Electrical Engineering
Electronics
Computers
Communications

Technion
Israel Institute of Technology

SIPL

Fax
In Your Pocket

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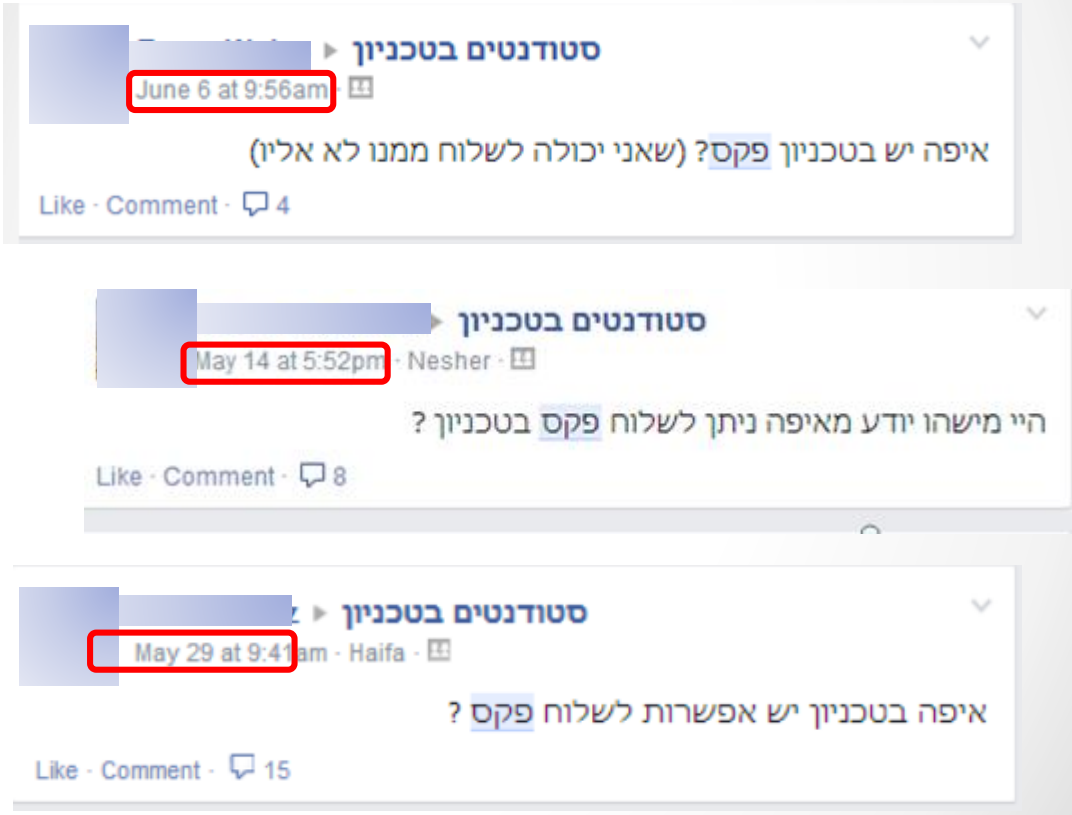
24.6.2014

Isn't fax out of date?

Nowadays, everyone has a Smart Phone. And everyone has access to the Internet

But there are still places that work only with Fax over Public Switch Telephone Network (PSTN)



23.01.2014
מוסף כלכליסט

הרשימה השחורה

- **בנקים**: ביצוע חלק מהפעולות, שליחת מסמכים חתומים וקבלת מסמכים.
- **חברות וסוכני ביטוח**: ביצוע שינויים בפוליסות או בקרנות, שליחת מסמכים, בקשות לפדיון קרנות וקבלת החזרים.
- **שלל חברות גדולות** (yes,אורנג', "אפילו נציגת תמיכה של מיקרוסופט!" ועוד)
- **ביטוח לאומי**: כן המלך הבלתי מעורער של הפקסים בישראל , הכל רק בפקס.

