11

Facsimile — Radiofax

Facsimile (from latin *facere* – make and *simile* – similar) is one of the oldest communication modes and it is used for an image transmission. The facsimile is mainly used by professional services for wireless distribution of meteorological maps and informations, hence the name *Weather Facsimile (WEFAX)* follows from it. The *radiofax* can be used by radio amateurs too.

11.1 The history of image transmission

Already in 1843 a Scottish clockmaker Alexander Bain suggested that some images can be broadcast via electric lines, when it is electrically scanned by rows and point by point. That's the basic idea of image transmission.

Bain's example was soon followed by other entrepreneurs. In 1847 an Englishman Frederick Collier Bakewell reeled an image in the transmitter and sheet of paper to cylinder in the receiver, which was turned by the clock machine. The picture were printed with fat on a tinfoil sheet.

A honor for the first fax service, however belongs to Giovanni Caselli, Italian catholic priest and physicist. In 1856 he built device named *panthèlègraph*. With pantèlègraph could be sent images or texts.

Caselli received enthusiastic support from the French emperor Napoleon III. The emperor personally visited his workshop in 1860 and enabled him an access to telegraphy lines. The first commercial fax service started in 1865 in Paris and it was connecting some major cities of France. Indeed the transmission was very slow and the fees were high so there was only few clients. The service wasn't profitable and had to be stopped.

In 1901 a German scientist Dr. Arthur Korn invented the principle of the photoelectric reading and began to transfer some positive photographic slides on a transparent substrate. These slides were illuminated point by point and row by row and light passed through transparent slide influence the selenium cell. The cell

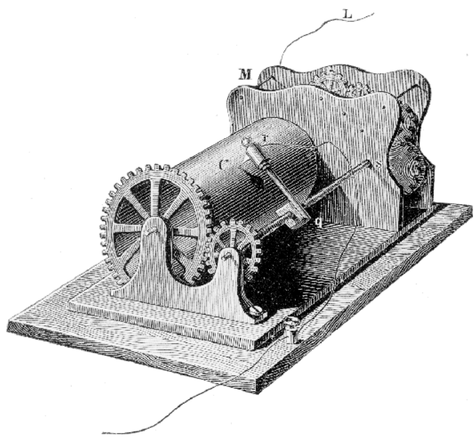

Figure 11.1: Bakewell's image telegraph.

changes its resistance depending on the light intensity and transform image pixel shade to electric current. The receiver contained “light relay”, a device with early gas-discharge lamp. The intensity of light exposed present point on photographic paper and it varied according to current flowed form receiver.

Dr. Korn designed the first phototelegraph device in 1902 and already in March 1904 he managed to reproduce photo transfered form Munich to Nuremberg. The transfer of postcard size photo took 24 minutes. In 1907 major cities Berlin, Munich, Paris and London were linked and his devices were bought by newspaper agencies and the first phototelegraphic service was founded.

The transfer was simplified by using of an electric photocell. Thanks to the photocell the transfer speed increased and the preparation of transparent slides wasn't necessary. The photocell is so sensitive that it is influenced by reflected light and some photos could be scanned directly. The photocell was used for the first time by American captain Richard H. Ranger for test transmission between Cleveland and New York. In November 30th, 1924 was wirelessly transfered photo of the British royal couple from London to New York. The first phototelegraphic service between America and Europe was established in May 1st, 1926.

11.2 The fax mode

The modern facsimile (fax) is used for transmitting images in the high resolution (usually 1810 dots per line) with image size up to several thousand lines. An relatively long time of transmission is used due to small bandwidth. In dependency on image size and transmission speed it takes from 3 to 20 minutes.

11.2.1 Image transmission

A typical mechanical transmitter consist of cylinder rotated by crystal controlled synchronous motor. Broadcast material is attached to the cylinder, which rotates in a constant speed. A small ray of light is focused on the broadcast medium (map, text, photos, etc.). The light reflected from the medium is processed by a photoelectric sensor. The sensor bears the light source, photocell and moves along rolled in a constant speed. The sensor moves from one end to the other and captures the image line by line. Voltage difference from the photo sensor are amplified and it is used to modulate the signal carrier.

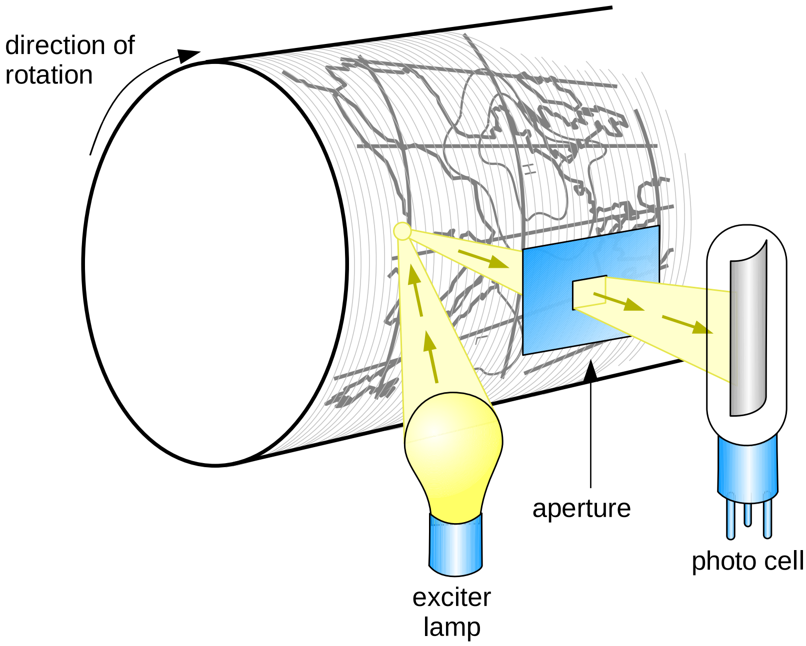

Figure 11.2: The principle of an electromechanical image capture.

