

# Overview of Speech Coding Standards

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ECE 241

# ITU-T Standard Speech Coders

(Kondo, 2004)

Speech coder	Bit rate (kb/s)	VAD	Noise reduction	Delay (ms)	Quality	Year
G.711 (A/ $\mu$ -Law PCM)	64	No	No	0	Toll	1972
G.726 (ADPCM)	40/32/24/16	No	No	0.25	Toll	1990
G.728 (LD-CELP)	16	No	No	1.25	Toll	1992
G.729 (CSA-CELP)	8	Yes	No	25	Toll	1996
G.723.1 (MP-MLQ/ACELP)	6.3/5.3	Yes	No	67.5	Toll/ Near-toll	1995
G.4k (to be determined)	4	-	Yes	~55	Toll	2001

# ETSI Speech Coding Standards for GSM (Kondo, 2004)

Speech coder	Bit rate (kb/s)	VAD	Noise reduction	Delay (ms)	Quality	Year
FR (RPE-LTP)	13	Yes	No	40	Near-toll	1987
HR (VSELP)	5.6	Yes	No	45	Near-toll	1994
EFR (ACELP)	12.2	Yes	No	40	Toll	1998
AMR (ACELP)	12.2/10.2/7.95/ 7.4/6.7/5.9/ 5.15/4.75	Yes	No	40/45	Toll ~ Communi- cation	1999

# TIA/EIA Speech Coding Standards for North American TDMA/CDMA Mobile Communications (Kondo, 2004)

Speech coder	Bit rate (kb/s)	VAD	Noise reduction	Delay (ms)	Quality	Year
IS-96-A (QCELP)	8.5/4/2/0.8	Yes	No	45	Near-toll	1993
IS-127 (EVRC)	8.5/4/2/0.8	Yes	Yes	45	Toll	1995
IS-733 (QCELP)	14.4/7.2/3.6/1.8	Yes	No	45	Toll	1998
IS-54 (VSELP)	7.95	Yes	No	45	Near-toll	1989
IS-641-A (ACELP)	7.4	Yes	No	45	Toll	1996

# U. S. DoD Standards (Kondo, 2004)

Speech coder	Bit rate (kb/s)	VAD	Noise reduction	Delay (ms)	Quality	Year
FS-1015 (LPC-10e)	2.4	No	No	115	Intelligible	1984
FS-1016 (CELP)	4.8	No	No	67.5	Communication	1991
DoD 2.4 (MELP)	2.4	No	No	67.5	Communication	1996
STANAG (NATO) 2.4/1.2 (MELP)	2.4/1.2	No	Yes	>67.5	Communication	2001

# Mean Opinion Score (MOS)

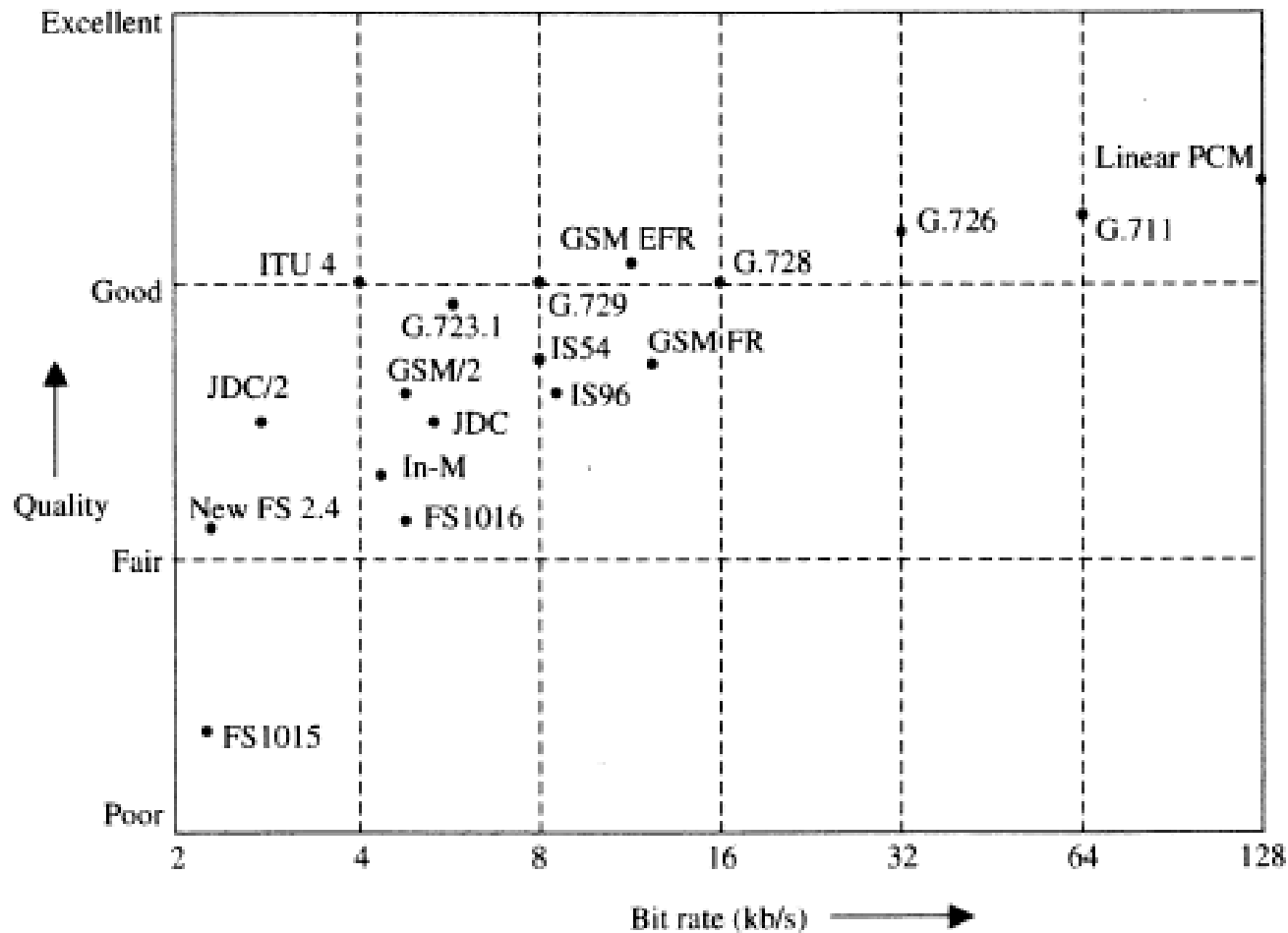
(Kondo, 2004)