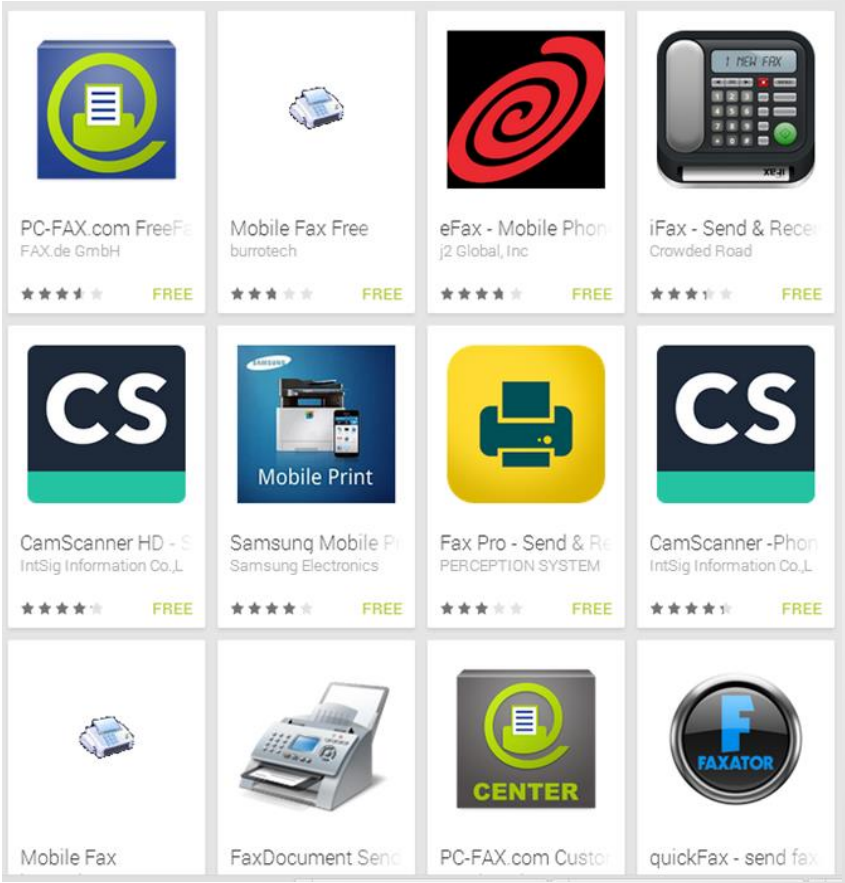
מתוך אתר כלכליסט

Fax App?

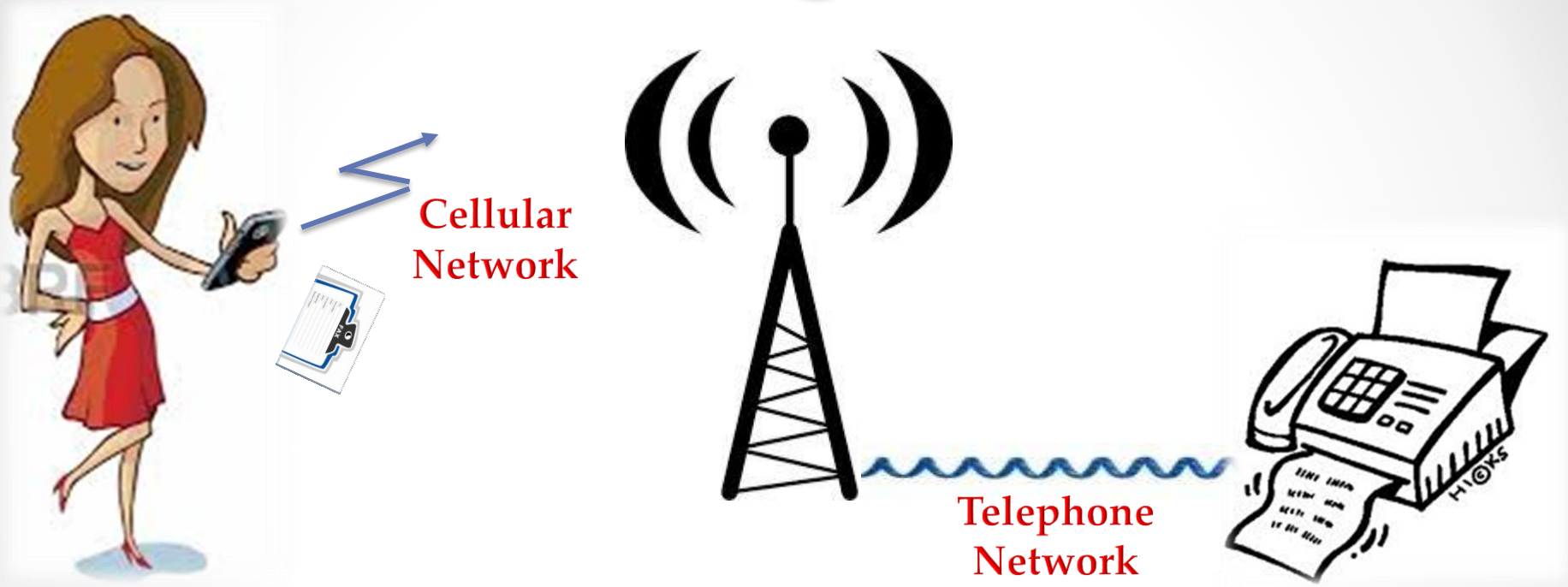
There are other Fax apps for Android.

