Sharmon - Hartley theorem (Channel Capacity of a Gravesian Channel) channel with Gaussian noise characteristics are known as Gaussian channel. The result obtained for a Gaussian channel. often provide a lower bound on the performance of a system with the non-gaussian channel. For a Gaussian channel probabaility density function P(m) P(N) = 1 = e -22/202 H(N) = - 5 P(N) (og P(N) dx = - [P(n) logP(n) dx = - lug - luge - x2/202 = lug 12110 + x2 luge. H(x) = S(log \( \frac{1}{202} + \frac{\chi^2}{202} \) \( \log \) P(n) dx = S lug DIT o 2 dx + S x2 luge P(n) dx = lug Jeror + lage f x2 p(n)dn = lug 52110 + 1 luge = lug 52110 + lugse = lug /211eo2

Hartley theorem (Channel Capacity of a Gaussian C the Gaussian ruise characteristics one known as hannel. The result obtained for a Gaussian ch vide a lower bound on the performance of a non-gaussian channel. aussian channel, probabaility density function  $P(N) = \frac{1}{\sqrt{2\pi c^2}} e^{-\chi^2/2\sigma^2}$  $H(u) = -\int P(x) (og P(n) dx$ = - P(n) logP(n) dx - lug P(n) = - lug ( ) e - x2/202)  $=-\log\frac{1}{\sqrt{2\pi\sigma L}}-\log e^{-\chi^2/26^2}$ = lug 12TTor + x2 luge.  $H(x) = \int \left(\log \sqrt{2\pi\sigma^2} + \frac{x^2}{2\sigma^2} \log e\right) P(x) dx$ = Sug DIT of dx + S x2 loge P(n) dx = lig Jerror + loge f x2 p(n)dx = lug 52110 + 1 luge = lug 52110+ lug = Wg /211002

Sharmon - Hartley theorem (Channel Capacity of a Gaussian Channel) Channel with Gaussian ruise characteristics one known as Gaussian channel. The result obtained for a Gaussian channel. offen provide a lower bound on the performance of a system with the non-gaussian channel. For a Gaussian channel, probabaility density function P(m)  $P(N) = \frac{1}{\sqrt{2776^2}} e^{-\chi^2/2\sigma^2}$  $H(x) = -\int_{-\infty}^{\infty} p(x) (\log p(n)) dx$  $=-\int P(n) \log P(n) dn$ - lug P(n) = -lug ( 1 e - 2/202)  $=-\log\frac{1}{\sqrt{2\pi\sigma L}}-\log e^{-\chi^2/26^2}$  $H(x) = \int \left(\log \sqrt{2\pi\sigma^2} + \frac{x^2}{2\sigma^2} \log e\right) P(x) dx$ =  $\int \log \sqrt{2\pi} \sigma_{AM}^2 dx + \int \frac{x^2}{2\sigma^2} \log \rho(x) dx$ =  $lig \sqrt{2\pi\sigma L} + \frac{lige}{2\sigma L} \int_{-\infty}^{\infty} \chi^2 p(n) dn$ = lug 52110 + 1 luge = lug 52110 + lugue

= lug \( \sqrt{211e02}

The Rode of information.

$$R(x) = 2B H(x)$$

$$= 2B \log \sqrt{2\pi e \sigma^2}$$

$$= B \log (2\pi e \sigma^2)^2$$

$$= B \log (2\pi e \sigma^2)$$

If P(x) is a bondlimited Gaussian moise with an annaye noise power N, thun

R(m) = Blog(2TIEN).

If the Received signal is composed of a transmitted signed n and noise n, then the joint entropy of the source and noise is given by.