The fax transmission on shortwaves has only few similarities with the fax machines you know from home and offices. The fax transmission is based on CCITT recommendations Facsimile CCITT Group 1 (T.2) of 1968, the short wave recommendation is described **chapter 11.6**. The CCITT recommends the frequency 1500 Hz for white and 2300 Hz for black. In North America it is 1500 Hz for white and 2300 Hz or 2400 Hz for black. The transmission speed is 180 lpm. The fax machines of this type could be adjusted for amateur operation. The later recommendations T.3, T.4 or T.30 can not be used on HF and there are used in telephone lines.

The frequency modulation *F3C* is used for shortwave transmission (*F* – frequency modulation, 3 – single channel containing analog information, *C* – facsimile). The transmitter modulates the frequency of carrier in the range ±400 Hz on shortwaves and ±150 Hz on long waves. This range is called *signal deviation.*

The fax signal can be created by direct modulation of broadcast frequency or by frequency modulation of subcarrier 1900 Hz. Then the transmitter changes frequency between black and white colour. Black color corresponds to 1500 Hz and white 2300 Hz.

The amplitude modulation (AM) used for image transmission on VHF and microwave meteo satellite downlinks. There is used positive AM and level of modulation determines the brightness. For black colour it is 4 % level and for white it is 90 % to 100 %. The negative modulation inverts levels, the minimal value is for white and the maximal value for black.

Most commercial stations use *APT – Automatic Picture Transmission* for a fully automated reception without requiring the presence of an receiver operator. The image transmission begins with *start tone*, when transmitter modulates the carrier with some frequency, mostly 300 Hz (changing the maximal levels of modulation 300× in a second). This signal is recognized be the receiving device and it switches from stand-by mode to working mode and waits for *phasing signal*.

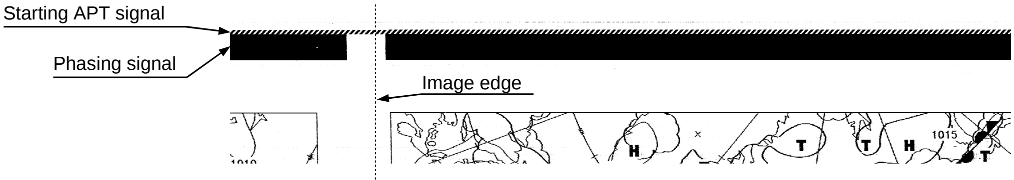

Figure 11.3: The start of facsimile transmission.

The phasing signal is used for synchronization and it is broadcast few second before an image. Normally consist of rows of 95 % black and 5 % white. It generats a vertical white line, which identifies the edge of the transmitted image.

After the end of image transmission another APT signal is sent, it has modulation 450 Hz and switches the receiving device back to stand-by mode.

11.2.2 The reception

Shortwave facsimile reception can be realized by using upper single sideband (USB) receiver. For this reason, you'll have to tune on the frequency, which si about 1900 Hz below the station frequency. So if the station uses frequency 3855.0 kHz, you must tune in USB on 3853.1 kHz (i.e. 1900 Hz below), **see 11.4**. All facsimile reception software is equipped by spectroscope, the same as for SSTV, so precise tuning should not be a problem. You can control tuning by the fact that the largest portion in the fax image is mostly white.

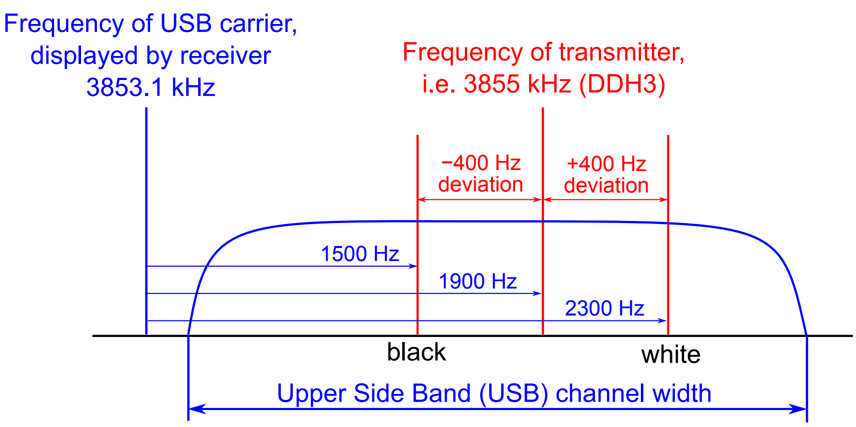

Figure 11.4: Relation between reception and transmission frequencies.

There are still used analog WEFAX receivers with electromechanical printers, but in our case we can use only PC with sound card and proper software.

Figure 11.5: Modern receiver Sony CRF-V21 for WEFAX and RTTY reception equipped with printer.

The most important parameters of the transmission are the speed and *index of co-operation – IOC*. The IOC relates with a horizontal scan rate and can be converted to number of pixels by simple formula:

$$\text{line} = \pi \times IOC \sim \text{pixels}$$

The most frequently used IOC is 576 (1810 pixels), then 288 (900 pixels).

The speed of transmission is given by rotation of cylinder (round per minute, rpm) and it is equivalent to number of lines per minute, lpm. Professional stations use most often 120 lpm, in eastern European countries and in post-soviet states it is 90 lpm, news agencies use 60 lpm and meteo satellites 240 lpm.

The most common fax images (synoptic maps) are transmitted only in black and white, but some images like retransmission of weather satellite images are in gray scale.

