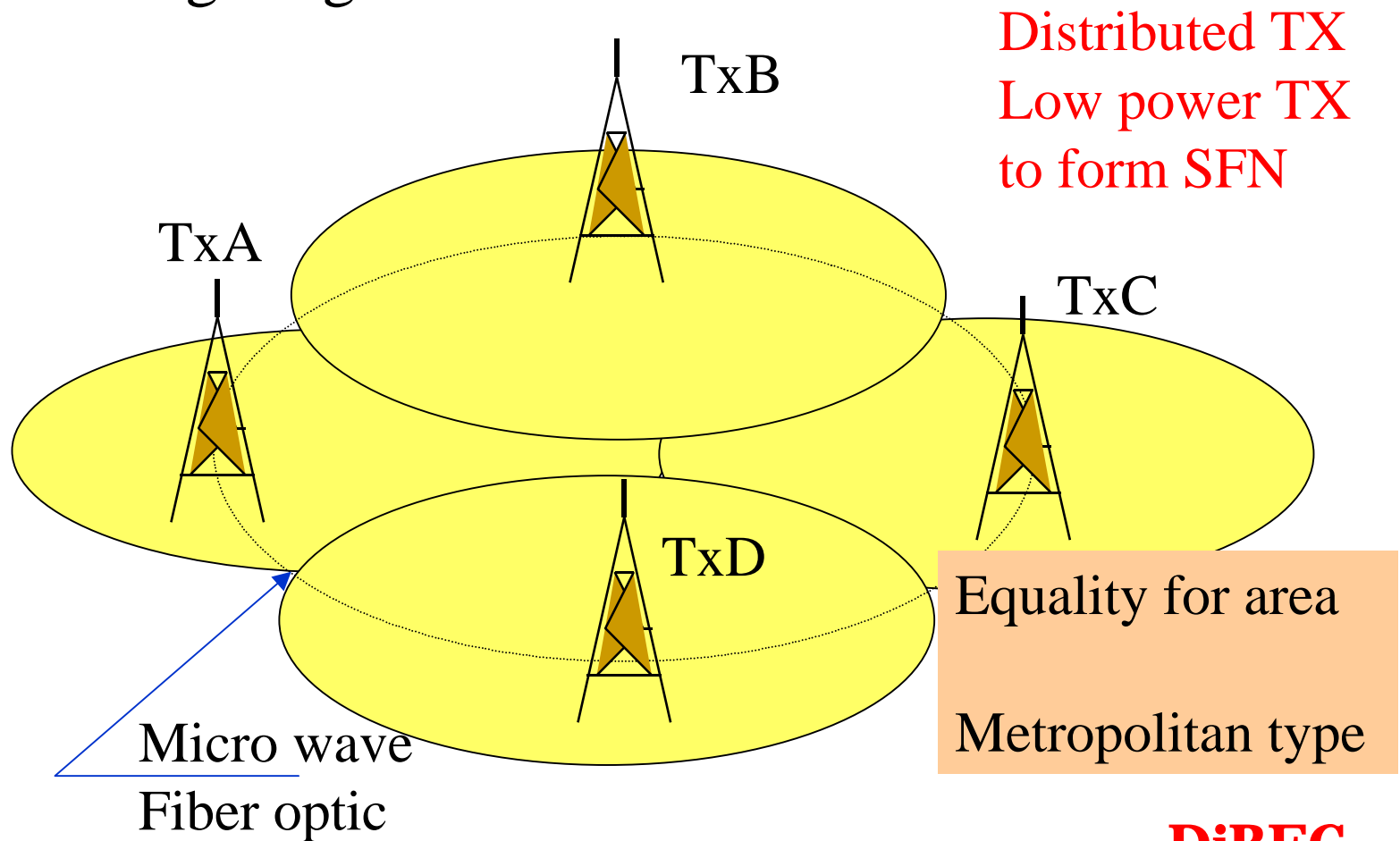
New idea for installation place of transmitter
which can be realized by featuring OFDM

SFN: Single Frequency Network



New idea of transmitting station (1)

Stadium lighting allocation



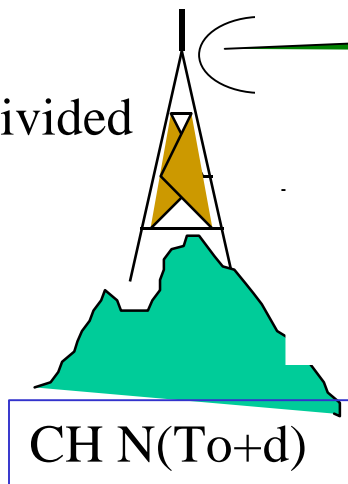
New method of SFN Link

UHF broadcasting wave is used both for broadcasting and relaying link

Transmitter

CH N(T_0)

