Protocols, Modulations, & Modes… Oh, my!

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Overview

- Mode – An Antique
- Basic Terms and Ideas
- The Deck is Stacked
- Examples
  - Digital comm systems
  - Sending a form
- Goal – acquaint you with useful datacomm models and make you a more skilled user

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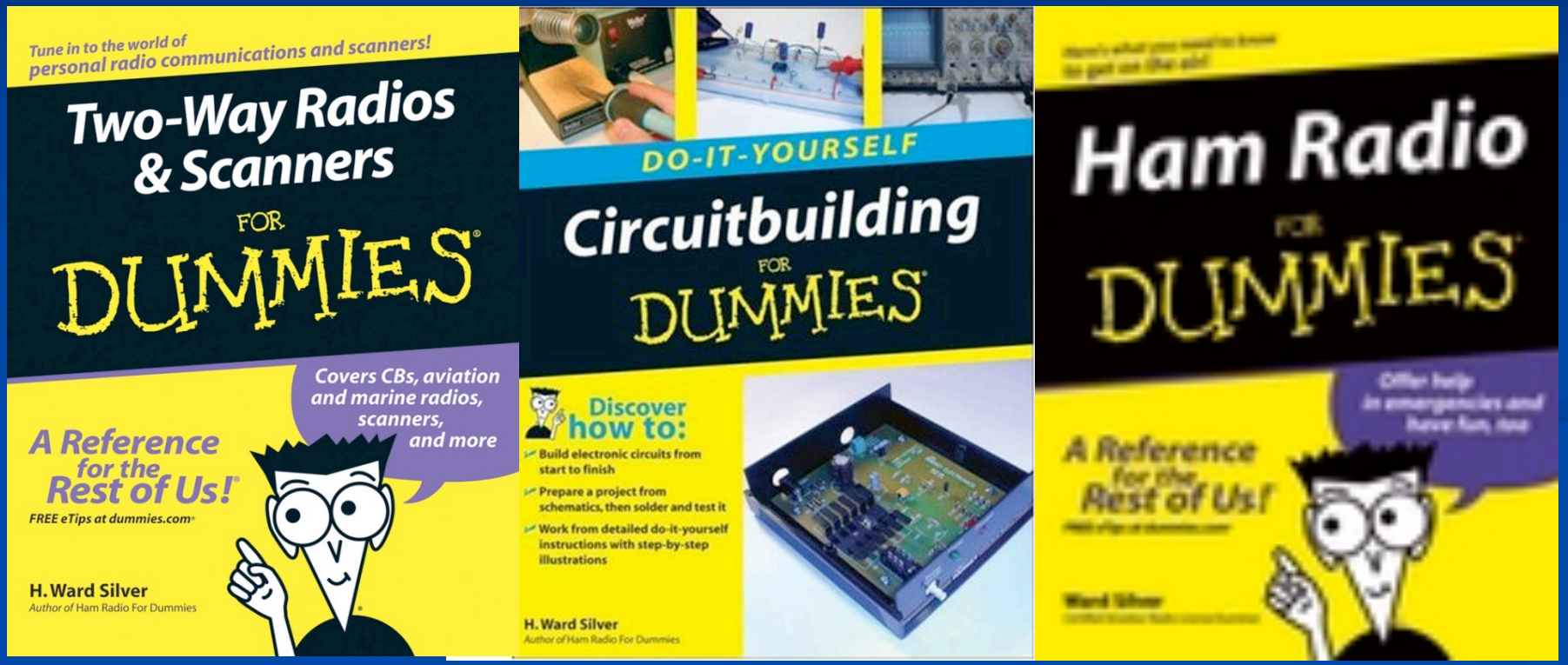
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Digital Comm - History

- Stage 1
  - Keyboard to keyboard “chat”, 100 bps or less
  - RTTY, various “TOR”, PSK31/63
- Stage 2
  - Packetized data transfer, to 9600 bits/second
  - AX.25 (“Packet”), PACTOR, DRM, TCP/IP
- Stage 3
  - Network-compatible, 100 kbps and up
  - D-STAR, HSMM

Traditional Concept of Mode

- FCC "emission" combines
  - Modulation type (AM, SSB FM, PM)
  - Modulating signal (an/dig, mpx/non-mpx)
  - Information (voice, data, Morse, image, video)
- RTTY J2B, VHF Packet F2D, ATV C6F
- What is the designator for sending code practice as MP3 data over a packet network?
- "Mode" is overloaded

Dealing with "Mode"

- "Data" modes can carry any information
- Does "mode" mean "configuration" or "modulation" or both or what?
- New "modes" being invented weekly
  - Variants of PSK
  - Systems running over D-STAR
  - Regulatory and technical confusion
- Start by using terms correctly

