DIRECT BROADCAST SATELLITE TELEVISION (DBS)

IN THE UNITED STATES

Presented By Brad KN9B
This presentation is not original research.

It is based on US patents, public released corporate statements, after market vendor data and standard satellite industry communication designs. It was compiled from material readily available to the public via popular internet search engines.

Appropriate pages are noted and attributed to their authors in the source material index that can be found at the end of this document.
Currently the Earth has 341 Satellites Down-linking Television Programming

- The 341 satellites in this category have the following common characteristics:
  - Geostationary
  - Known to broadcast TV signals
  - Currently in service
- The once experimental broadcast TV of the 1930’s and growth media of the 1950’s is now down-linked into homes from satellites, worldwide, 24 hours a day.
- Direct Broadcast Satellites (DBS) are the lowest cost per viewer-program to operate.
History of DBS

- 1962 – Telstar - TUNDRA satellite sent TV from Europe to the USA
- 1967 – Orbita - MOLNYA satellite TV Station network in the USSR
- 1972 - Anik 1 - GEO satellite TV Station network in Canada
- 1974 - ATS 6 - GEO satellite experimented with DBS by NASA (1 of 23 payloads)
- 1976 – Ekran - GEO satellite DBS network in the USSR
- 1989 - Astra 1A - GEO satellite DBS network in the UK, 4 Commercial TV Chan.
- 1991 - PrimeStar began analog TV DBS to USA
- 1994 - PrimeStar transitioned to all digital DBS
- 1994 - DirecTV, Dish, Astro, AlphaStar, & Sky Angel all began digital DBS to USA
- 1996 - DirecTV & Dish/EchoStar are all digital DBS to USA
- 1999 - DirecTV buys PrimeStar
- 2008 - Dish/EchoStar separate DBS = Dish Network & EchoStar = Satellites
- 2010 - DirecTV has 19 Million & Dish Network has 14 Million Customers

The other DBS operators are gone except Sky Angel as the sole surviving DBS pioneer from 1981 first round of FCC applicants. The independent Sky Angel has subscriber channels on the same satellites, transmission facilities, & receiving equipment used for Dish Network.
A GEO orbit is an orbit around the earth with a period that matches rotation of the earth. This means that for an observer on earth, a GEO satellite stays in the same place.

An elliptic orbit or polar orbit is an orbit in which a satellite passes above or nearly above both poles of the earth on each revolution. Most have an inclination close to 90 degrees to the equator to improve ground coverage.

The TUNDRA and MOLNYA are highly elliptical orbits (HEO) with an apogee above a desired earth site provide more in-view time per orbit. LEO, MEO and GEO are normally at a constant radius from earth.
Standard Satellite Links

Uplinks
- S = 2.1 GHz
- C = 5.8–6.4 GHz
- Ku = 14.0-14.5 GHz
- Ka = 27-30 GHz

C Band - normally a Transponder “Bent Pipe”

Ka Band - normally a Transponder “Bent Pipe” with two 500 MHz Bandwidth DBS Down-Links
- 18.3-18.8 & 19.7-20.2 GHz for DBS

Downlinks
- S = 2.2-2.3 GHz
- C = 3.6–4.2 GHz
- Ku = 10.7-12.7 GHz
- Ka = 18-20 GHz

S Band - used for secondary satellite control & status

Ku Band - normally a Transponder “Bent Pipe” with a 500 MHz Bandwidth Down-Link
- 12.2-12.7 GHz ITU Region 2 for DBS
Generic DBS Receiver System

- Multiple QPSK Downlinks
- 30 dB Gain Parabolic Dish
- Low Noise Block Converter (LNB)
  - Input RF Carriers 12 GHz
  - Receivers RHCP or LHCP
  - Output IF 950 – 1450 MHz
- Home Receiver
  - IF Input
  - Superheterodyne Tuner
  - Proprietary Demodulator IC
  - Proprietary Crypto
  - MPEG Decoder
  - Output NTSC or HDMI
- Television Set
USA DBS in 2010

- Free To Air
- DirecTv
- Dish Network
Free To Air (FTA)