11.2.2.1 Facsimile transmission modes

11.3 Professional stations

There are dozens of stations operating on high frequency bands. It depends on your location, some of them are well-catchable all day, others only when conditions improve. Broadcast images are in most cases a variety of meteorological

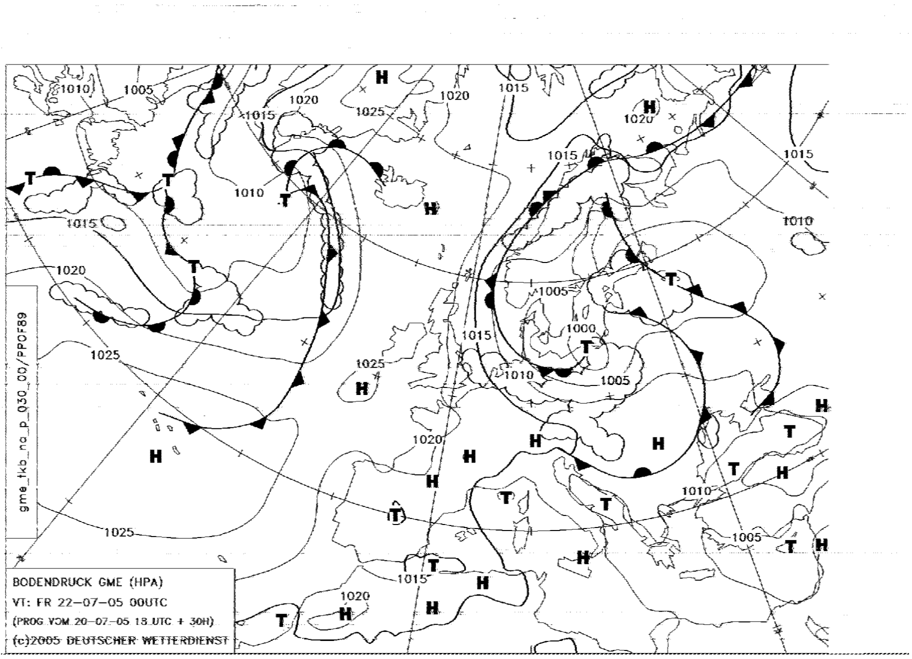

Figure 11.6: Typical synoptic map transmitted on HF by facsimile, here from station DDH3, line speed 120 lpm and IOC 576.

Name	IOC	lpm	APT start	d	APT stop	d	Note
Wefax 288	288	120 / 90 / 60	675 Hz	3 s	450 Hz	3 s	
Wefax 576	576	120 / 90 / 60	300 Hz	3 s	450 Hz	3 s	
Ham Color	204	360	200 Hz	5 s	450 Hz	5 s	color
Ham 288b	240	240 / 120	675 Hz	5 s	450 Hz	5 s	
Color 240	288	240	200 Hz	3 s	450 Hz	5 s	color
FAX 480	204	480	500 Hz	3 s	450 Hz	3 s	
Photopress	352	60	?	?	450 Hz	?	

d – minimal duration of APT signal

Table 11.1: Facsimile transmission modes.

maps, synoptic charts, graphs of pressure and altitude, direction of wind, weather forecasts, cyclone or typhoon warnings, retransmissions of satellite imagery and broadcast of news agencies.

Even today when Internet is almost everywhere the fax broadcast has still its foundation. The main customers are naval ships, military, remote airports and islands, where the shortwave transmission is only way how to get actual information. They are often very important, because station distributes also weather warning of upcoming storm and hurricanes.

Each station has given its daily broadcast schedule, for example **see 11.7**. You can find here what images will be transmitted in a time of day.