But they use the FoIP protocol and the internet connection to send the document to server and the server sends it over the PSTN network.

You pay per page.



Target



Use your own smartphone to send fax at the cost of telephone call (free in most programs)

Challenges

- Understanding and implementing the fax protocol
- Building software modem on a smartphone platform
- Dealing with data distortion resulting from GSM and the voice codec
- Building a friendly Android application

Fax

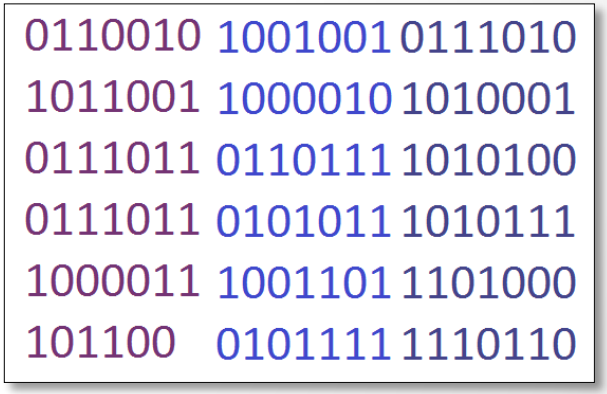
Image Processing & Coding

Modulation

Fax Transmission

Image Processing & Coding

Image Acquisition (Take a picture) → Image Resizing → RGB to Gray Scale → Binary Image → Huffman Coding



Fax

Image Processing

Modulation

Fax Transmission

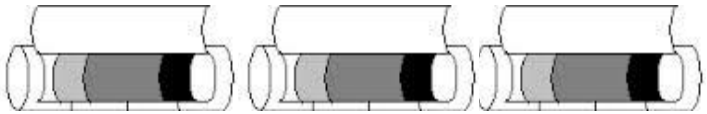
Modulation

- The process of conveying a message signal, for example a digital bit stream, inside another signal that can be physically transmitted
- The aim of **digital modulation** is to transfer a digital bit stream over an analog channel, in our case over the telephone network
- Two fundamental digital modulation methods
  - **Frequency shift key**
  - **Phase shift key**