OFDM is divided
in IF band



$d(\text{propagation delay}) < \text{guard interval}$

Cross polarization

Relay station



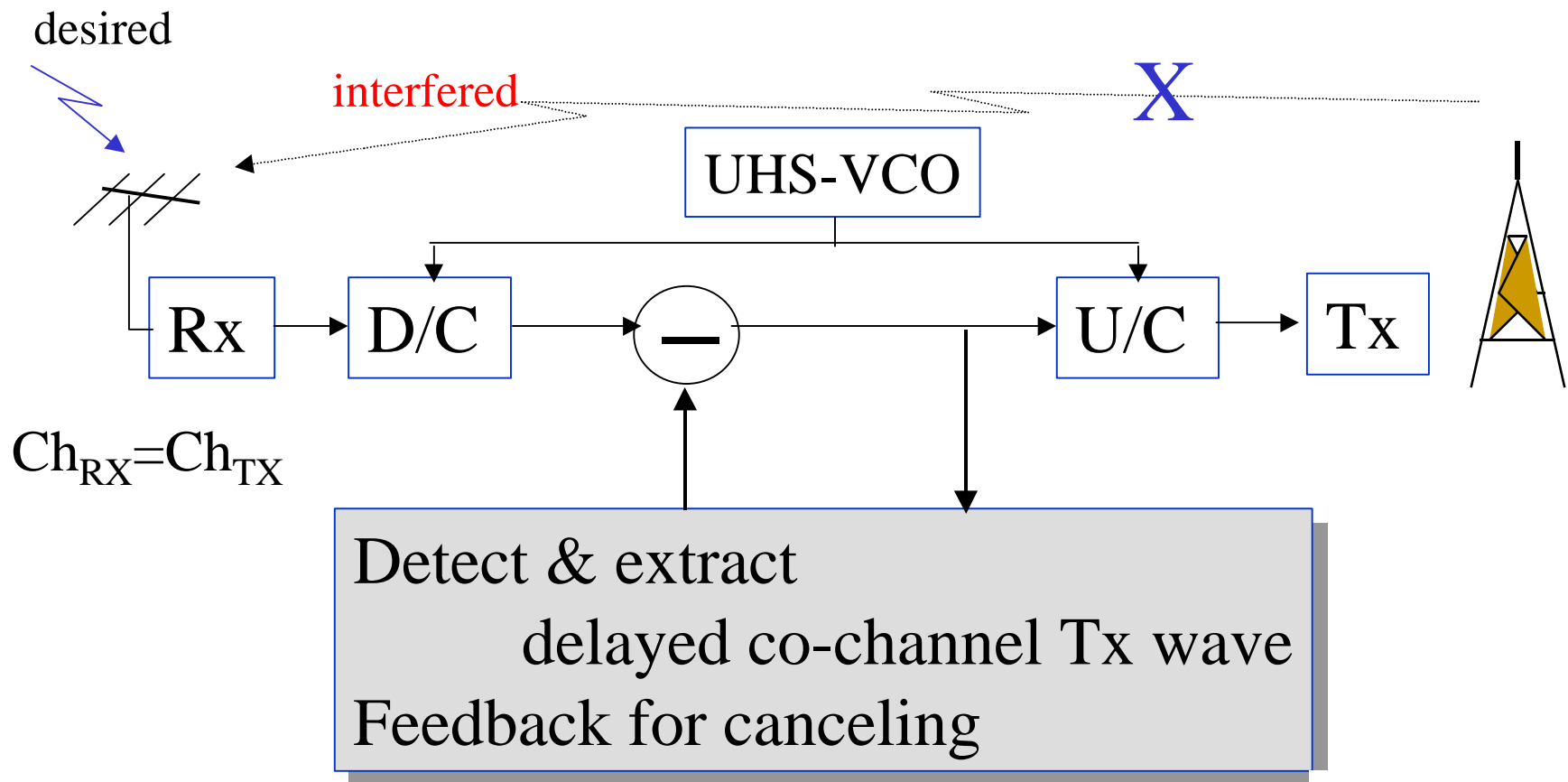
CH N(T_0+d)

Co-loop cancellor
in relay station

SFN network can be realized without using microwave or fiber optic.

(for SFN relay transmitter)

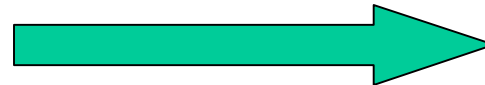
Realize SFN by broadcasting relay station by canceling co-channel interference caused by system itself



CLC-2101 Co-channel loop Canceller



Input C/I > 3dB



Output C/I > 35dB

Available for SFN relay station using same in & output channel
Adaptive feed-back system applied
3 multi-path waves are cancelled

Transmission signal	ISDB-Modulation site	Transmission Modulation	Featuring
OFDM/IF	studio	OFDM	Concerned link degradation
Transport stream	transmitter	64-QAM	Independent link budget

SHF OFDM Transmitter

Digital Terrestrial Broadcasting

2 pilot signals assist frequency synchronization of microwave link.