Datacomm Lingo

- Baud & Symbols
  - A baud is a signaling "event"
  - Baud rate is the number of events per second
    - Rate is "baud" – not "bauds"
  - A baud transfers a symbol
    - "one if by land, two if by sea"
    - Mark or space tone
    - CW signal on or off

Signaling Rate

- Baud Rate may *not* be Data Rate
- A symbol may represent more than one bit
  - 9600 bps is sent at 4 bits per symbol
  - Baud rate is 2400 baud, data rate is 9600 bps
- System data rate includes overhead
  - Framing bits (start, stop, parity)
  - Eror-corection data
  - Protocol control data and delays

Codes

- Codes are the way that information is formatted for transfer or storage
  - HDLC – serial data, 10 bits/byte (COM port)
  - ASCII – 7 or 8 bits/character (text files)
  - Baudot – 5 bits/character (RTTY)
  - Unicode – 16 bits/character
  - Varicode – variable length code for PSK31
  - Morse – variable length code for telegraphy

Protocol

- A set of rules including:
  - Formatting specification
    - Data codes
    - Data grouping
    - Arrangement of data within groups
  - Transfer rules
    - Beginning and ending transfer
    - Conducting transfer

Packet

- Set of characters of known length and format
- Defined by protocol rules
- Example – AX.25 data packet

Flag	Address	Control	ID	Information	FCS	Flag
1 byte	14-70 bytes	1 byte	1 byte	up to 256 bytes	2 bytes	1 byte

Control – status and instruction bits for use by the receiver
FCS - Frame Control Sequence, a packet ID number
Flag – allows the receiver to synchronize to the data
ID – what variation of the AX.25 protocol is being used

Protocol Examples

- AX.25 – Packet Radio
- HTTP – Hypertext Transfer Protocol
- FTP – File Transfer Protocol
- TCP – Transport Control Protocol
- IP – Internet Protocol
- D-STAR – Digital data and voice
- B2F – Winlink system

Protocol Combinations

- TCP/IP – transfers data on the Internet
- HTTP+ TCP/IP – World Wide Web
- FTP + IP – upload and download Internet files
- SMTP + B2F – Send email over Winlink

Protocol Encapsulation

- Sending the data from one protocol "inside" the data for another protocol
  - AX.25 "information" can contain a packet from another protocol as data (aka – *payload*)
- Example
  - Drop a mailed envelope in an office mailer
  - Office mail protocol "encapsulates" the envelope
  - Once removed, USPS protocols again apply
- TCP data is encapsulated in IP packets

More Datacomm Lingo

- Session – using a protocol from the initiation to its conclusion
- Connection – creating a one-to-one relationship of systems running the same protocol that persists between packets
- Connectionless – protocols that run without requiring a connection (such as information broadcasts that use the UDP protocol)

And More Datacomm Lingo

- Transport – the transfer of data between systems
- Reliable transport – transport that occurs with 100% accuracy or not at all
- Air link – the radio signal part of a comm system
- Format – rules for arrangement of data
- Form – a physical data record

Modulation

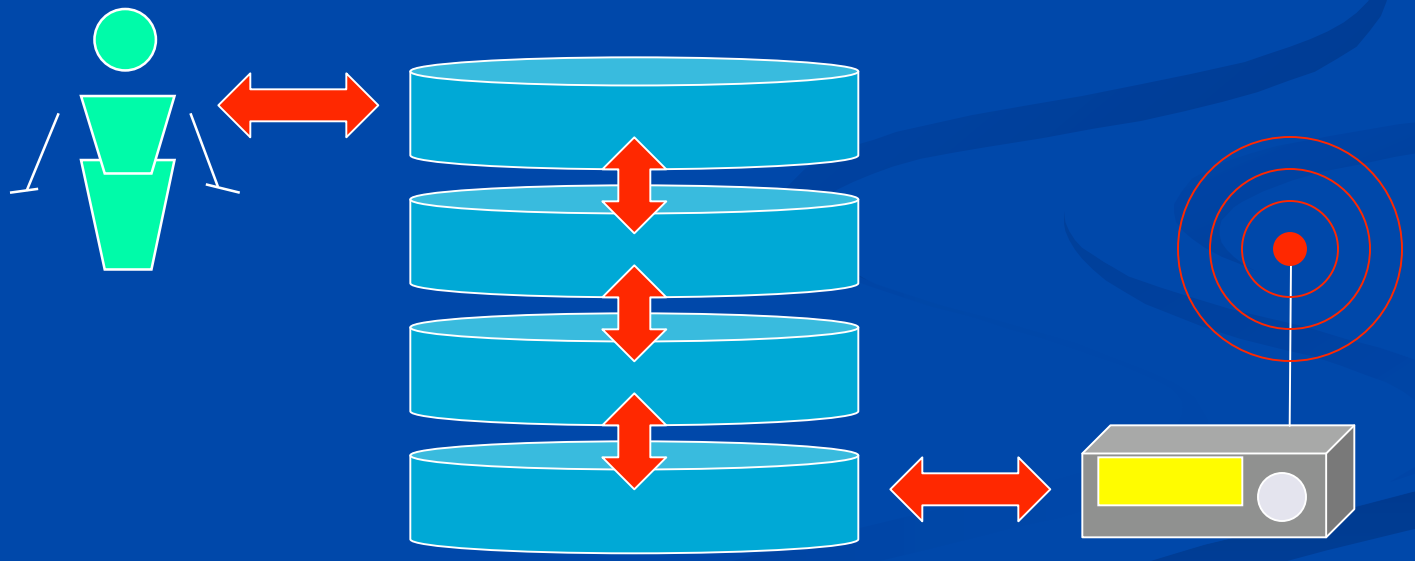
- Method of adding information to an RF signal
- Modulation is NOT mode
- SSB can be used to transmit voice, RTTY, SSTV, DRM, PSK31, MFSK16, Clover, etc
- Modulation + Protocol = Air Link