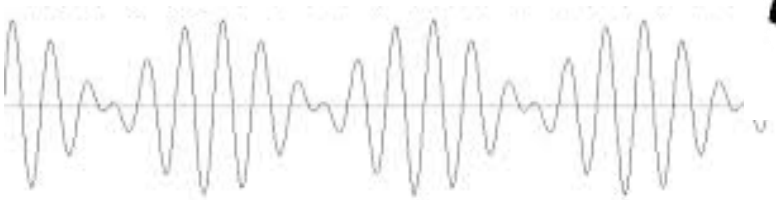
Fax

Image Processing → Modulation → Fax Transmission

Fax -Protocol



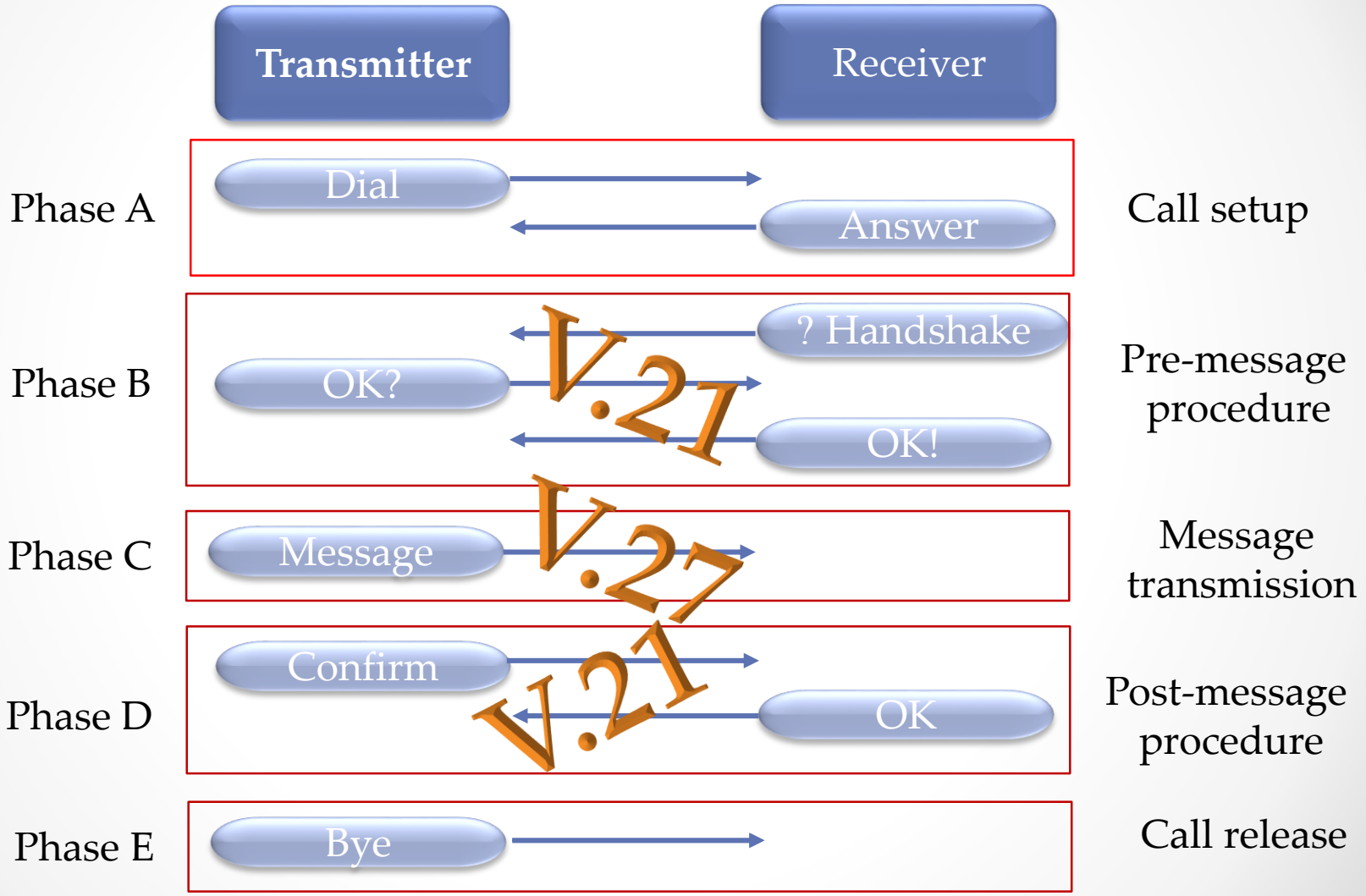
T.30



V.21/V.27ter

Handshake / Image date

T.30 Protocol



V.21 protocol

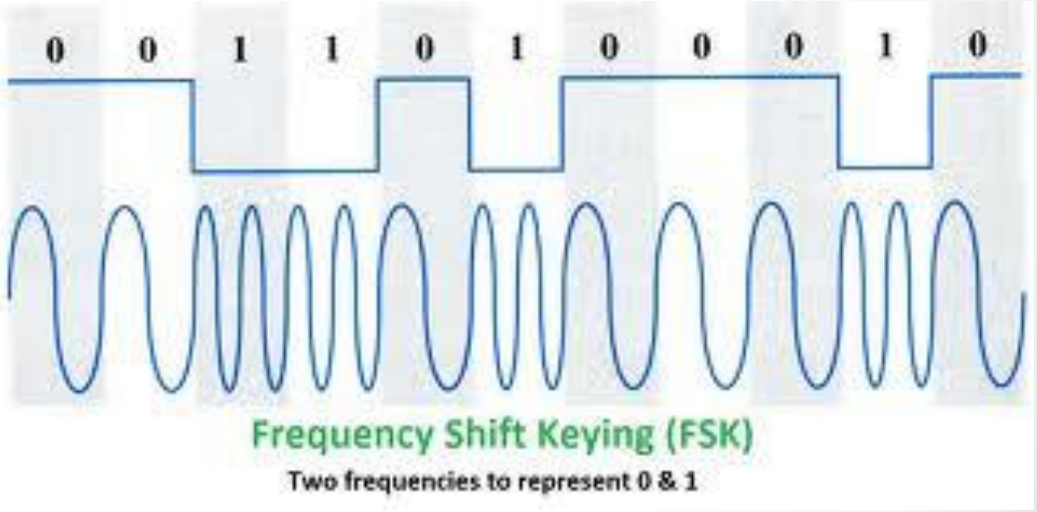
- The V.21 is used for the handshake between the two fax machines