FLEET WEATHER AND OCEANOGRAPHIC CENTRE, NORTHWOOD, ENGLAND

AMENDED B14A RADIOFAX SCHEDULE WITH EFFECT FROM 190001Z JAN 05

TIME	PRODUCT	TIME	PRODUCT
ALL TIMES IN ZULU			
0000	18Z SFC ANALYSIS	1200	06Z SFC ANALYSIS
0012	18Z SFC PROGNOSIS T+24	1212	06Z SFC PROGNOSIS T+24
0024	18Z 850MB WBPT/PPTN T+24	1224	06Z 850MB WBPT/PPTN T+24
0036	18Z OAT AND TD CONTOUR T+24	1236	06Z OAT AND TD CONTOUR T+24
0048	12Z SHIP ICE ACCRETION	1248	00Z SHIP ICE ACCRETION
0100	MAIN SCHEDULE	1300	MAIN SCHEDULE
0124	QSL REPORT	1324	QSL REPORT
0136	OCEAN FRONTS	1336	OCEAN FRONTS
0148	18Z 300MB GPH	1348	06Z 300MB GPH
0212	SYMBOLOGY	1400	00Z SEA SURFACE TEMP T+12
0236	00Z SFC ANALYSIS	1436	12Z SFC ANALYSIS
0300	00Z SFC ANALYSIS	1500	12Z SFC ANALYSIS
0348	04Z GALE WARNING SUMMARY	1548	16Z GALE WARNING SUMMARY
0400	00Z SFC ANALYSIS	1600	12Z SFC ANALYSIS
0412	00Z OAT AND TD CONTOUR T+24	1612	12Z OAT AND TD CONTOUR T+24
0424	00Z 850MB WBPT/PPTN T+24	1624	12Z 850MB WBPT/PPTN T+24
0436	00Z SFC PROGNOSIS T+24	1636	12Z SFC PROGNOSIS T+24
0448	06Z SCEXAS TAFS	1648	18Z SCEXAS TAFS
0500	00Z SFC ANALYSIS	1700	12Z SFC ANALYSIS
0512	00Z SFC PROGNOSIS T+24	1712	12Z SFC PROGNOSIS T+24
0524	00Z SFC PROGNOSIS T+48	1724	12Z SFC PROGNOSIS T+48
0536	06Z SCEXAS TAFS	1736	18Z SCEXA TAFS
0548	06Z GALE WARNING SUMMARY	1748	18Z GALE WARNING SUMMARY
0600	00Z SFC ANALYSIS	1800	12Z SFC ANALYSIS
0612	00Z SFC PROG T+24	1812	12Z SFC PROG T+24
0624	00Z JMC T+12	1824	12Z JMC T+12
0636	00Z JMC T+24	1836	12Z JMC T+24
0648	07Z SCEXA TAFS	1848	19Z SCEXA TAFS
0700	07Z SPARE SCEXA TAFS	1900	19Z SPARE SCEXA TAFS
0712	00Z SIG WINDS T+24	1912	12Z SIG WINDS T+24
0724	00Z SFC PROGNOSIS T+48	1924	12Z SFC PROGNOSIS T+48
0736	00Z SFC PROGNOSIS T+72	1936	12Z SFC PROGNOSIS T+72
0748	00Z SFC PROGNOSIS T+96	1948	12Z SFC PROGNOSIS T+96
0800	00Z SFC PROGNOSIS T+120	2000	12Z SFC PROGNOSIS T+120
0812	00Z THICKNESS/GPH ANALYSIS	2012	12Z THICKNESS/GPH ANALYSIS
0824	00Z SIG WINDS T+48	2024	12Z SIG WINDS T+48
0836	00Z SIG WINDS T+72	2036	12Z SIG WINDS T+72
0848	00Z SIG WINDS T+96	2048	12Z SIG WINDS T+96
0900	06Z SFC ANALYSIS	2100	18Z SFC ANALYSIS
0912	00Z THICKNESS/GPH ANALYSIS	2112	12Z THICKNESS/GPH ANALYSIS
0924	00Z THICKNESS/GPH T+24	2124	12Z THICKNESS/GPH T+24
0936	00Z 850MB SPOT WINDS T+24	2136	12Z 850MB SPOT WINDS T+24
0948	00Z 700MB SPOT WINDS T+24	2148	12Z 700MB SPOT WINDS T+24
1000	06Z SFC ANALYSIS	2200	18Z SFC ANALYSIS
1012	06Z SFC PROGNOSIS T+24	2212	18Z SFC PROGNOSIS T+24
1024	06Z REDUCED VIS T+24	2224	18Z REDUCED VIS T+24
1036	06Z 850MB WBPT/PPTN T+24	2236	18Z 850MB WBPT/PPTN T+24
1048	06Z OAT AND TD CONTOUR T+24	2248	18Z OAT AND TD CONTOUR T+24
1100	06Z SFC ANALYSIS	2300	18Z SFC ANALYSIS
1112	06Z SFC PROGNOSIS T+24	2312	18Z SFC PROGNOSIS T+24
1124	06Z SEA AND SWELL T+24	2324	18Z SEA AND SWELL T+24
1136	00Z THICKNESS/GPH T+24	2336	12Z THICKNESS/GPH T+24
1148	00Z GALE WARNING SUMMARY	2348	12Z GALE WARNING SUMMARY

FREQS

2618.5KHZ
4610.0KHZ
8040.0KHZ
110885.5KHZ

Figure 11.7: The station schedule of GYA.

For first experiments with facsimile reception are suitable strong local stations. Here in Europe it is the German station DDHx, which is active on frequencies 3855.0, 7880,0 a 13 882,5 kHz. As already announced, station always receive in USB mode and tune it 1900 Hz below. Therefore DDH3 tune on 3853.1 kHz. Its speed is 120 lpm and IOC 576.

Another station is an Englich GYA broadcasting from Northwood (120/576) on frequencies 2618.5, 4610.0, 8040.0, 11085.5 kHz (active are at least two channels simultaneously).

From long distance stations cab be received almost daily Tokyo station JMH4. Of the three transmitters is the best JMH4 on 13597.0 kHz with 5 kW output power. Besides the usual synoptic chart there are available satellite imagery too.

Next Tokyo station is JJC, it is Kyodo News Agency. Transmission speed is 60 lpm and IOC 576, sometimes 120 lpm when weather charts are posted. The station broadcast simultaneously on several frequencies: 12745.5, 16971.0, 17069.6, 22542.0 kHz, by listening find the active frequency. Interestingly, the owner of

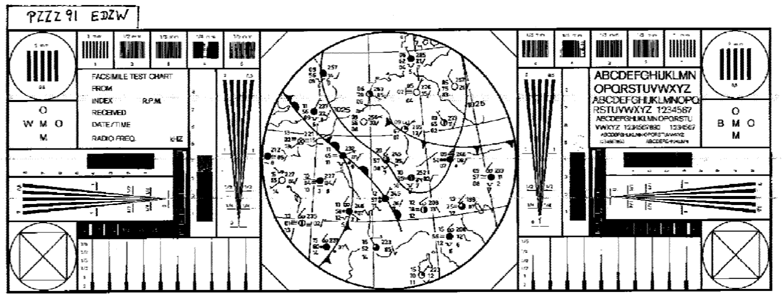

Figure 11.8: Test chart of DDH3 transmitted daily in 11:10 UTC.

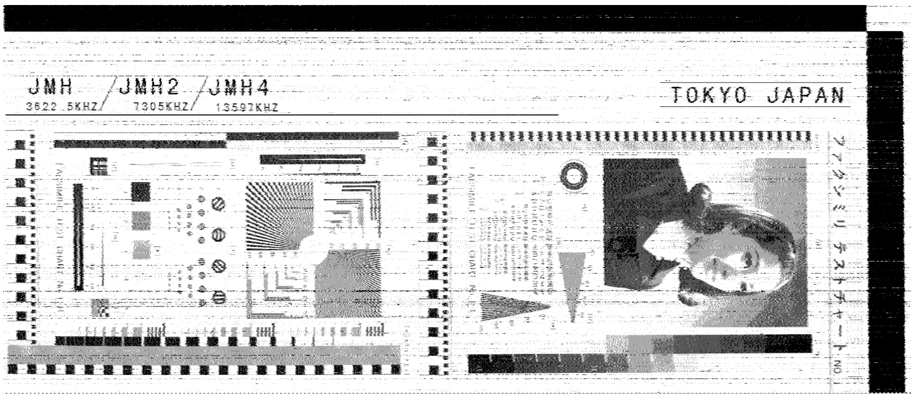

Figure 11.9: Test chart from JMH4 available daily at 13:00 UTC.