Transmission Freq.	3.5GHz to 13GHz (pre-assigned)
RF power	+12dBm/+27dBm(with IPA)
Bandwidth	within 9MHz
Input IF	37.15MHz match to OFDM modulator

Sufficient phase noise for ISDB-T carrier

SHF OFDM Receiver

Digital Terrestrial Broadcasting



Receiving Freq.	3.5GHz to 13GHz (pre-assigned)
IF output	37.15MHz/-10dBm
Bandwidth	within 9MHz

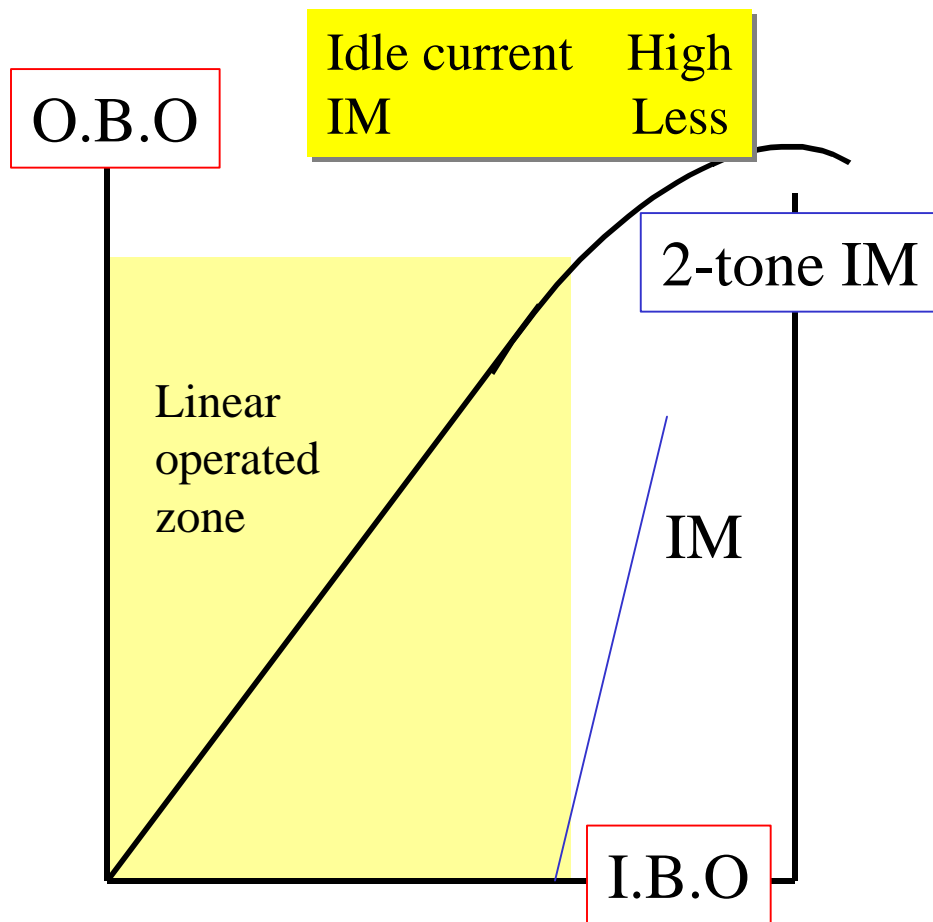
Sufficient phase noise for ISDB-T carrier

Advanced technology of
DTTB Transmitter

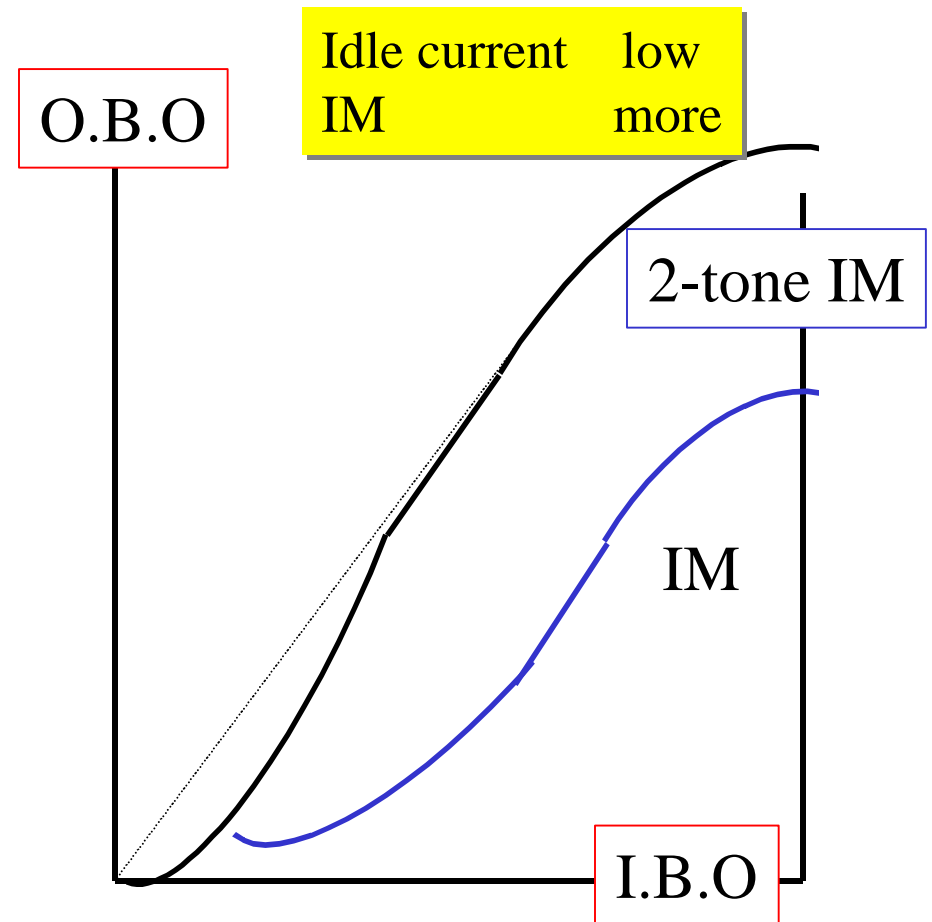
Transmitter

issues	Analog TV-Tx	DTTB Tx
Carriers/PA	1	(1300 ~ 5200)
Defined power(r.m.s)	1	1/9
Peak power	1	1
Efficiency (%)	20 - 25 %	?
2 tone IM	Equivalent To 33 dB	more than 37 dB