- Based on Frequency-Shift Keying (**FSK**) modulation
  - Pair of discrete frequencies to transmit binary (‘0’s or ‘1’s) information
  - ‘0’ is represented by 1850 Hz tone.
  - ‘1’ is represented by 1650 Hz tone.

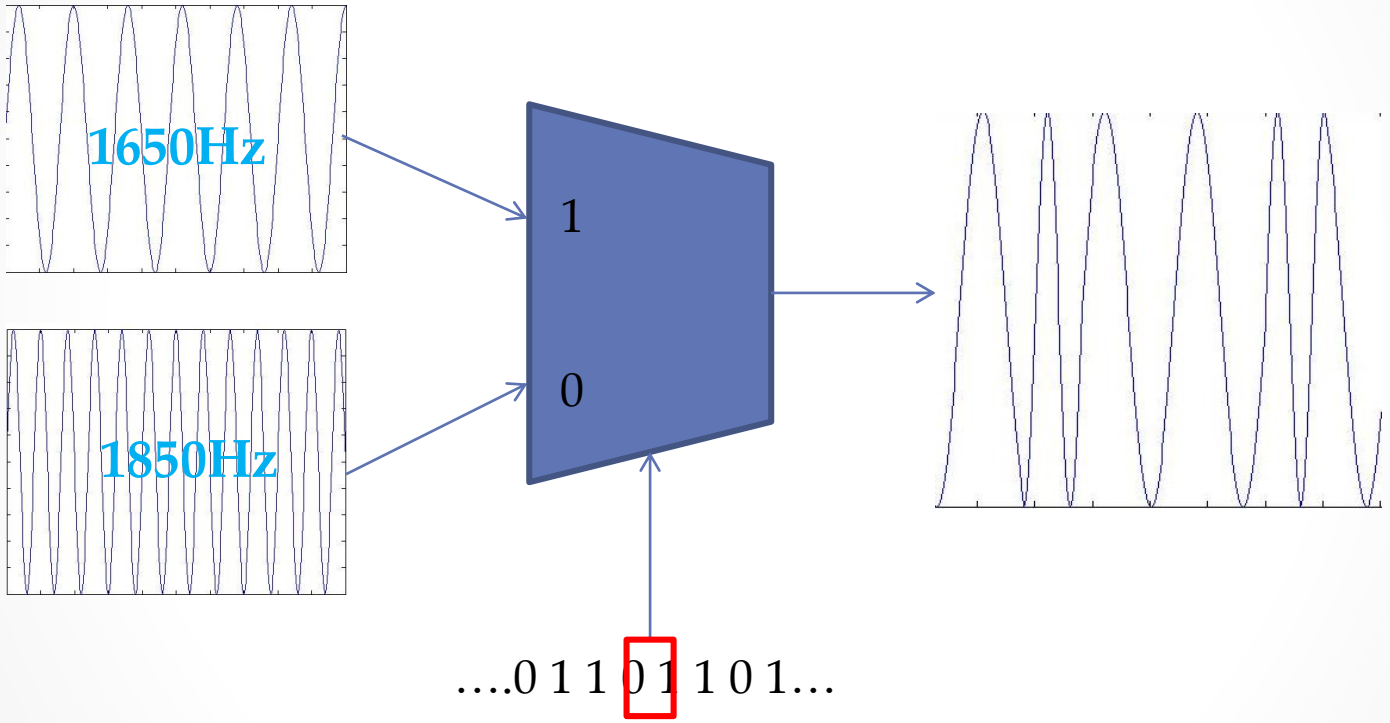
- Works at 300 baud (symbols/sec)