- AMC 1 2 channels
- AMC 3 5 channels
- AMC 4 16 channels
- AMC 5 3 channels
- AMC 6 2 channels
- AMC 9 2 channels
- AMC 21 9 channels
- EchoStar 7 3 channels
- Galaxy 18 7 channels
- Galaxy 19 140 channels
- Galaxy 25 3 channels
- Galaxy 28 2 channels
- Galaxy 3C 6 channels
- SatMex 5 4 channels
- SatMex 6 5 channels
- SBS 6 1 channel

- 1980’s 3 Meter satellite dishes
  - C-band 3.9 - 4.2 GHz

- 2000’s ½ to 1 Meter satellite dishes
  - 11.7 - 12.2 GHz Ku band

- Most use DVB-S standard
  - BPSK, MPEG & Framing Standards

- Most content is ethnic or religious
DirecTV

- 19 Million Customers
- 3407 programs (USA)
- Operating 12 Satellites
  - Ku @ 72 W Lon
  - Ka (2 Satellites) @ 99 W Lon
  - Ku (3 Satellites) @ 101 W Lon
  - Ka (3 Satellites) @ 103 W Lon
  - Ku @ 110 W Lon
  - Ku @ 119 W Lon
  - Spare (DBS 1)
- Packages with 285 Programs
  - Ku - QPSK + DVB
    - MPEG-2 & Framing Standards
  - Ka – 8PSK + DVB-S2 (HD)
    - MPEG-4 AVC

Ref # 3, 25, 26, 27

Sept. 21, 2010
<table>
<thead>
<tr>
<th>Posit</th>
<th>Satellite Name</th>
<th>Transponders</th>
<th>Comments</th>
<th>Vendor</th>
<th>Model</th>
<th>Launched</th>
<th>Vehicle</th>
<th>Launch site</th>
</tr>
</thead>
<tbody>
<tr>
<td>72.5 W</td>
<td>Directv 1R</td>
<td>16 Ku-band</td>
<td>11 Transponders Active, 186 Channels, June 18, 2010</td>
<td>Hughes Electronics</td>
<td>HS-601HP</td>
<td>10-Oct-99</td>
<td>Zenit-3SL</td>
<td>Sea Launch (Odyssey)</td>
</tr>
<tr>
<td>99.2 W</td>
<td>Spaceway 2 (Spaceway F2)</td>
<td>72 Ka-band</td>
<td>North America and Hawaii</td>
<td>Boeing Space Systems</td>
<td>BSS-702</td>
<td>16-Nov-05</td>
<td>Ariane 5 ECA</td>
<td>Guiana Space Center</td>
</tr>
<tr>
<td>101.0 W</td>
<td>Directv 4S</td>
<td>48 Ku-band</td>
<td>Parkerd with Directv 8 &amp; 9..... June 18, 2010</td>
<td>Hughes Electronics</td>
<td>BSS-601HP</td>
<td>27-Nov-01</td>
<td>Ariane 4</td>
<td>Guiana Space Center</td>
</tr>
<tr>
<td>101.0 W</td>
<td>Directv 8</td>
<td>36 Ku-band</td>
<td>Parkerd with Directv 4 &amp; 9..... June 18, 2010</td>
<td>Loral Space Systems</td>
<td>LS-1300</td>
<td>22-May-05</td>
<td>Proton M</td>
<td>Baikonur Cosmodrome</td>
</tr>
<tr>
<td>101.1 W</td>
<td>Directv 9S</td>
<td>52 Ku-band + 2 Ka-band</td>
<td>27 Active Ku-band Spot Beams</td>
<td>Loral Space Systems</td>
<td>LS-1300</td>
<td>13-Oct-06</td>
<td>Ariane 5 ECA</td>
<td>Guiana Space Center</td>
</tr>
<tr>
<td>102.8 W</td>
<td>Spaceway 1 (Spaceway F1)</td>
<td>72 Ka-band</td>
<td>24 Transponders Active, 238 Channels, June 18, 2010</td>
<td>Boeing Space Systems</td>
<td>BSS-702</td>
<td>26-Apr-05</td>
<td>Zenit-3SL</td>
<td>Sea Launch (Odyssey)</td>
</tr>
<tr>
<td>102.8 W</td>
<td>Directv 10</td>
<td>32 (+12) Ka-band</td>
<td>55 (+15) Ka-band Spot-Beam</td>
<td>Boeing Space Systems</td>
<td>BSS-702</td>
<td>7-Jul-07</td>
<td>Proton M</td>
<td>Baikonur Cosmodrome</td>
</tr>
<tr>
<td>102.8 W</td>
<td>Directv 12</td>
<td>32 (+12) Ka-band</td>
<td>55 (+15) Ka-band Spot-Beam</td>
<td>Boeing Space Systems</td>
<td>BSS-702</td>
<td>29-Dec-09</td>
<td>Proton M</td>
<td>Baikonur Cosmodrome</td>
</tr>
<tr>
<td>109.8 W</td>
<td>Directv 5 (TEMPO 1)</td>
<td>32 Ku-band</td>
<td>3 Transponders Active, 2 Channels, June 18, 2010</td>
<td>Loral Space Systems</td>
<td>LS-1300</td>
<td>7-May-02</td>
<td>Proton</td>
<td>Baikonur Cosmodrome</td>
</tr>
<tr>
<td>119.0 W</td>
<td>Directv 7S (DTV 7S, DBS 7S)</td>
<td>54 Ku-band + 27 Ka-band spot beams</td>
<td>11 Transponders Active, 524 Channels, June 18, 2010</td>
<td>Loral Space Systems</td>
<td>LS-13005</td>
<td>4-May-04</td>
<td>Zenit-3SL</td>
<td>Sea Launch (Odyssey)</td>
</tr>
<tr>
<td>NA</td>
<td>Directv 1 (DBS 1)</td>
<td>In-orbit backup</td>
<td>In-orbit backup June 18, 2010</td>
<td>Hughes Electronics</td>
<td>HS-601</td>
<td>18-Dec-93</td>
<td>Ariane 4</td>
<td>Guiana Space Center</td>
</tr>
</tbody>
</table>
### Co-location of Satellites