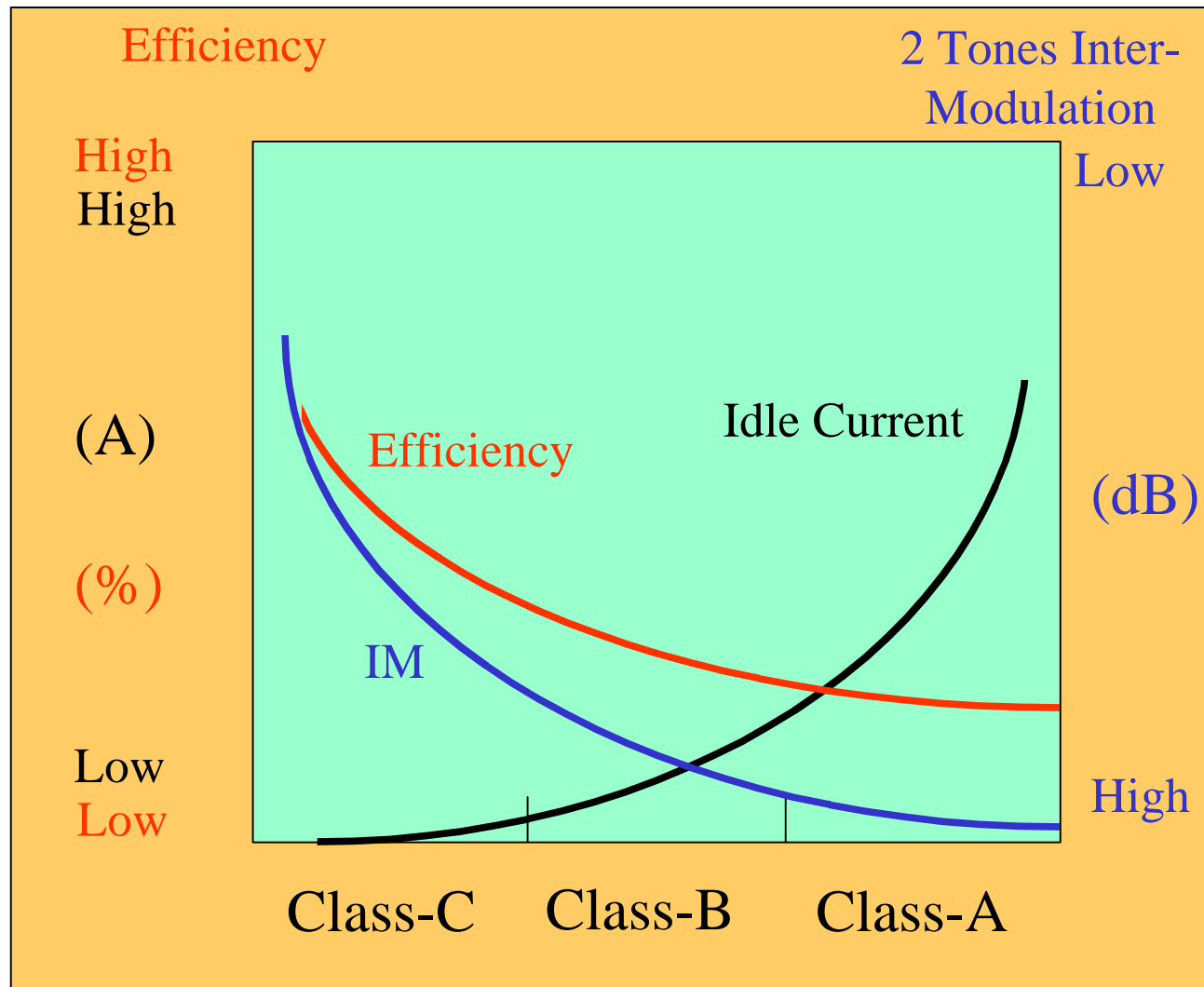
A-class HPA



B-class HPA



Typical performance of HPA



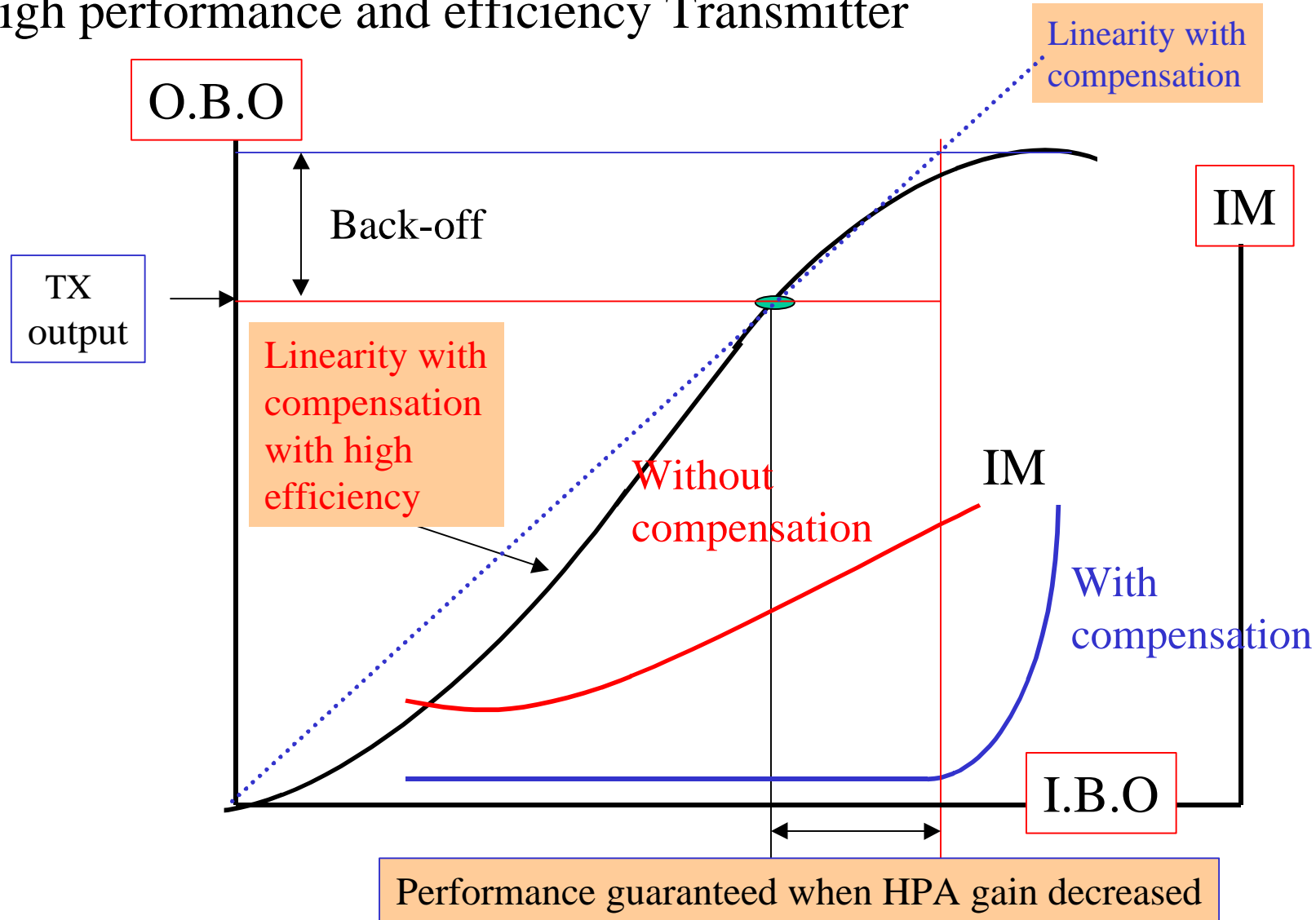
OFLC 2101 Prototype of non-linearity compensating unit