Defining a Mode

- Information + Protocol+ Modulation creates what hams call a "mode"
- How to describe the combination
  - Stack - The collection of techniques and methods a system uses to transfer information
  - Pipe – A set of stacks that gets information from one system to another as a single system

The Stack Model

- A "layer cake" of techniques
- The air link is at the bottom and the data source or data consumer is at the top



Industry Standard – OSI Stack

Highest Level, Closest to the data user

7 - Application	The data gets put to work here
6 - Presentation	What the data looks like after transfer
5 - Session	Manages the overall transfer process
4 - Transport	Manages data in and out of the pipe
3 - Network	Controls data routing through the pipe
2 - Data Link	Controls data bits in the pipe
1 - Physical	Voltage, current, tone, signal in the pipe

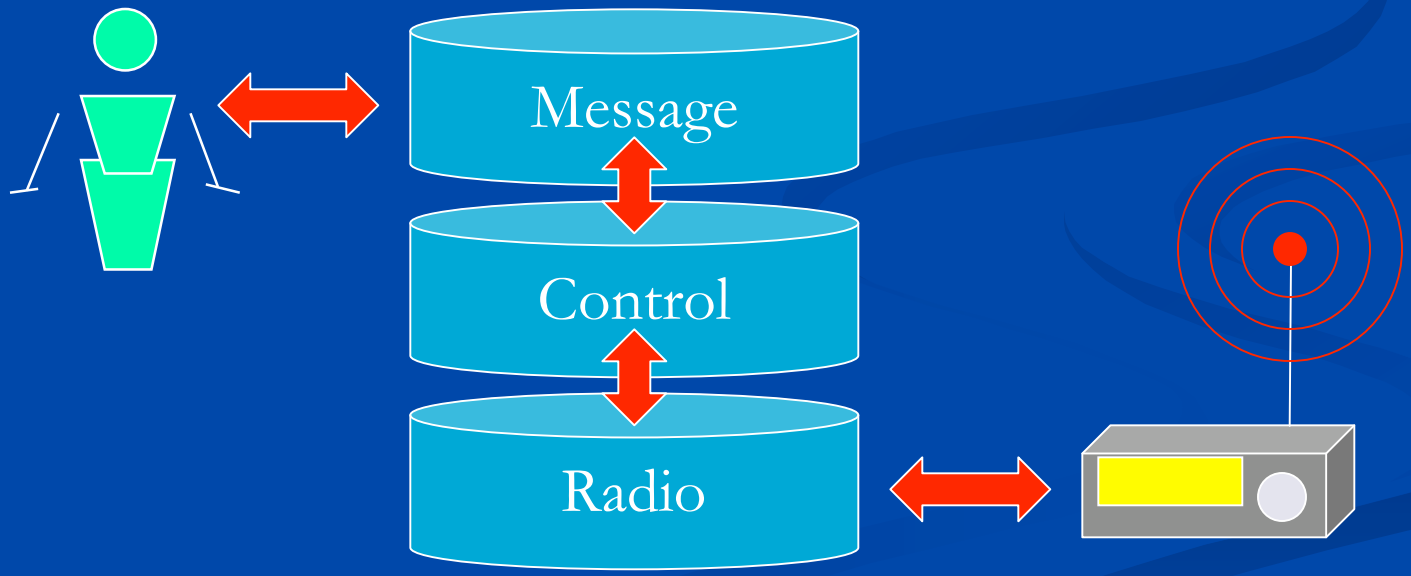
Lowest Level, Closest to the electronics or radio

Example - Post-Office Stack

7 - Write a letter	7 - Read the letter
6 - Address the envelope	6 - Open the envelope
5 - Place in the mailbox	5 - Take from the mailbox
4 - Postman takes to P.O.	4 - Postman takes to box
3 - Sort letters by dest'n	3 - Sort letters by addressee
2 - Take to routing center	2 - Send to P.O.
1 - Transport between routing centers	