FSK

FSK is a frequency modulation scheme in which digital information is transmitted through discrete **frequency** change of carrier wave



V.21 modulator



V.21 Demodulator

- Single-Tone Frequency Estimation based on Autoregressive Model

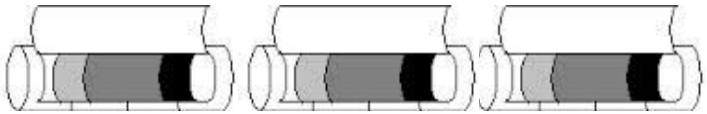
$$Y[n] = A \cdot Y[n-1] - Y[n-2]$$

$$A = 2\cos\left(\frac{2\pi f}{F_s}\right)$$

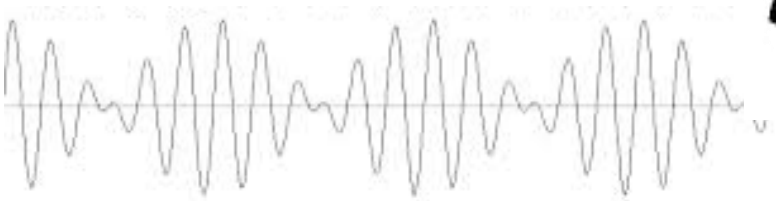
$$f - the \sin wave\ frequency$$

$$F_s - sampling\ rate$$

Fax -Protocol



T.30



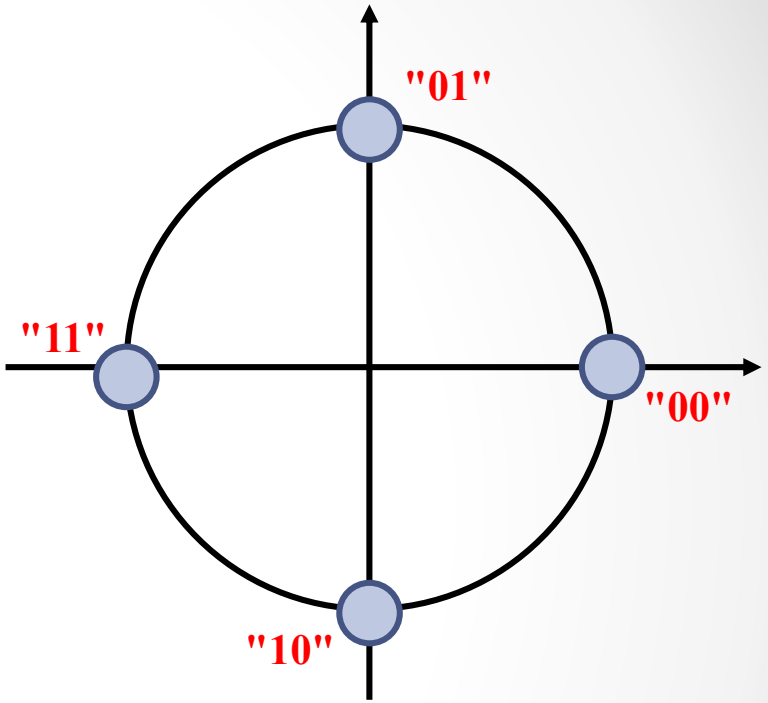
V.21/V.27ter

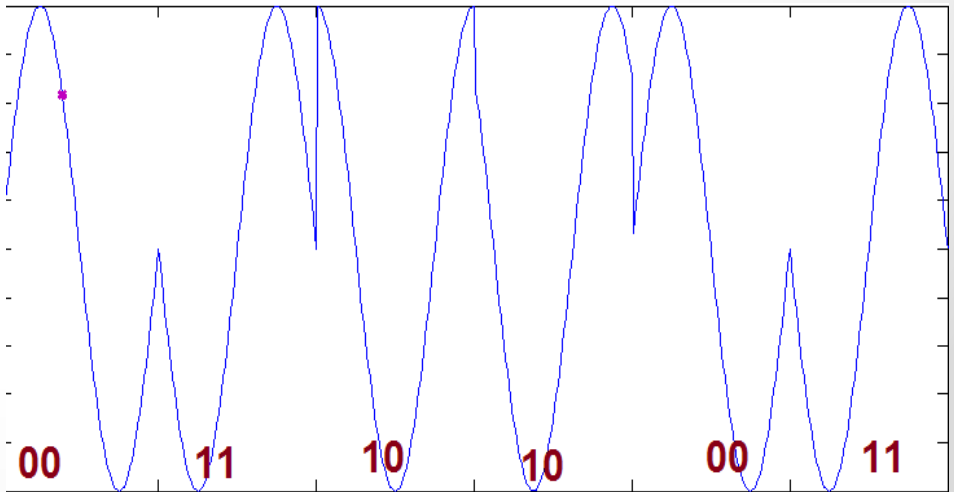
V.27ter

- The V.27ter is used for the transmission of image data between the two fax machines
- Based on Phase-Shift Keying (**PSK**) modulation
  - Signal carrier frequency (1800 Hz)
  - The signal phase is shifted according to the binary data
- The coded image data (bitstream) is divided into consecutive dibit (2 bit) groups
- Works at 1200 baud (symbols/sec) = 2400 bits/sec

PSK

- Phase-Shift Keying is digital modulation scheme that conveys data by changing , or modulating, the **phase** of a reference signal (the carrier wave)
- The phase shift is shifted in respect to the preceding signal