- **12 Physical Satellites + Spare**
- **7 Virtual Satellites**
- Mapping Virtual Transponders
- **72 W**
  - Latin America + Spot Beams to North East USA for Local Stations = 186 Channels
- **99 W**
  - USA HD = Est 300 Channels + 7 Spots Beams to North & South America
- **101 W**
  - USA - 918 Channels Plus 24 Spots Beams to East & Midwest for Local Stations
- **103 W**
  - USA HD = Est 320 Channels + 54 Spots Beams to North America
- **110 W**
  - 3 Transponders Active, 2 Channels active on June 18, 2010 ??????
- **119 W**
  - USA - 524 Channels Plus 27 Spots Beams to West & Southwest for Local Stations

<table>
<thead>
<tr>
<th>PRIMARY USAGE</th>
<th>DIRECTV SATELLITE</th>
<th>RECEIVER DISPLAY</th>
<th>RECEIVER TRANSPOUNDER DISPLAY</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPEG2: SD CONUS</td>
<td>D1R</td>
<td>72.5° conusbeams</td>
<td>1-8</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>9-16</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>17-24</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>25-32</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td>MPEG2: SD CONUS</td>
<td>G3C</td>
<td>95° conusbeams</td>
<td>1-8</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>9-16</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>17-24</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>25-32</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td>MPEG4: HD LIL</td>
<td>SW2 and D11</td>
<td>99° spotbeams</td>
<td>1-8</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>9-16</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>17-24</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>25-32</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td>MPEG4: HD CONUS</td>
<td>D11</td>
<td>99° conusbeams</td>
<td>1-8</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>9-16</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>17-24</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>25-32</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td>MPEG2: SD CONUS</td>
<td>D4S D8 D9S</td>
<td>101° D45 or D95 spotbeams</td>
<td>1-8</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>9-16</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>17-24</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>25-32</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td>MPEG4: HD LIL</td>
<td>SW1 and D10</td>
<td>103° spotbeams</td>
<td>1-8</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>9-16</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>17-24</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>25-32</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td>MPEG4: HD CONUS</td>
<td>D10</td>
<td>103° conusbeams</td>
<td>1-8</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>9-16</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>17-24</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>25-32</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td>MPEG4: HD LIL</td>
<td>D5</td>
<td>110° conusbeams</td>
<td>1-8</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>9-16</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>17-24</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>25-32</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td>MPEG4: HD CONUS</td>
<td>D7S</td>
<td>119° conusbeams</td>
<td>1-8</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>9-16</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>17-24</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>25-32</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
</tbody>
</table>
Ka-band Boeing 702 satellites
DIRECTV 10, 11 & 12