Simplified Stack Model

- Full 7-layer stack is too complicated for general use – SIMPLIFY!
- Simple 3-layer model will suffice:



Radio Layer

- Air Link
  - Frequency – HF, VHF, UHF
  - Modulation – CW, SSB, FM, GMSK, PSK
  - Type of symbols – on/off, tone, phase
  - Channel access – busy or not busy

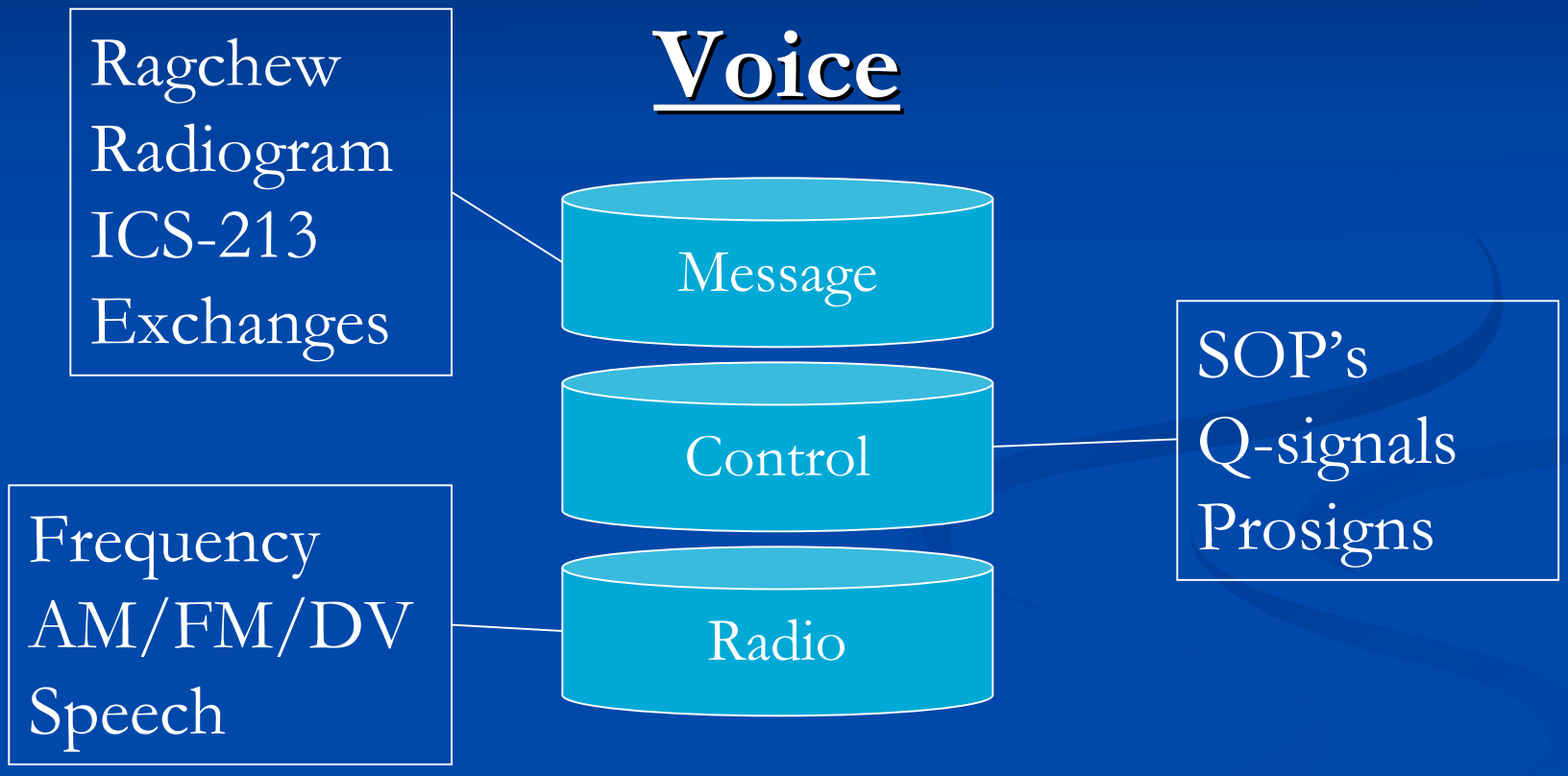
Control Layer

- Manages the flow of information
  - Session – start or stop the protocol
  - Connection – establish the relationship
  - Transport – exchanging data
  - Protocol – rules for session and transport