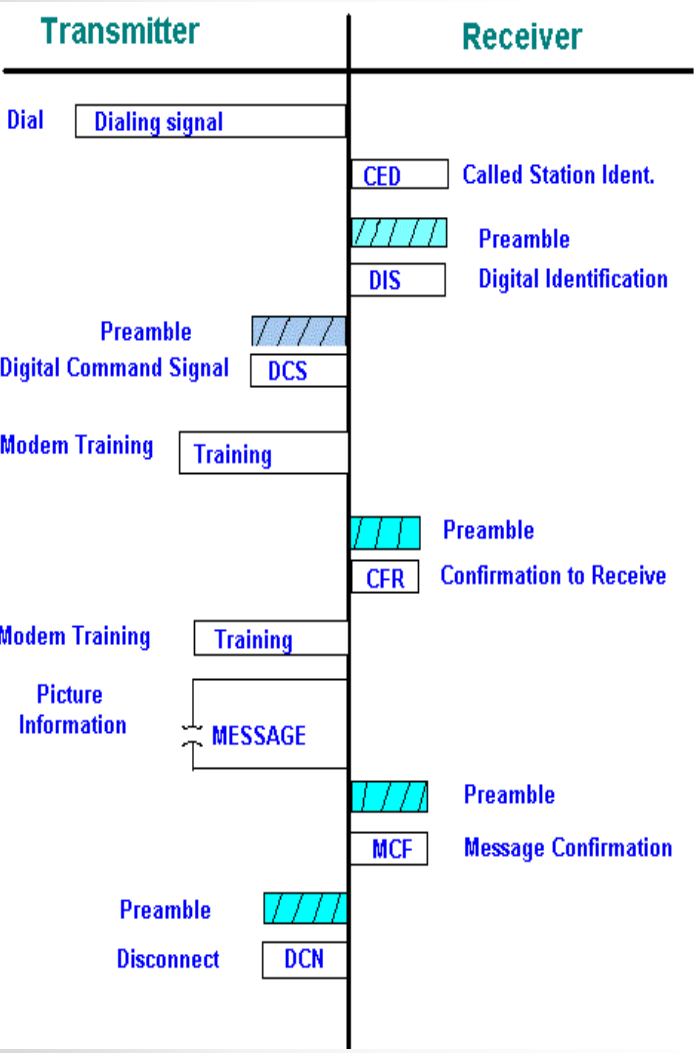
What has been done

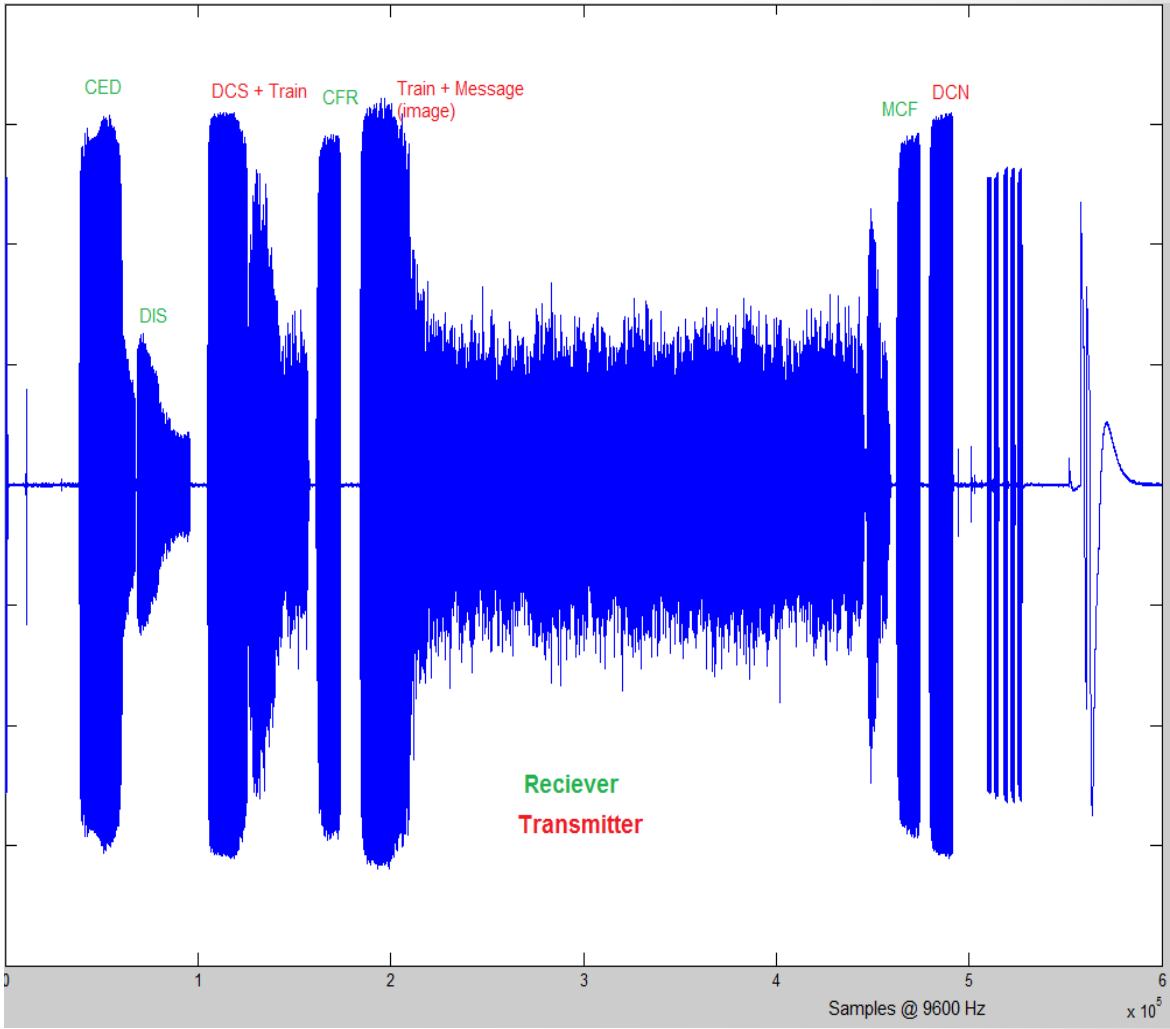
Complete software implementation of modem on PC

- Image processing and coding
- Digital modulation and Demodulation

What next?

Example


Transmitter
Receiver
Dial
Dialing signal
CED
Called Station Ident.
Preamble
DIS
Digital Identification
Preamble
Digital Command Signal
DCS
Modem Training
Training
Preamble
CFR
Confirmation to Receive
Modem Training
Training
Picture Information
MESSAGE
Preamble
MCF
Message Confirmation
Preamble
Disconnect
DCN


CED
DIS
DCS + Train
CFR
Train + Message (image)
MCF
DCN
Reciever
Transmitter
0
1
2
3
4
5
6
Samples @ 9600 Hz
x 10^5