- 200 US HD channels from Two 3 Meter Transmit Antenna Phased Arrays
  - 36 active and 8 spare 492 MHz BW High Power Amplifiers (Traveling Wave Tube Amplifiers - TWTA)

- 1,500 spot beam HD channels from Four 2 Meter Transmit Antenna Phased Arrays
  - 54 active and 16 spare 80 MHz BW TWTAs

- One 2 Meter and Two 50 cm Receive Antennas

- 18,000 Watt Solar Array 158 X 8 Feet

- Batteries are 59 NiH cells with 328 Amp-Hours

- 8,157 LBS On-Orbit Weight
- A simple parabolic antenna will form a round power density pattern (footprint) directly below the satellite.
- Indirect angles form an elliptical footprint.
Coverage on the Ground

- Combining of antennas plus control of amplitude and phase provides complex footprints
- Marketing requires tailored coverage
- Satellite Power Management requires tailored coverage
Antenna Phased Arrays

- A phased array antenna is multiple elements combined in phase to form a direction high gain antenna.
- Shifting the phase steers the beam in the desired direction.

2 M QUAD by W2RTV & KC2QEA

UHF HDTV QUAD Element
Fixed Array

Generic Shifted Six Element Array
Phased Arrays

A phased array antenna is composed of radiating elements each with a phase shifter. Beams are formed by shifting the phase of the signal emitted from each radiating element, to provide constructive/destructive interference to steer the beams in the desired direction.

**Advantages**

- Multifunction operation by emitting several beams simultaneously
- Ability to permit the beam to jump from one target to the next in a few microseconds under computer control
- Fault of single components reduces the beam sharpness, but the system remains operational

**Disadvantages**

- Limited to a 120 degree in AZ & EL
- Gain deteriorates with increased angle
- Limited BW (~5 to 10%)
- Very complex - processor, phase shifters
- High costs
2000 Channels on One Satellite!

- 18.6-18.8 GHz & 19.7-20.2 GHz Downlinks
- Left & Right Circular polarization
- Steering antennas provides increased frequency reuse = Channels x Spot Beams
- This results in more bandwidth per satellite
  - National footprint 2000 MHz of bandwidth/satellite
  - Virtual 6000 MHz of bandwidth/satellite via Spot Beams

CONUS Main Footprint

Spot Beams

Sept. 21, 2010
Optimizing Satellite Downlinks

- Satellite Power Management and Marketing dictate downlink allocation
  - The national footprint and spot beams are monitored on the ground
  - A closed loop feedback is developed from nationwide monitoring stations

- Programming channels can be arranged by frequency, polarization, spot beam or satellite

- Current look up tables of program channels are sent to home receivers similar to network severs and Ethernet routers
Receiving DirecTv DBS

- Receiving 7 Virtual Satellites
  - DIRECTV markets based on a small 18 Inch dish. Starting with one LNB in 1996 to today with 5 LNB to receive 99°, 101°, 103°, 110°, 119° degree satellites
  - 5 Ku
    - LHCP with 500 MHz BW
    - LHCP with 500 MHz BW
  - 2 Ka
    - LHCP with 1000 MHz BW
    - LHCP with 1000 MHz BW

- Demod IC
  - BCM4500 contains dual 7-bit A/D converters, an all-digital variable rate BPSK / QPSK / 8PSK / 16QAM receiver, an advanced modulation turbo FEC decoder, and a DVB / DIRECTV / DCII compliant FEC decoder. Output is delivered in MPEG-2 or MPEG-4. plus a DiSEqCTM controller for two way communication with LNB.
DirecTv DBS Downlink Evolution

- DirecTv LNB, Dish & Receivers have morphed over the past 15 Years into five backwards compatible designs
Receiving DirecTV Phase 1

- Round Parabolic Dish
  - One Satellite (101)
- Low Noise Block Converter (LNB)
  - Input RF Carriers 12.2-12.7 GHz
  - Selects RHCP or LHCP (13V or 18V)
  - Output IF 950 – 1450 MHz
- Home Receiver
  - Superheterodyne Tuner
  - Power for LNB
  - Polarization by LNB Voltage (13V or 18V)
- Television Set
  - RF Ch 3 or NTSC 1 Vpp
Receiving DirecTV Phase 2