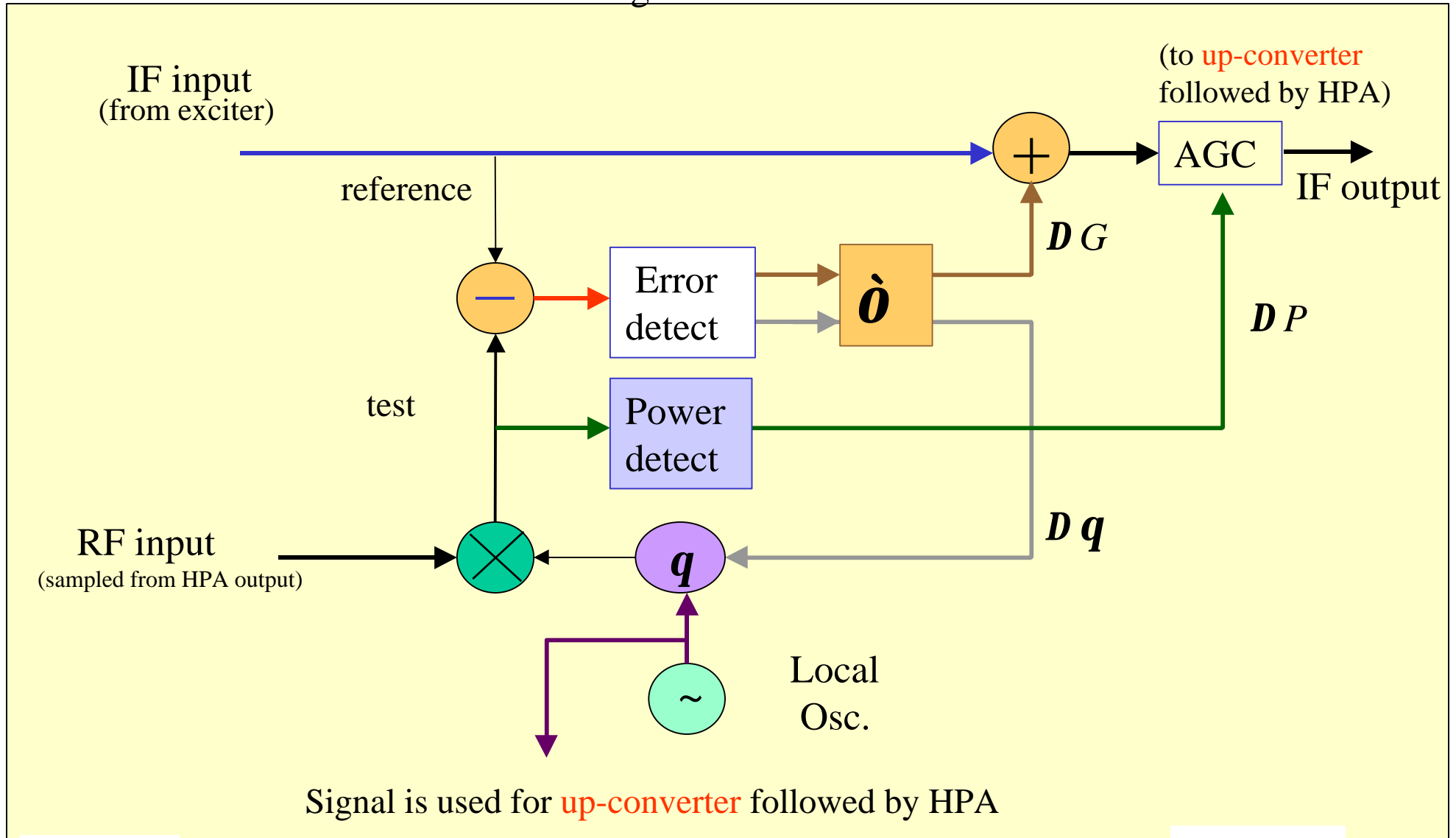
Available for all DTTB standard and analog system.
Improvement of **power efficiency** and
inter-modulation distortion