JJC station was in 1997 thinking about closure, if they find some other way for news distribution. It didn't stop yet and Kyodo News Agency still distributes newspapers via facsimile.


洋上でご購読の皆さまへ 平素から「共同ニュース」のご購読を賜り、誠にありがとうございます。船舶向けニュース送信は、皆さまからのご購読料なしでは成り立たないサービスです。受信契約を締結されていない船舶は、ご加入のほど、何とぞよろしくお願い申し上げます。なお、紙面に対するご意見などがございましたら、下記までFAXかメールでお寄せ下さい。【FAX】03−6252−8805【Eメール】compas@kyodonews.jp （共同通信社メディア局編集部）

KYODO NEWS 2005年 7月28日(木曜日) 夕刊 Evening (2)

成人の健診受診率9割に

医療費抑制へ取り組み目標

厚労省

対米報復関税を発動へ

9月にも鉄鋼などに15%

「目撃、生存情報は」

KYODO NEWS 第24552号 2005年 7月28日(木曜日) 夕刊 Evening (1)

共同ニュース

次のシャトル飛行凍結

タンク断熱材落下が判明

NASA

野口さん救援飛行も困難に

楽天で顧客情報大量流出か

284件確認、取引は9万件超

Figure 11.10: Typical JJC transmission.

For those who deal with DX radio reception on the HF While listening to the interesting DXů will be rewarded by received image. Complete list of stations sorted by country or frequency see chapter ??.

The detail list of frequencies and station schedule can be find in publication *Marine Worldwide Radiofacsimile Broadcast Schedules*, which is published by the National Oceanic and Atmospheric Administration's (NOAA) and it's freely available to download.

Radiofacsimile Worldwide Marine Broadcast Schedules:
http://www.nws.noaa.gov/om/marine/rfax.pdf

Another excellent source of information for those who are interested in receiving of meteorological data is the website of the *World Meteorological Organizations W.M.O.* Besides general information about meteorology there are lists of frequencies and schedules, not only for the fax, but also for other professional stations which use for distribution radio teletype (RTTY), NAVTEX and other types of digital modes.

World Meteorological Organization: http://www.wmo.ch/

11.4 Satellite imagery retransmission

Following list is compiled from It's the list of stations retransmitting meteo-satellites imagery. All listed stations transmit in 120 lpm and IOC 576.

UTC	Station	Ident.	Frequencies (kHz)	Note
00:34	Hawai, USA	KVM70	9982.5; 11090; 16135	East pacific GOES IR
00:48	Hawai, USA	KVM70	9982.5; 11090; 16135	SW pacific GOES IR
01:01	Halifax, Canada	CFH	122.5; 4271; 6496.4; 10536; 13510	IR
01:10	Tokyo, Japan	JMHx	3622.5; 7795; 13988.5	MTSAT
01:20	Taipei, China	BMF	4616; 8140; 13900; 18560	GMS
01:43	California, USA	NMC	8682; 12786; 17151.2; 22527	NE GOES IR
01:54	California, USA	NMC	8682; 12786; 17151.2; 22527	Pacific GOES IR
02:00	Lousiana, USA	NMG	4317.9; 8503.9; 12789.9; 17146.4	Tropical GOES IR
03:51	Massachusetts, USA	NMF	4235; 6340.5; 9110; 12750	
05:06	Alaska, USA	NOJ	2054; 4298; 8459; 12412.5	GOES IR
06:35	Hawai, USA	KVM70	9982.5; 11090; 16135	East pacific GOES IR
06:49	Hawai, USA	KVM70	9982.5; 11090; 16135	SW pacific GOES IR
07:10	Tokyo, Japan	JMHx	3622.5; 7795; 13988.5	MTSAT
07:20	Taipei, China	BMF	4616; 8140; 13900; 18560	GMS
07:37	California, USA	NMC	8682; 12786; 17151.2; 22527	Tropical GOES IR
08:00	Lousiana, USA	NMG	4317.9; 8503.9; 12789.9; 17146.4	Tropical GOES IR
09:06	Hawai, USA	KVM70	9982.5; 11090; 16135	Pacific GOES IR