- Eliptical Parabolic Dish
  - Two Satellites (101, 119)
- Low Noise Block Converter (LNB)
  - RF Carriers 12.2-12.7 GHz (22 KHz)
  - Selects RHCP or LHCP (13V or 18V)
  - Output IF 950 – 1450 MHz
- Home Receiver
  - Superheterodyne Tuner
  - Power for LNB
  - Polarization by LNB Voltage (13V or 18V)
  - Satellite by LNB Tone (22 KHz) On/Off
- Television Set
  - RF Ch 3 or NTSC 1 Vpp
Receiving DirecTV Phase 3

- **Eliptical Parabolic Dish**
  - Three Satellites (101, 110, 119)

- **Low Noise Block Converter (LNB)**
  - RF Carriers 12.2-12.7 GHz (22 KHz)
  - Selects RHCP or LHCP (13V or 18V)
  - Output IF 950 – 2150 MHz

- **Home Receiver**
  - Superheterodyne Tuner
  - Power for LNB
  - Polarization by LNB Voltage (13V or 18V)
  - Satellite 110 or 119 Tone (22 KHz) On/Off

- **Television Set**
  - HDMI, RF Ch 3 or NTSC
Receiving DirecTv Phase 4

- Eliptical Parabolic Dish
  - Five Satellites (99, 101, 103, 110, 119)

- Low Noise Block Converter (LNB)
  - RF Carriers 12.2-12.7 & 18.3-18.8 & 19.7-20.2 GHz (22 KHz)
  - Selects RHCP or LHCP (13V or 18V)
  - Output IF 250 – 2150 MHz
    - Lo Ka = 250-750 IF and Hi Ka = 1650-2150 IF

- Home Receiver
  - Superheterodyne Tuner
  - Power for LNB
  - Polarization & Satellite Selection
    - 13V = Ka 99/101 RHCP
    - 18V = Ka 99/101 LHCP
    - 13V + 22 KHz Tone = 103/110/119 RHCP
    - 18V + 22 KHz Tone = 103/110/119 LHCP

- Television Set
  - HDMI, RF Ch 3 or NTSC
Receiving DirecTV SWM (Phase 5)

- Single-Wire Multi-switch (SWM) is in the LNB
  - Looks the same as the Phase 4 LNB, has 1 wire instead of 4 Coaxial Cables
  - LNB/Switch are NOT Backwards Compatible
  - Receivers work with Phase 1-5

- Receiver commands LNB to select:
  - Satellite, Polarization and IF center frequency
  - Design by Entropic uses 2.3 MHz Control Carrier
  - Permits DBS & Off the Air / Cable in One Coaxial Cable

### One Coax Freq vs. Function in MHz

<table>
<thead>
<tr>
<th>DBS</th>
<th>IF</th>
<th>Freq</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>974</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1076</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1178</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>1280</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>1382</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>1484</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>1586</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>1688</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>1790</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>1892</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>1994</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>2096</td>
<td></td>
</tr>
</tbody>
</table>

- **Student**
- **SSTV**
- **IF**
- **Freq**
- **2**
- **54**
- **862**
- **1075**
- **1125**
- **2150**

- **CTL**
- **Cable TV**
- **IP TV**
- **DirecTv DBS**
- 14 Million Customers
- 4435 programs (USA)
- Operating 9 Satellites
  - Ku/Ka (3 Satellites) @ 61 W Lon
  - Ku/Ka @ 72 W Lon
  - Ku (2 Satellites) @ 110 W Lon
  - Ku (2 Satellites) @ 119 W Lon
  - Ku/Ka @ 129 W Lon
  - Spare None (all above leased)
- Packages with 295 Programs
  - Ku - QPSK + DVB
    - MPEG-2 & Framing Standards
  - Ka – 8PSK + DVB-S2 (HD)
    - MPEG-4 AVC
## Dish Network Satellites