Message Layer

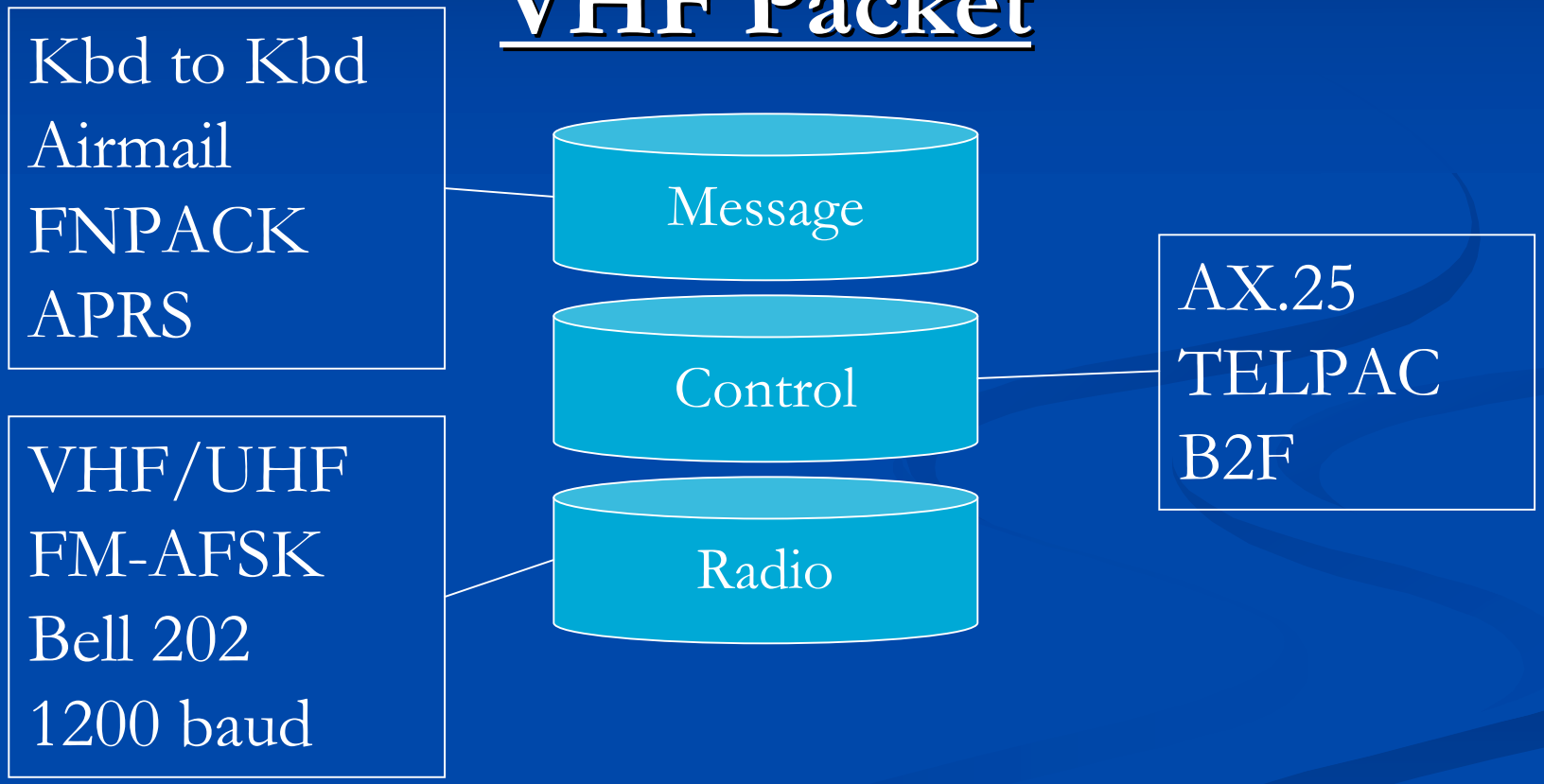
- Exchanges data with the user or the user's application software
  - Application – the use for the data
  - Presentation – the format in which data is presented to the application