UTC	Station	Ident.	Frequencies (kHz)	Note
09:08	California, USA	NMC	8682; 12786; 17151.2; 22527	Pacific GOES IR
09:43	Hawai, USA	KVM70	9982.5; 11090; 16135	Tropical GOES IR
09:51	Massachusetts, USA	NMF	4235; 6340.5; 9110; 12750	
10:22	Halifax, Canada	CFH	122.5; 4271; 6496.4; 10536; 13510	IR
11:17	Alaska, USA	NOJ	2054; 4298; 8459; 12412.5	GOES IR
11:30	Playa Ancha, Chile	CBV	4228; 8677; 17146.4	
12:32	Hawai, USA	KVM70	9982.5; 11090; 16135	East pacific GOES IR
12:48	Hawai, USA	KVM70	9982.5; 11090; 16135	SW pacific GOES IR
13:10	Tokyo, Japan	JMHx	3622.5; 7795; 13988.5	MTSAT
13:20	Taipei, China	BMF	4616; 8140; 13900; 18560	GMS
14:00	Lousiana, USA	NMG	4317.9; 8503.9; 12789.9; 17146.4	Tropical GOES IR
14:03	California, USA	NMC	8682; 12786; 17151.2; 22527	NE GOES IR
14:14	California, USA	NMC	8682; 12786; 17151.2; 22527	Pacific GOES IR
15:03	Massachusetts, USA	NMF	4235; 6340.5; 9110; 12750	
16:45	Playa Ancha, Chile	CBV	4228; 8677; 17146.4	
17:06	Alaska, USA	NOJ	2054; 4298; 8459; 12412.5	GOES IR
18:35	Hawai, USA	KVM70	9982.5; 11090; 16135	East pacific GOES IR
18:49	Hawai, USA	KVM70	9982.5; 11090; 16135	SW pacific GOES IR
19:02	California, USA	NMC	8682; 12786; 17151.2; 22527	Tropical GOES IR
19:10	Tokyo, Japan	JMHx	3622.5; 7795; 13988.5	MTSAT
19:20	Taipei, China	BMF	4616; 8140; 13900; 18560	GMS
19:30	Playa Ancha, Chile	CBV	4228; 8677; 17146.4	
20:00	Lousiana, USA	NMG	4317.9; 8503.9; 12789.9; 17146.4	Tropical GOES IR
21:06	Hawai, USA	KVM70	9982.5; 11090; 16135	Pacific GOES IR
21:13	California, USA	NMC	8682; 12786; 17151.2; 22527	Pacific GOES IR
21:43	Hawai, USA	KVM70	9982.5; 11090; 16135	Tropical GOES IR
21:51	Massachusetts, USA	NMF	4235; 6340.5; 9110; 12750	
23:17	Alaska, USA	NOJ	2054; 4298; 8459; 12412.5	GOES IR
23:25	Playa Ancha, Chile	CBV	4228; 8677; 17146.4	

It depends on your own position if you have interest in reception of images from these stations. For long distance stations should not be reception conditions so good every day. Their images for me in Europe is not interesting for weather forecast, but there are images of hurricanes, typhoons and other unusual weather phenomena.

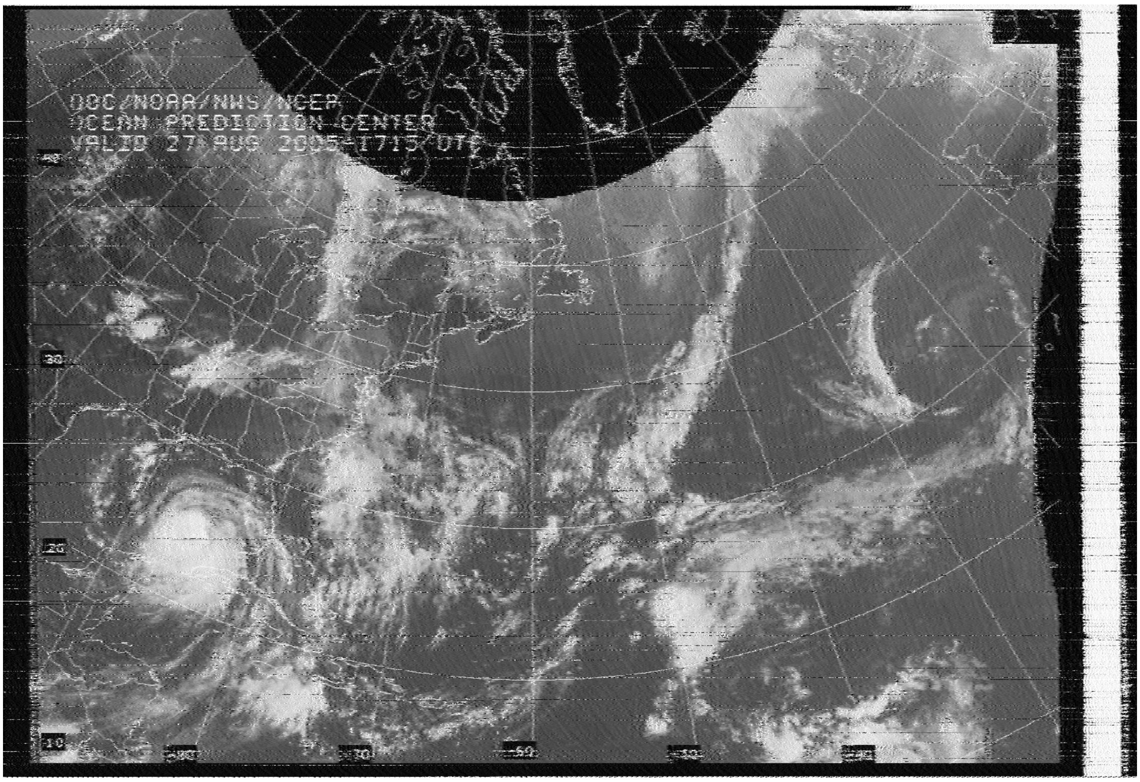

Figure 11.11: Restransmission of satellite image from Boston NMF station received on 12.750 kHz, hurricane Katrina is devastating Mexican gulf

11.4.1 Meteorologic satellites

If you are interested in reception of satellite imagery, there is few basic informations.

For amateur reception it is possible to use NOAA satellites on low Earth orbit. These satellites transmit in 137MHz band in WEFAX mode with amplitude modulation, so an sound card can be used as signal decoder with some dedicated software like JVComm32 or WXtoIMG. For the best reception should be used a receiver with 30 kHz intermediate frequency (IF) width, which unfortunately common receivers and TRXes don't support. The narrower IF causes image distortion and receiver for wideband FM (about 200 kHz) is not very suitable due to more noise that affecting signal. Also it is necessary to use an antenna with right-handed circular polarization as *turnstile antenna* (crossed dipoles) or *QFH (Quadrifillar Helix Antenna)*.

Satellites NOAA, MetOp and Fengyun are carrying high resolution scanners and digital transmitters – *HRPT (High Resolution Image Transmission)*. They broadcast on 1.6GHz band, but used system is digital and for data reception must be used band converter, special modem and main difficulty rests in need of antenna aiming. A computer controlled rotator is needed for aiming of azimuth and elevation.