Grade (MOS)	Subjective opinion	Quality
5 Excellent	Imperceptible	Transparent
4 Good	Perceptible, but not annoying	Toll
3 Fair	Slightly annoying	Communication
2 Poor	Annoying	Synthetic
1 Bad	Very annoying	Bad

# A Comparison of Speech Coding Standards (Kondo, 2004)

Standard	Year	Algorithm	Bit rate (kb/s)	MOS*	Delay <sup>+</sup>
G.711	1972	Companded PCM	64	4.3	0.125
G.726	1991	VBR-ADPCM	16/24/32/40	toll	0.125
G.728	1994	LD-CELP	16	4	0.625
G.729	1995	CS-ACELP	8	4	15
G.723.1	1995	A/MP-MLQ CELP	5.3/6.3	toll	37.5
ITU 4	-	-	4	toll	25
GSM FR	1989	RPE-LTP	13	3.7	20
GSM EFR	1995	ACELP	12.2	4	20
GSM/2	1994	VSELP	5.6	3.5	24.375
IS54	1989	VSELP	7.95	3.6	20
IS96	1993	Q-CELP	0.8/2/4/8.5	3.5	20
JDC	1990	VSELP	6.7	commun.	20
JDC/2	1993	PSI-CELP	3.45	commun.	40
Inmarsat-M	1990	IMBE	4.15	3.4	78.75
FS1015	1984	LPC-10	2.4	synthetic	112.5
FS1016	1991	CELP	4.8	3	37.5
New FS 2.4	1997	MELP	2.4	3	45.5

# Performance of Telephone Band Speech Coding Standards (Kondo, 2004)



**TABLE 9.6.1** Quantizer Characteristic and Code Assignment for D2, D3, and D4 Channel Bank Codecs<sup>a</sup>

Input Amplitude Range:	Step Size:	Polarity Bit:	Quantization Segment Code:	Quantizer Step Code:	Output Value:
0-1	1	1	111	1111	0
1-3	2	1	111	1110	2
3-5				1101	4
⋮				⋮	⋮
29-31				0000	30
31-35	4	1	110	1111	33
⋮				⋮	⋮
91-95				0000	93
95-103	8	1	101	1111	99
⋮				⋮	⋮
215-223	0000	219			
223-239	16	1	100	1111	231
⋮				⋮	⋮
463-479				0000	471
479-511	32	1	011	1111	495
⋮				⋮	⋮
959-991				0000	975
991-1055	64	1	010	1111	1023
⋮				⋮	⋮
1951-2015	0000	1983			
2015-2143	128	1	001	1111	2079
⋮				⋮	⋮
3935-4063				0000	3999
4063-4319	256	1	000	1111	4191
⋮				⋮	⋮
7903-8159	0000	8031			

<sup>a</sup> Positive inputs only; assumed symmetric about zero.