ALC enables constant HPA output power

Non-linearity corrector realize both of

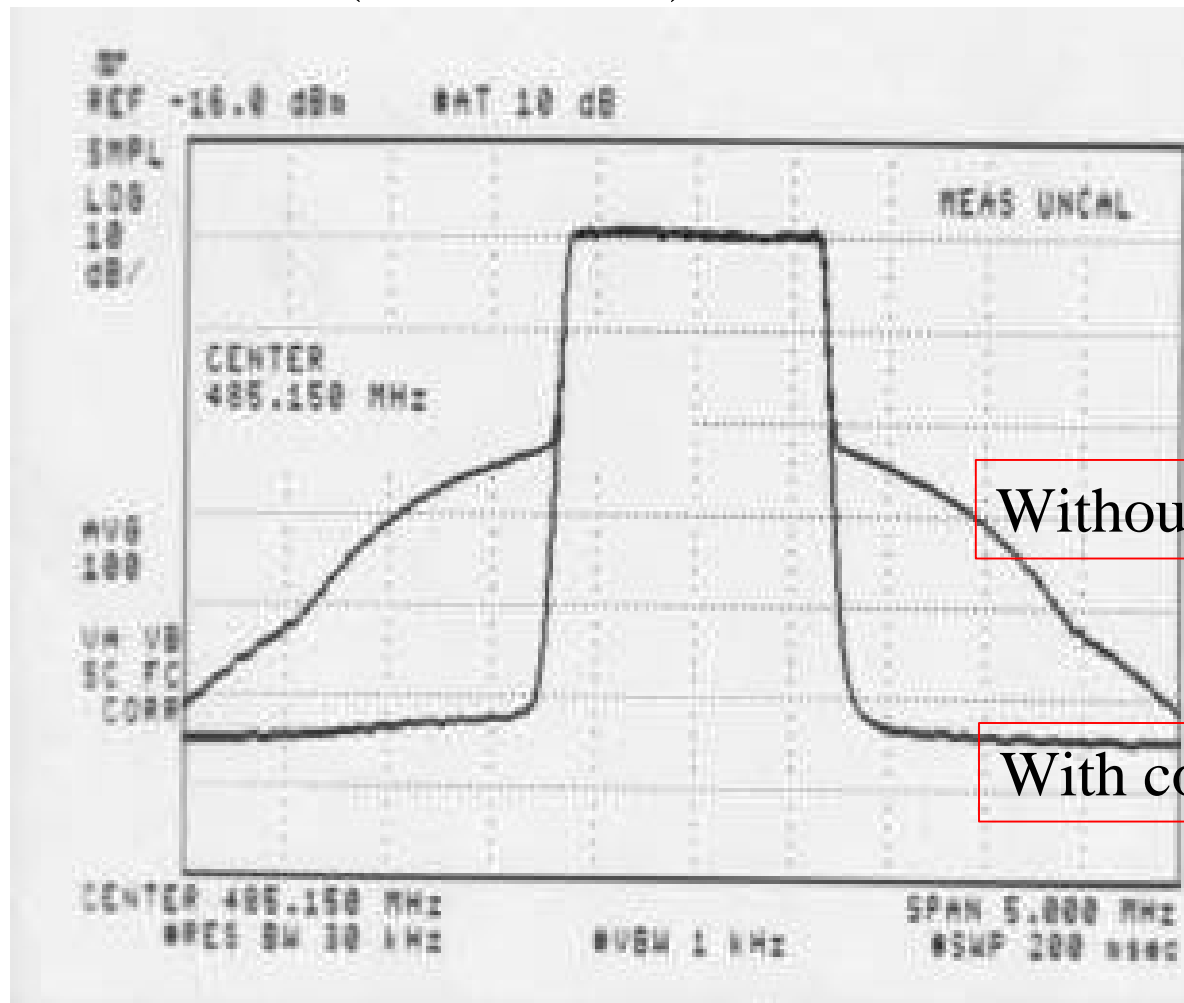
High performance and efficiency Transmitter