Next option is a reception of geostationary satellites of Meteosat and GOES family. The analog WEFAX broadcast in 1.6GHz band was discontinued. For analog WEFAX reception could be used NOAA receiver with band converter and dish or yagi antenna.

The follower of the analog broadcasst is new system *MSG (Meteosat Second Genereation)*, it is fully operational since 2004. Digital data *LRIT (Low Rate Information Transmission)* and *HRIT (High Rate Information Transmission)* are broadcast via television transponder EuroBird 9 (Ku band 10.7 – 12.75 GHz) on 11,976.82 MHz (EUMETCAST). An extension PCI card for DVB-S reception is used for data reception, e.g. SkyStar 2 card for PCI or external version for USB. The data are decoded with tq-TELLICAST software. The disadvantage is that almost all data is distributed encrypted, so it is necessary to register at Eumetsat provider and buy the hardware decoding key. The price for hobby purposes is €100 (software is for €60 and key is for €40). The are also higher demands on PC configuration: 2GHz CPU, 1 GB RAM and 36 GB hard disk.

The radiometer of Meteosat 8 and 9 provides images in 11 spectral channels in 3 km/pixel resolution and in *HRV (High Resolution Visible* channel it is 1 km/pixel, although in regard to slant projection of the Earth's surface the resolution for Europe and Globe edges is lower. Image data *(High Rate SEVIRI)* have a standard size 3712×3712 pixels and for HRV it is 5568×11136 pixels. Data from satellite are send first to the primary station in German Darmstadt and then they are processed and they are distributed via EuroBird 9.

The Meteosat 9 provides image of Earth globe every 15 minutes, the Meteosat 8 sends data every 5 minutes (Rapid Scanning Service), but only European part of globe is sent. In addition to these data via EUMETCAST are broadcast further meteorological products, such as NOAA and MetOp HRPT imagery and processed data from other satellite sensors (infrared, microwaves,...).

11.4.2 Essential Services

The unencrypted data from Meteosat 9 and Meteosat 7 are transmitted every six hours, also GOES and MTSAT-1R is available every 3 hours.

Satellite	Interval	Transmittion times (UTC)
Meteosat 9 HRIT/LRIT	6 hours	05:45, 11:45, 17:45, 23:45
Meteosat 7	6 hours	00:00, 06:00, 12:00, 18:00
GOES 9, 10, 12; MTSAT-1R	3 hours	00:00, 03:00, 06:00, 09:00, 12:00, 15:00, 18:00, 21:00

Table 11.2: Essential services data.

11.5 Hamradio facsimile operations

The facsimile operation did not spread as SSTV in the past years. The reason for this is using of complex mechanical scanners and recorders and also a relatively long time of image transfer. A little development came with the computer software and cheap interfaces, but it is very rare to hear amateur fax on bands.

The use of facsimile fits for very high resolution images, which is better than any SSTV mode. The number of lines for image is not given, but aspect ratio 4:3 should be used. Hamradio operators use IOC 576 or 288 and speed 120 lpm or 240 lpm, the usage of other modes depends on agreement of both parties. A report is given in common RST code (*Readibility, Strenght, Tone*).

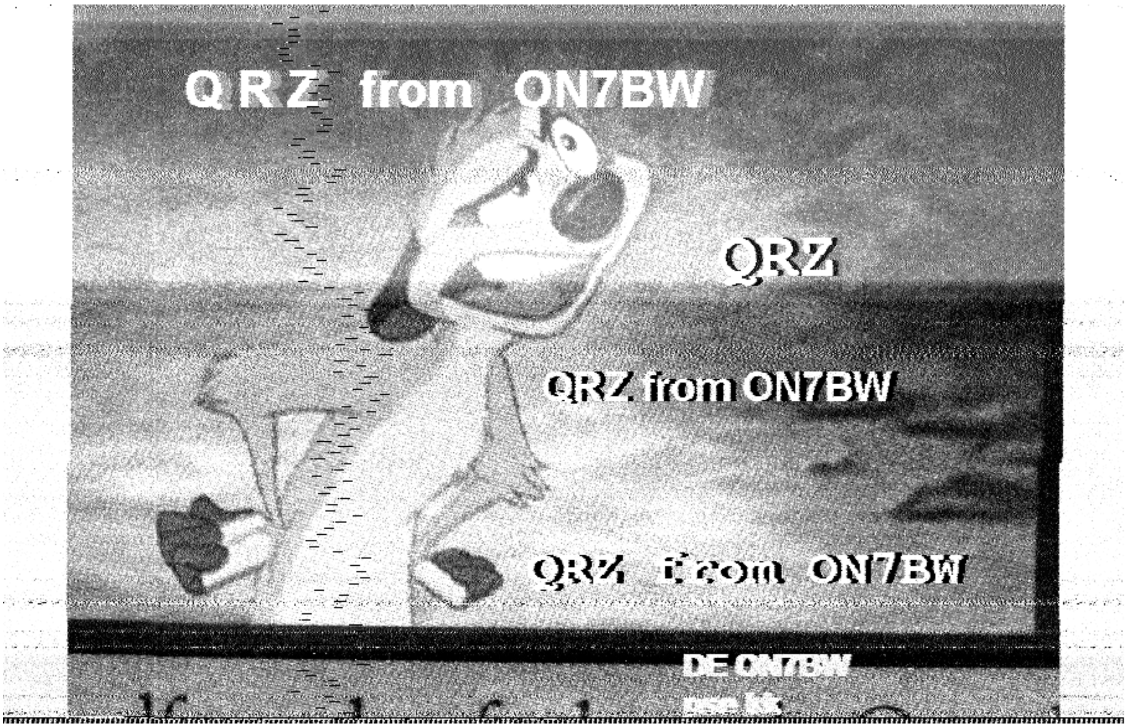

Figure 11.12: Hamradio facsimile from ON7BW received on 14MHz band, speed 240 lpm, IOC 288.

