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EE6403
Distributed Multimedia Systems
Part 4 Discussion

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Why Standardize and Use Protocols?

- Networking supports communication among multiple entities.
- Agreement needed to make communication correct, efficient, and meaningful.

Which Organizations Issue Standards?

- IEEE (*Institute of Electrical and Electronics Engineers*)
- IETF (*Internet Engineering Task Force*)
- ITU (*International Telecommunications Union*)
- ISO (*International Organization for Standardization*)
- W3C (*World Wide Web Consortium*)
- and many others

Solution: Channel Capacity

$$B = 4\ \text{MHz} - 3\ \text{MHz} = 1\ \text{MHz}$$

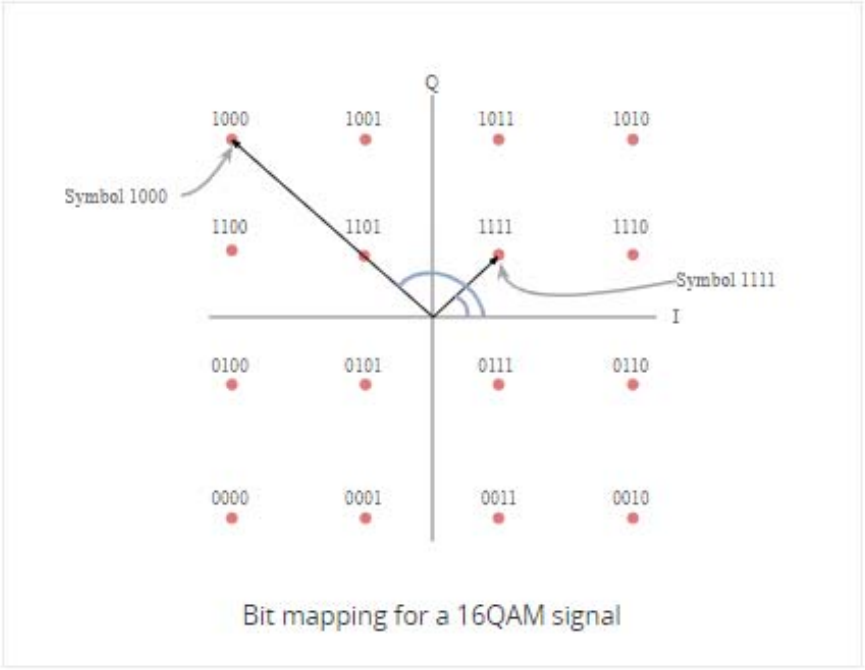
$$\text{SNR}_{\text{dB}} = 24\,\text{dB} = 10\log_{10}(\text{SNR})$$

$$\text{SNR} = 251$$

Using Shannon's formula,

$$C = 10^6 \times \log_2(1 + 251) \approx 10^6 \times 8 = 8\ \text{Mbps}$$

Quadrature Amplitude Modulation (QAM)



Bit mapping for a 16QAM signal

QAM FORMATS & BIT RATES COMPARISON

MODULATION	BITS PER SYMBOL	SYMBOL RATE
BPSK	1	1 x bit rate
QPSK	2	1/2 bit rate
8PSK	3	1/3 bit rate
16QAM	4	1/4 bit rate
32QAM	5	1/5 bit rate
64QAM	6	1/6 bit rate

2-D Parity Check

- When would 2-D Parity Check fail?

0	1	1	1	1	1	0	1
0	(0)	1	1	0	(1)	1	0
0	0	1	1	0	0	1	1
0	(0)	0	0	0	(0)	0	0
1	0	1	1	1	1	1	0
1	1	0	0	0	1	1	0

(d) Uncorrectable error pattern

Solution: CRC Using Modulo 2 Arithmetic (1)

Source: ques10.com

Solution: CRC Using Modulo 2 Arithmetic (2)

Transmitted codeword :

1 1 0 1 0 1 1 1 1 1 0 0 1 0

Erroneous transmitted codeword

1 1 0 1 0 1 1 0 1 1 0 0 1 0

↑ 8th bit from left.

```
                1 1 0 0 0 0 1 0 1 0
          ------------------------------
1 0 0 1 1 | 1 1 0 1 0 1 1 0 1 1 0 0 1 0
            1 0 0 1 1
          ------------
              1 0 0 1 1
              1 0 0 1 1
          ------------
                  1 0 1 1 0
                  1 0 0 1 1
          ------------
                    1 0 1 0 1
                    1 0 0 1 1
          ------------
                    1 1 0 0   ← Remainder ≠ 0
```

∴ Can detect error

Solution: CRC Using Polynomial Approach

Data : 00111011001

Data polynomial M(x) : $X^8 + X^7 + X^6 + X^4 + X^3 + 1$

Augmented data polynomial, $X^4M(X)$: $X^{12} + X^{11} + X^{10} + X^8 + X^7 + X^4$, $P(X) = X^4 + X^3 + 1$

Perform long division of $\frac{X^4M(X)}{P(X)}$

$$
\begin{array}{r}
X^8 + X^6 + X^5 + X^4 + X^2 \\
X^4 + X^3 + 1 \;\big)\; X^{12} + X^{11} + X^{10} + X^8 + X^7 + X^4 \\
X^{12} + X^{11} + X^8 \\
\hline
X^{10} + X^7 + X^4 \\
X^{10} + X^9 + X^6 \\
\hline
X^9 + X^7 + X^6 + X^4 \\
X^9 + X^8 + X^5 \\
\hline
X^8 + X^7 + X^6 + X^5 + X^4 \\
X^8 + X^7 + X^4 + X^2 \\
\hline
X^6 + X^5 + X^2 \\
X^6 + X^5 + X^2 \\
\hline
0
\end{array}
$$

Remainder R(x) : X^2

∴ Polynomial codeword : $X^4M(X) + R(X)$

: $X^{12} + X^{11} + X^{10} + X^8 + X^7 + X^4 + X^2$

Codeword : 001110110010100

TCP vs UDP

Summary Comparison of UDP and TCP		
Characteristic / Description	**UDP**	**TCP**
General Description	Simple, high-speed, low-functionality "wrapper" that interfaces applications to the network layer and does little else.	Full-featured protocol that allows applications to send data reliably without worrying about network layer issues.
Protocol Connection Setup	Connectionless; data is sent without setup.	Connection-oriented; connection must be established prior to transmission.
Data Interface To Application	Message-based; data is sent in discrete packages by the application.	Stream-based; data is sent by the application with no particular structure.
Reliability and Acknowledgments	Unreliable, best-effort delivery without acknowledgments.	Reliable delivery of messages; all data is acknowledged.
Retransmissions	Not performed. Application must detect lost data and retransmit if needed.	Delivery of all data is managed, and lost data is retransmitted automatically.
Features Provided to Manage Flow of Data	None	Flow control using sliding windows; window size adjustment heuristics; congestion avoidance algorithms.
Overhead	Very low	Low, but higher than UDP
Transmission Speed	Very high	High, but not as high as UDP
Data Quantity Suitability	Small to moderate amounts of data (up to a few hundred bytes)	Small to very large amounts of data (up to gigabytes)
Types of Applications That Use The Protocol	Applications where data delivery speed matters more than completeness, where	Most protocols and applications sending data that must be