Block diagram of OFLC



Example of compensation (OFLC 2101)



Without compensation

With compensation

OFDM modulator with FEC (OFEX-2001)



1/8
in size
from
prototype

Light weight

Compact

Low power

Easy to operate and maintain

Remote control available

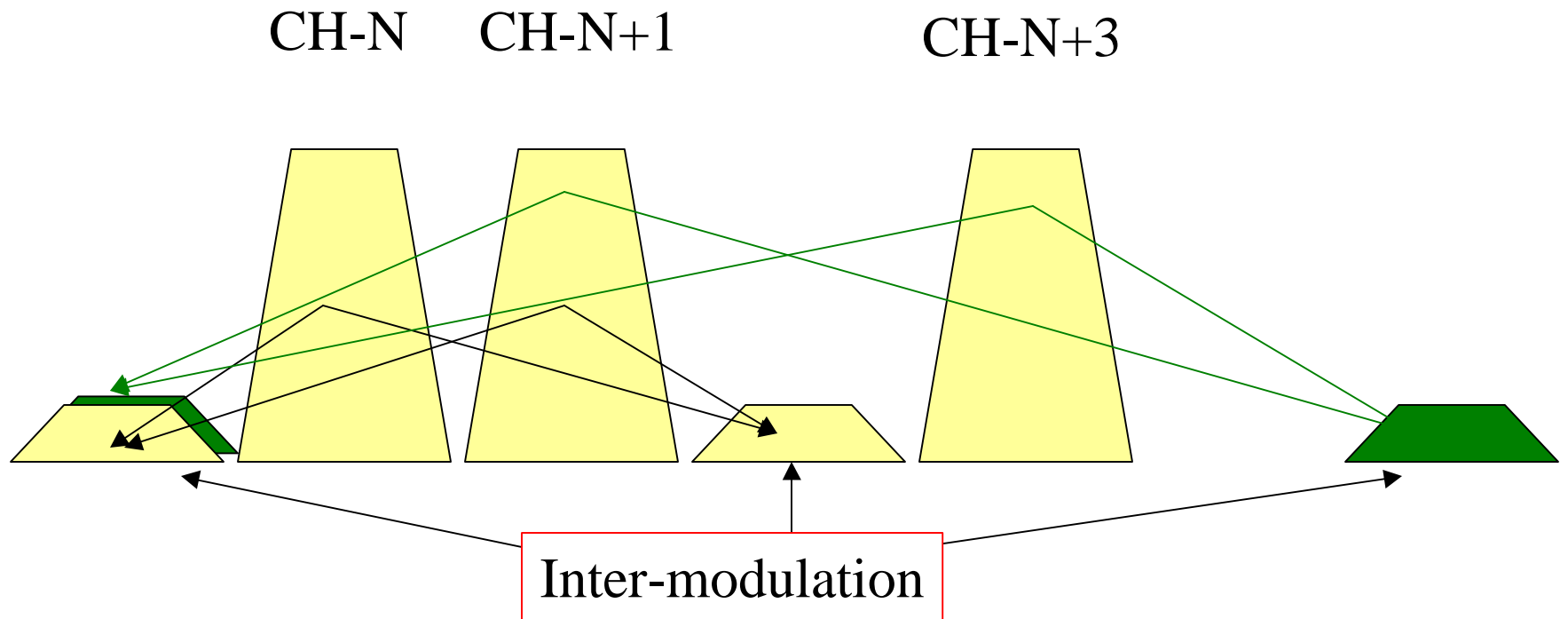
Digital Terrestrial Broadcasting

Translator

Issues	Analog translator	DTTB translator	
		Single CH	Multi- CH
Carriers / PA	3	(1300~ 5200)	(1300~ 5200)×n
Power (r.m.s)	1	1 / 9	1 / 9 × n
Peak power	1	1	N
2-tone IM (dB)	more than 33dB	more than 37dB	More than 50dB
solution		OFLC-2101	MCPA