Amateur Stack Examples



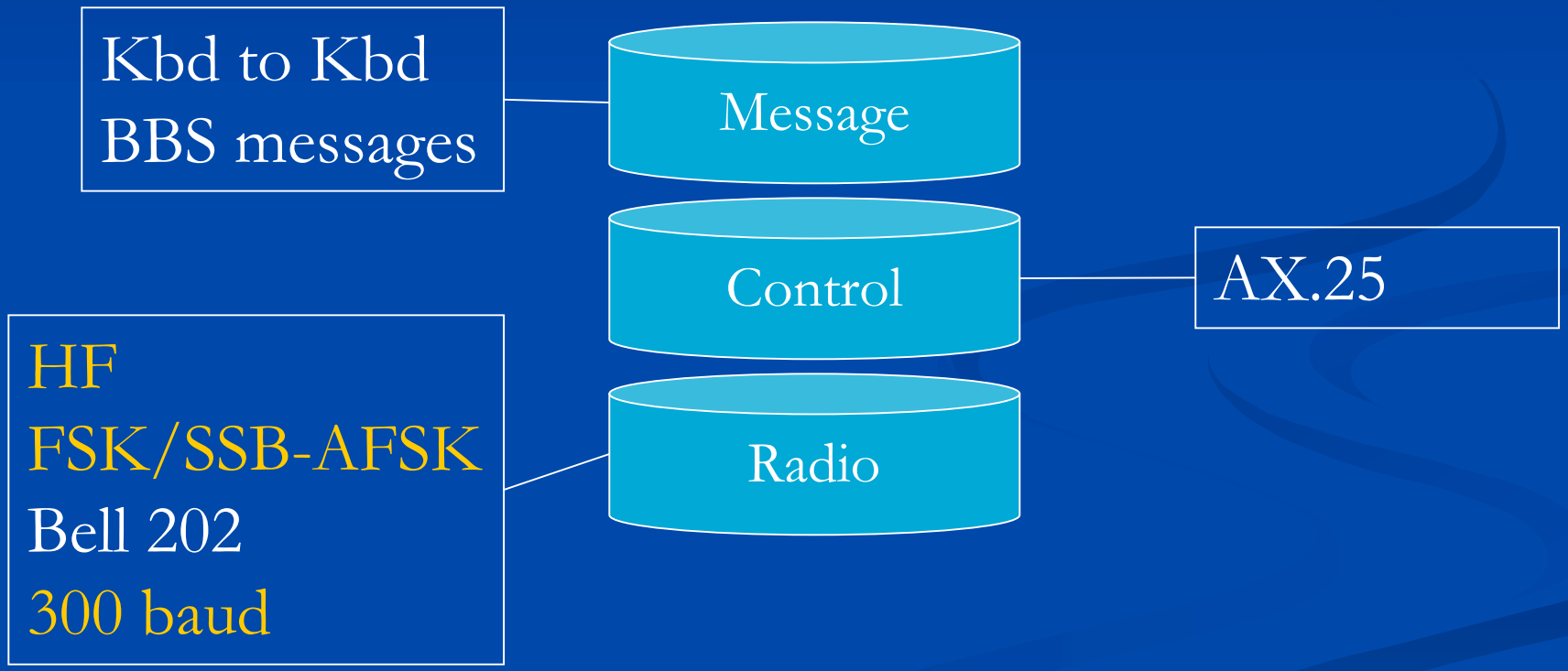
Amateur Stack Examples

VHF Packet



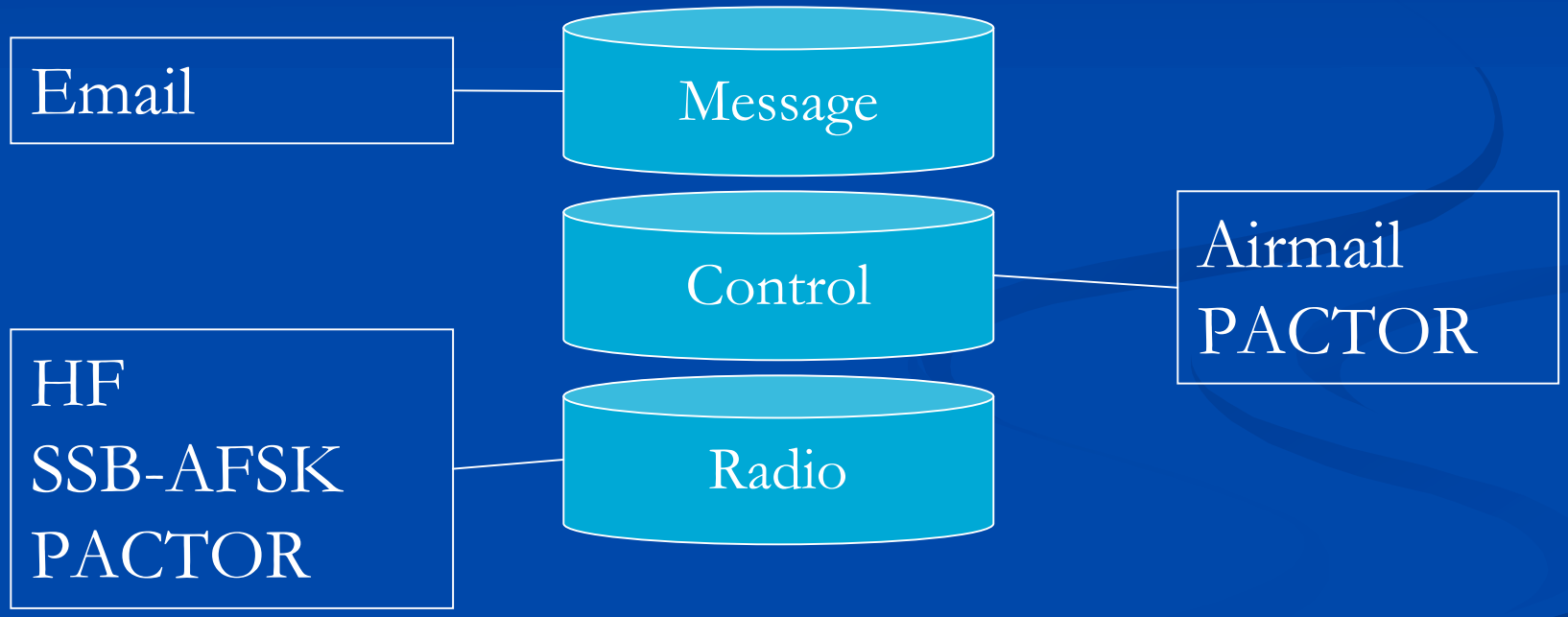
Amateur Stack Examples

HF Packet



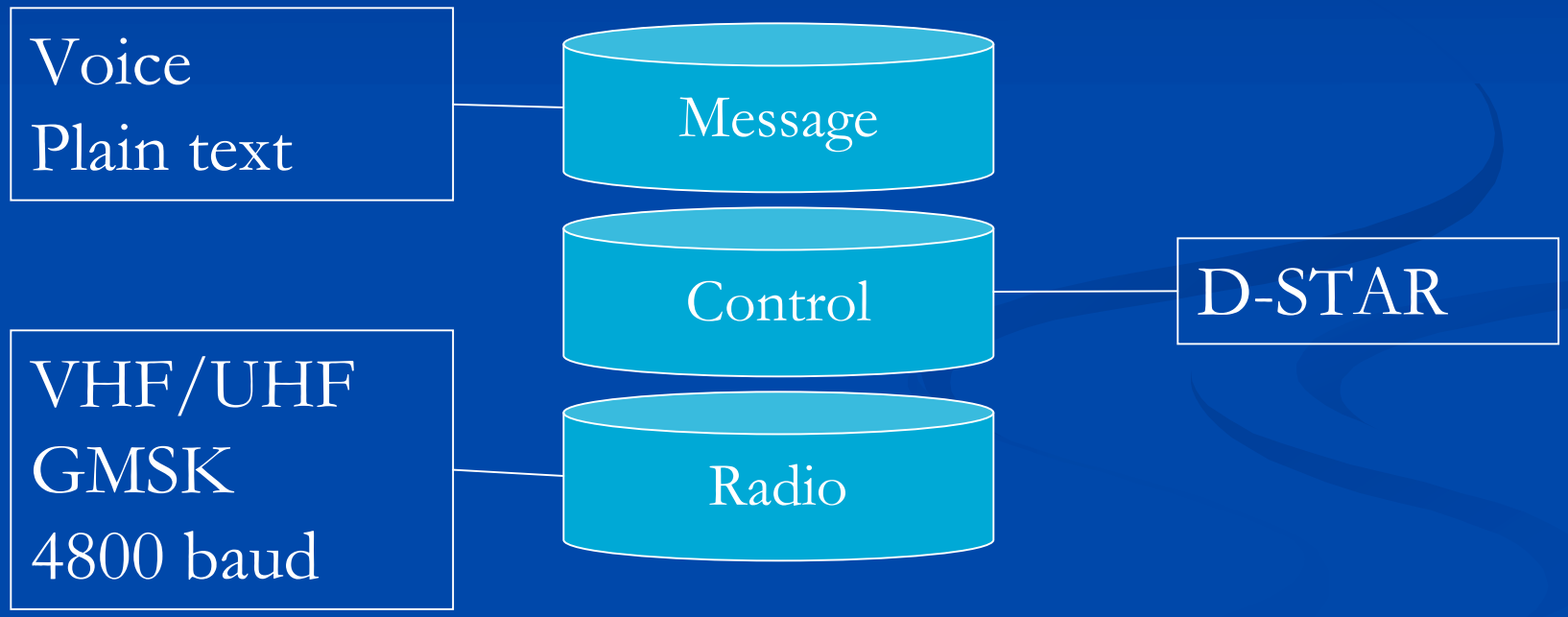
Amateur Stack Examples

HF Winlink



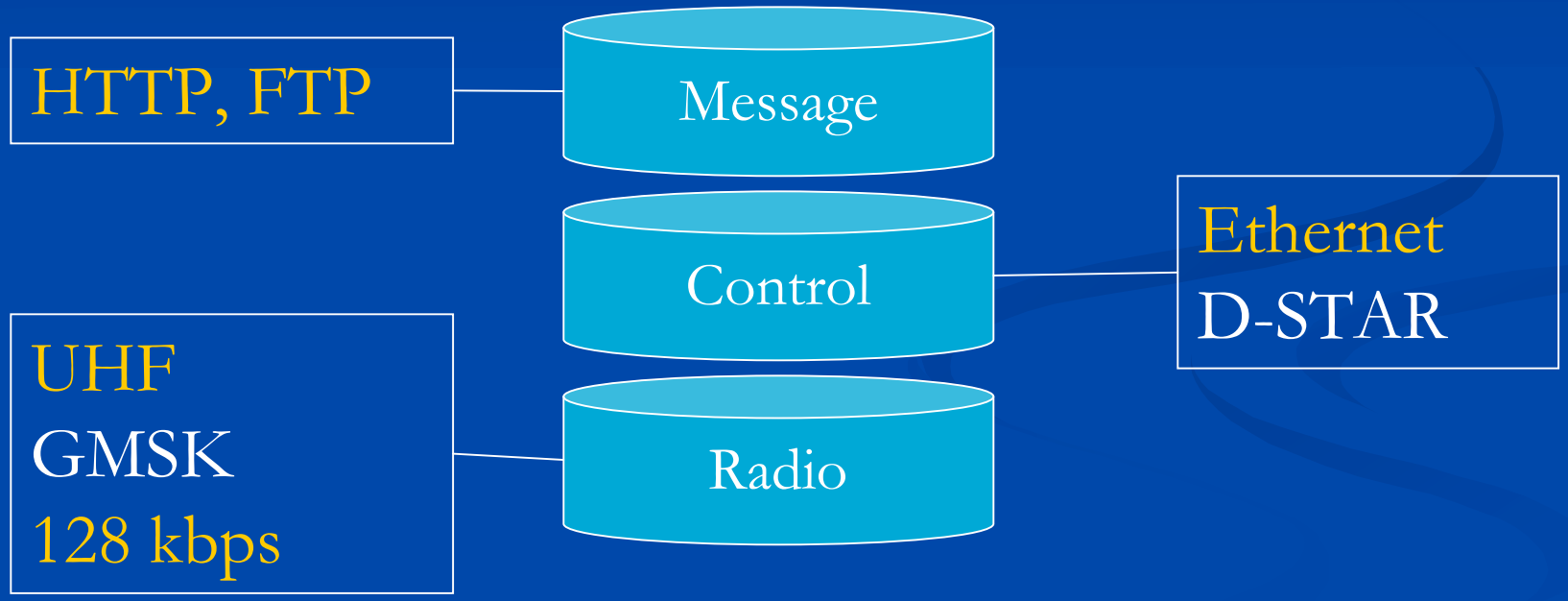
Amateur Stack Examples

D-STAR DV



Amateur Stack Examples

D-STAR DD



Selecting a Stack

- Example – What happens when the Incident Commander hands you a sheet of paper and says, "Get this to the IC at State EOC!"
- Means what?
  - Make this piece of paper go to the state EOC?
  - Replicate this form at the state EOC?
  - Create equivalent data at the state EOC?
  - Make the State EOC IC aware of the data?

Stack 0 - Sneakernet

- Saddle up ol' Betsy
- Ride down to the State EOC
- Hand the form to the State EOC IC
- Ride home
- Feed ol' Betsy

- This *might* be the most reliable way!