<table>
<thead>
<tr>
<th>Lon</th>
<th>Status</th>
<th>Satellite Name</th>
<th>Comments</th>
<th>Satellite Model</th>
<th>Launch Date</th>
<th>Launch Site</th>
</tr>
</thead>
<tbody>
<tr>
<td>61 W</td>
<td>Active</td>
<td>Echostar 3</td>
<td>Primary HD Service East. Provides national HD programming and HD spotbeam locals. 32 Ku-band transponders to cover Central/Mountain region to Eastern U.S.</td>
<td>A2100AX</td>
<td>5-Oct-97</td>
<td>Cape Canaveral</td>
</tr>
<tr>
<td>61 W</td>
<td>Active</td>
<td>Echostar 12 (Rainbow 1, Cablevision 1)</td>
<td>36 Ku-band transponders to provide DTH telecommunications to CONUS</td>
<td>A2100AXS</td>
<td>17-Jul-03</td>
<td>Cape Canaveral</td>
</tr>
<tr>
<td>61 W</td>
<td>Active</td>
<td>Echostar 15</td>
<td>32 Ku-band transponders to provide BSS services to CONUS and Puerto Rico</td>
<td>LS-1300</td>
<td>10-Jul-10</td>
<td>Baikonur Cosmodrome</td>
</tr>
<tr>
<td>73 W</td>
<td>Active</td>
<td>Nimiq 5</td>
<td>A Canadian satellite operated by Telesat Canada. Echostar leases the satellite's capacity.</td>
<td>LS-1300</td>
<td>17-Sep-09</td>
<td></td>
</tr>
<tr>
<td>110 W</td>
<td>Active</td>
<td>Echostar 10 (Echostar X)</td>
<td>Direct-to-home transmission of voice, video and internet.</td>
<td>A2100AXS</td>
<td>15-Feb-06</td>
<td>Sea Launch (Odyssey)</td>
</tr>
<tr>
<td>110 W</td>
<td>Active</td>
<td>Echostar 11 (Echostar XI)</td>
<td>29 Ku-band transponders to provide direct-to-home services to CONUS</td>
<td>LS-1300</td>
<td>16-Jul-08</td>
<td>Sea Launch (Odyssey)</td>
</tr>
<tr>
<td>119 W</td>
<td>Active</td>
<td>Echostar 7</td>
<td>32 Ku-band transponders covering CONUS, Hawaii, Alaska and Puerto Rico.</td>
<td>A2100AX</td>
<td>21-Feb-02</td>
<td>Cape Canaveral</td>
</tr>
<tr>
<td>119 W</td>
<td>Active</td>
<td>Echostar 14 (Echostar XIV)</td>
<td>103 Ku-band transponders to provide expanded DTH services for DISH Network's subscribers</td>
<td>LS-1300</td>
<td>21-Mar-10</td>
<td>Baikonur Cosmodrome</td>
</tr>
<tr>
<td>129 W</td>
<td>Active</td>
<td>Ciel-2</td>
<td>Primary HD Service West. Provides national HD programming and HD spotbeam locals.</td>
<td>Spacebus-4000C4</td>
<td>10-Dec-08</td>
<td></td>
</tr>
</tbody>
</table>
Receiving Dish Network DBS

- Receiving 5 Virtual Satellites*
  - Dish markets based on a small ½ M dish. Starting with one LNB in 1996
  - Today with 3 LNB to receive;
    - 61°, 72°, 77° degree satellites (East Coast)
    - 110°, 119°, 129° degree satellites (West Coast)
  - 3 Ku
    - LHCP with 500 MHz BW
    - LHCP with 500 MHz BW
  - 2 Ka
    - LHCP with 1000 MHz BW
    - LHCP with 1000 MHz BW

* 77° W is Non-USA Latin America DBS Only
Receiving Dish Network 300

- 18 Inch Round Parabolic Dish
- One Satellite (119 W Lon)
- Low Noise Block Converter (LNB)
  - Input RF Carriers 12.2-12.7 GHz
  - Selects RHCP or LHCP (13V or 18V)
  - Output IF 950 – 1450 MHz
  - One RG-6 Coaxial Cable

Home Receiver
- IF Superheterodyne Tuner
- Power for LNB
- Polarization by LNB Power (13V or 18V)
- One RG-6 Coaxial Cable per Tuner

Television Set
- RF Ch 3 or NTSC 1 Vpp
Receiving Dish Network 500

- 20 Inch Round Parabolic Dish
  - Two Satellites (110, 119)
- Low Noise Block Converter (LNB)
  - Input RF Carriers 12.2-12.7 GHz
  - Selects RHCP or LHCP (13V or 18V)
  - Output IF 950 – 1450 MHz
  - Two RG-6 Coaxial Cables

Home Receiver
- IF Superheterodyne Tuner
- Power for LNB
- Polarization by LNB Power (13V or 18V)
- LNB/Satellite by Tone Command (22 KHz)
- One RG-6 Coaxial Cable per Tuner