Inter-modulation of multi-channel Amplification

Gives **interference** to adjacent channel

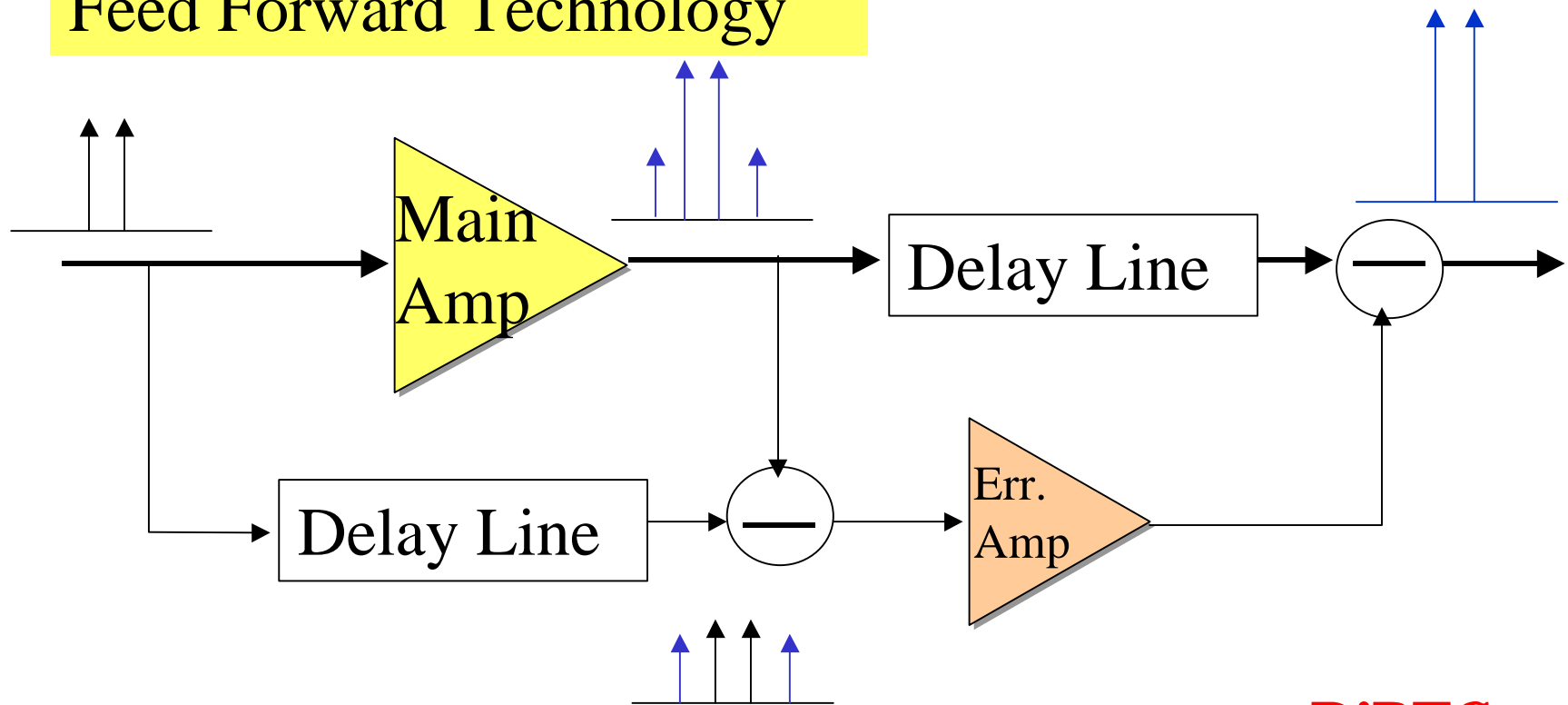


Should be lower than 50dB

MCA/Feed forward PA

Multi-channel Amplifier with linearity compensation
Single channel Amplifier with linearity compensation

Feed Forward Technology



Re-generate studio quality in transmission system

	function
Multi-Pass Cancel Unit	Cancel ghost wave occurred in transmission line such as microwave, broadcast wave link.
Spectrum equalizing Unit	Equalize RF amplitude in frequency domain damaged in propagation pass.
Synthesized Oscillator	Ultra high stabilized Oscillator using LW reference signal

OFDM multi-path canceling unit

OFLC2101



Input C/I > 3dB

Output C/I > 35dB

Available for relay station with **canceling multi-path waves**

Adaptive feed-back system applied

ghost waves should be within **guard interval** from main carrier

3 multi-path waves are cancelled

Transmission Equalizer unit

OFEQ-2101



Compensate rf **amplitude distortion** in broadcasting relay link
Tilt, ripple and band edge are independently compensated
Adopt into system(relay station) in **IF**(intermediate frequency)

Synthesized Up-converter with UHS-VCO

OFUC-2001



Ultra high stabilized Oscillator
using LW reference signal

Light weight

Compact

Low power

SFN available

Transmitting (Test equipment for transmitter)

Also used for test equipment in receiver mass-pro line

	function
Non-linear simulator	Generates voluntary nonlinear signal such as power amp distortion
Multi-pass simulator	Generates multi-pass signal adjustable ratio latency & set number of delayed carriers
OFDM spectrum simulator	Generates OFDM spectrum with linear distortion in RF amplitude characteristics
OFDM C/N simulator	Generates OFDM spectrum with random noise

Conclusion

New system, new technology and new products for DTTB age has been introduced.

These are under trial operation by using DTTB trial system at 10 cities in Japan.

Much more improvement are expected.

Most of products introduced in this paper has already exhibited at Inter-BEE '99 held in Tokyo.

Be our partner and go forward with us.