Method 1 – Voice

- Determine channel on HF, VHF, UHF
- Select modulation (SSB or FM)
- Call W7EMD
- Establish connection and function
- Use SOP's to transfer and record data
- End contact

Method 2 – As Image

- Scan the form, convert to digital image file
- Run AIRMAIL program, attach file, address
- Configure radio and control layer
  - HF Winlink
  - VHF/UHF Winlink - direct, digipeat, or relay
- Connect and transfer file
- Disconnect

Method 3 – As Data in Email

- Run AIRMAIL, load format template
- Enter data into template
- Send as in Method 2

Method 4 – Send As Data

- Open browser
- Connect to W7EMD on D-STAR DD
- Access W7EMD server at IP address
  - Brings up an HTML data entry form
- Enter data into form
- End connection
- Close browser

Understanding Digital Comm

- Understand your requirements FIRST
- Understand how the technology works
- Understand how combinations work
- Think of the process as a pair of stacks (one on each end)
- Remember the WHOLE stack has to work!
- Use the right terms, use terms consistently

Important Distinctions

- Form and format
- Mode and modulation
- Bits – Bytes – Symbols - Baud

Places to Go

- Tucson Amateur Packet Radio
  - http://www.tapr.org
- Winlink System
  - http://www.winlink.org
- ARRL Books (http://www.arrl.org/catalog)
  - HF Digital Handbook by WB8IMY
  - VHF Digital Handbook (new) by WB8IMY

Places to Go

- D-STAR
  - Icom
  - Texas Interconnect Team (http://www.k5tit.org)
  - Interest groups
    - http://groups.yahoo.com/group/dstar_digital/
    - http://groups.yahoo.com/group/illinoisdigitalham/
- Datacomm glossaries
  - http://nickara.com/glossary_v0.htm
  - http://www.arcelect.com/babel99.htm

Thank you!!


MicroHAMS
Where do you want to QSO today?