An opportunity to receive rare facsimile amateur stations is 3rd weekend in August, when *The International HF – FAX – Contest by DARC* is active. Those who are interested in this kind of communication mode may also try to obtain a diploma awarded by the DARC for two-way contacts.

11.5.1 EU – FAX – Diplom

The diplom is award for two-way facsimile contacts with European countries. There are three degrees for QSO with 10 prefixes in 5 countries, 20 prefixes in 10 countries and 40 prefixes in 20 countries. European countries are given by WAE list. Valid QSOs are from 1/1/1980 and QSL cards must have note *2-WAY FAX*. A confirmed list of QSL cards and €5 send to: *DARC FAX Manager, Werner Ludwig DF5BX, Post Box 1270, D-49110 Georgmarienshutte, Germany.*

11.5.2 The International HF – FAX – Contest by DARC

The contest is organized by the Deutscher Amateur Radio Club. Ongoing 3rd weekend of the August, starts at 8:00 UTC on Saturday and ends on Sunday at 20:00 UTC. It progress on all HF bands except the WARC. Assessed by two classes – listeners and one operator. All QSOs must be done in facsimile mode and image calls should include `CQ FAX TEST`. Report the RST and the number of connections from 001. Any QSO is a point valued, multipliers are countries WAE/DXCC and districts W, VE, and JA. QSO with a same station are valid on more bands. The log should be sent within 2 weeks after the contest to: *Werner Ludwig DF5BX, Post Box 1270, D-49110 Georgsmarienshuette, Germany*, email: `df5bx@darc.de`.

11.6 International facsimile standard recommedation

1. Drum speed:
   60, 90, 120, 240 revolutions per minute, if speeds greater then 120 rpm are used, they should be multiples of 60 rpm.
2. Diameter of drum:
   152 mm, in the case of flat-bed scanners this will be length of the scanning line (including the dead sector).
3. Index of co-operation (IOC):
   - ▷ 576 for minimum black or white picture elements of 0.4 mm and
   - ▷ 288 for minimum picture elements of 0.7 mm.
4. Length of drum:
   the length of the drum should be at least 550mm
5. Spanning density
   Scanning density = IOC / diameter of drum
   It is approximately: 4 lines per mm for index 576, 2 lines per mm for index 288.
6. Direction of scanning:
   at the transmitter, the plane (developed in the case of drum transmitter) of the message area is scanned along lines running from left to right commencing in the left hand corner at the bottom and this is equivalent of scanning over a left hand helix.
7. Dead sector:
   4.5 % ± 0.5 % of the length of the scanning line. The signal transmitted during the passage of the dead sector should correspond to white but it is permitted that a black pulse be transmitted within and not exceeding one half length of the dead sector.
8. Selection of index of co-operation:
   a five second transmission of alternating black and white signal at 300 Hz for index 576, 675 Hz for index 288. The envelopes of the signals transmitted will be roughly rectangular.
9. Synchronization:

the scanning speed should be maintained within 5 part in 10^6 of the normal value.

10. Starting recorders:

    recorders should be designed to start upon receipt of either the index selection signal or the phasing signal and no special signal for starting will be transmitted.

11. Phasing:

    a 30 second transmission of alternating white and black signal at the following frequencies:
    - ▷ 1.0 Hz for speed of 60 rpm,
    - ▷ 1.5 Hz for speed of 90 rpm,
    - ▷ 2.0 Hz for speed of 120 rpm.

12. Adjustment of recording levels:

    adjustment of recording level when used should be effected by reference to phasing signal.

13. Stopping recorders:

    a 5 second transmission of alternating black and white signals at 450 Hz followed by 10 seconds of signals corresponding to continuous black.

14. Modulation characteristics
    - ▷ Amplitude Modulation

      The maximum amplitude of the carrying frequency should correspond to the transmission of signal black. Value of the carrying frequency: 1800 Hz.
    - ▷ Modulation by frequency deviation
      - ▷ Value of central frequency: 1900 Hz.
      - ▷ Value of frequency for black: 1500 Hz.
      - ▷ Value of frequency for white: 2300 Hz.

      The frequency for black and white should not vary by over 8 Hz over a period of 30 s and by more than 16 Hz over a period of 15 minutes.

15. Levels of signals in case of AM:

    receiving equipment should accept any level between +5 dB and −20 db, zero reference level corresponding to a power of one milliwatt dissipated in a resistence of 600 ohms.

16. Contrast ratio

    contrast ratio for picture signals and control signals will be the same for any transmission and will be between 12 and 25 dB.

17. Facsimile transmission op meteorological charts over radio circuits:
    - ▷ When frequency modulation of the sub-carrier is employed for the facsimile transmission of meteorological charts over radio circuits, the following characteristics should be used:
      - ▷ Centre frequency: 1900 Hz.
      - ▷ Frequency corresponding to black: 1500 Hz.
      - ▷ Frequency corresponding to white: 2300 Hz.
    - ▷ When direct frequency modulation (FSK) is employed for the facsimile transmission of meteorological ctorts over radio circuits, the following characteristics apply:

- ▷ Decametric waves (3 MHz – 30 MHz)
  - ▷ Centre frequency: f_0.
  - ▷ Frequency corresponding to black: $f_0 - 400\,\mathrm{Hz}$.
  - ▷ Frequency corresponding to white: $f_0 + 400\,\mathrm{Hz}$.
- ▷ Kilometric waves (30 kHz – 300 kHz)
  - ▷ Centre frequency: f_0.
  - ▷ Frequency corresponding to black: $f_0 - 150\,\mathrm{Hz}$.
  - ▷ Frequency corresponding to white: $f_0 + 150\,\mathrm{Hz}$.