R(n,n) = R(n) + R(n/x)

Assume that eight and noise on independent. R(x,n) = R(x) + R(n)

Signal n and the noise n, we may equate

H(x,y) = H(x,n) H(y) + H(x/y) = H(x) + H(n). R(y) + R(x/y) = R(n) + R(n)R(x) - R(n/y) = R(y) - R(n)

Rate of Information. From channel R = R(n) - R(n/y) = R(y) - R(y)

The Rode of information. R(x) = 2B H(x)  $= 2B \log \sqrt{2\pi e \sigma^2}$   $= B \log (2\pi e \sigma^2)$   $= B \log (2\pi e \sigma^2)$ 

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Rate of Information. From channel R = R(n) - R(n)/y = R(y) - R(y)

The Rade of information. R(x) = 2B H(x)  $= 2B \log \sqrt{2\pi e \sigma^2}$   $= B \log (2\pi e \sigma^2)$   $= B \log (2\pi e \sigma^2)$ 

If P(x) is a bondlimited Gaussian moise with an amuge noise power N, thun

R(n) = Blog(2TICN).

If the Received signal is composed of a transmitted signal n and noise n, then the joint entropy of the source and noise is given by.

R(n,n) = R(n) + R(n/x)

Assume that signed and noise on independent. P(x,n) = P(x) + P(n)

Since the recived eignor is the sum of the transmitted Signal n and the noise n, we may equate

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Rate of Juformation. From channel R = R(n) - R(n)/y = R(y) - R(n)

channel capacity c = Max R = MAX[P(y)-P(m)] maximinize R, require maniroising Q(y). Ry) = Bwg[2TIC(S+N)] PIn) = B WY[ZNON] C = B lugene(STN), ] - Blug[znen] = Blug S+N C = B lug(1+ 5) where B = Board with of chams. S = Avery Signed power N= averge noise power = mut 12B = nBC = Blog (1+ S)

Channel Capacity ( = Max R = MAX[P(y)-P(m)] maximining R, require maximizing Q(y). Ply) = Blug[2TIC(S+N)] PIN) = B WG[ZNEN] C = Bluggerre(STN)] - Blugg[znen] = Blug STN C=BWg(1+5) where B = Band with. of channel. S = Avery Signal power N= averge noise power = med 21 2B = nB

$$C = B \log_2 \left(1 + \frac{S}{nB}\right)$$

Der Bandwickter Frede OFF

$$\frac{3}{N} = 15$$
 and  $B = 5 \times H_2$   $\frac{3}{N} = 31$ ,  $B = 7$   $C = 30$ 

cases: 20% reduction in the B-W. (5KHz to 4KHz) require a 100% in the sign of power to Noise Ratio.

Case II: 501. reduction in the SNR (from 31 to 15)

ENR- Bandwichth Trade OFF

$$C = B\log_{2}(1+\frac{5}{N}).$$

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$$20 = B\log(1+\frac{5}{N}).$$

$$\frac{3}{N} = 31$$

$$C = B \log (1 + \frac{5}{N})$$

$$20 = B \log (1 + 31)$$

$$20 = B \log_2 32$$

$$20 = B \log_2 2^5$$

$$20 = B \times 5 \log_2 2$$

$$\frac{20}{5} = B \log_2 2$$

$$B = 4 \log_2 2$$

$$B = 4 \log_2 2$$

=5x4

= 20 Kbps.

$$\frac{S}{N} = 31$$

$$B = 4 KH_2$$

case : 20% reduction in the B-W. (5KM to 4KHz) require a loss. in the sign of power to Noise Ratio.

Case II: 50.1. reductive in the SNR (from 31 to 15)

Channel Barolwidth of Infinite Bandwidth Channel. C = Blog (1+ 5) N= Noise power  $=\frac{n}{2} \times 2B = nB$ C = Blog (1+ S)  $= \frac{B}{\log 2} \log_e \left(1 + \frac{S}{50B}\right)$ Cos = lin B loge (1+ S) If Band width Infinite - ling B ( 5 - 1 (5) + 3 (5) + -) = lins & x 5 (1- 2 (5) + 3 (5) 2) = 5 7 loge (1-0+0+--) ( 00 = 1.44 s

Channel Bandwidth of Infinite Bandwidth channel C = Blog (1+ 5) N= Noise power  $=\frac{n}{2}\times 2B - nB$ C = Blog (1+ S) = B loge (1+ SB) Cos = lim B loge (1+ S) IF Band width Jufinite = lino B (5 - 1(5) + 3(5) + -) = lins wg2 x ng (1- 2 (5) + 3 (5) 2) = 5 (1-0+0+--) = 1.44 5