Television Set
- RF Ch 3 or NTSC 1 Vpp
Receiving Dish Network 1000+

- **Primary 110 & 119**
  - Add-On for HD 62 or 129

- **Low Noise Block Converter (LNB)**
  - RF Carriers 12.2-12.7 GHz
  - Power for LNBs on IF (~19 V PS)
  - Output IF 950–2150 MHz (Stacked IF)
    - RHCP 950-1450 MHz
    - LHCP 1650-2150 MHz

- **Multi-Switch** (or inside LNB)
  - Selects by DiSEqC 2.0 (22 KHz Carrier)
  - Digital Satellite Equipment Control
  - Receivers Control/Status to LNBs or MS

- **Home Receiver**
  - Superheterodyne Tuner
  - Power for LNB 19 V (10.5 V Min)
  - Polarization by DiSEqC 2.0
  - Satellite by by DiSEqC 2.0
  - One RG-6 Coaxial Cable per Tuner

- **Television Set**
  - HDMI, RF Ch 3 or NTSC 1 Vpp

Ref # 24, 31
Receiving Dish Network 1000.2

- **Primary 110 & 119 Plus 129 HD**
  - Add-On LNB for Special Packages
- **Low Noise Block Converter (LNB)**
  - RF Carriers 12.2-12.7 GHz
  - Output IF 950–2150 MHz (~19 V PS)
- **Multi-Switch** (or inside LNB)
  - Selects by DiSEqC 2.0 (22 KHz Carrier)
  - Digital Satellite Equipment Control
  - Receivers Control/Status to LNBs or MS
- **Home Receiver**
  - Superheterodyne Tuner
  - Power for LNB 19 V (10.5 V Min)
  - Polarization by DiSEqC 2.0
  - Satellite by DiSEqC 2.0
  - One RG-6 Coaxial Cable per Tuner
- **Television Set**
  - HDMI, RF Ch 3 or NTSC 1 Vpp

Sept. 21, 2010
Receiving Dish Network 1000.4

- Primary 72 & 77 Plus 61 HD
  - Add-On LNB for Special Packages
  - 72 Package includes most of Primary 110 & 119
  - 77 Latin America Package
  - Designed as an East Coast equivalent to 1000.2

- Low Noise Block Converter (LNB)
  - RF Carriers 12.2-12.7 GHz
  - Output IF 950–2150 MHz (~19 V PS)

- Multi-Switch (or inside LNB)
  - Selects by DiSEqC 2.0 (22 KHz Carrier)
  - Digital Satellite Equipment Control
  - Receivers Control/Status to LNBs or MS

- Home Receiver
  - Superheterodyne Tuner
  - Power for LNB 19 V (10.5 V Min)
  - Satellite & Polarization by DiSEqC 2.0
  - One RG-6 Coaxial Cable per Tuner

- Television Set
  - HDMI, RF Ch 3 or NTSC 1 Vpp
<table>
<thead>
<tr>
<th>Ref #</th>
<th>Source Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><a href="http://crankyflier.com/2009/05/20/livetv-explains-why-there-was-such-poor-signal-reception-on-my-jetblue-flight">http://crankyflier.com/2009/05/20/livetv-explains-why-there-was-such-poor-signal-reception-on-my-jetblue-flight</a></td>
</tr>
<tr>
<td>2</td>
<td><a href="http://en.wikipedia.org/wiki/Direct-broadcast_satellite">http://en.wikipedia.org/wiki/Direct-broadcast_satellite</a></td>
</tr>
<tr>
<td>4</td>
<td><a href="http://en.wikipedia.org/wiki/Dishnetwork">http://en.wikipedia.org/wiki/Dishnetwork</a></td>
</tr>
<tr>
<td>5</td>
<td><a href="http://en.wikipedia.org/wiki/Satellite_television">http://en.wikipedia.org/wiki/Satellite_television</a></td>
</tr>
<tr>
<td>6</td>
<td><a href="http://flickr.com/blog/category/television/">http://flickr.com/blog/category/television/</a></td>
</tr>
<tr>
<td>8</td>
<td><a href="http://i1.ambrybox.com/270510/1274980147208.jpeg">http://i1.ambrybox.com/270510/1274980147208.jpeg</a></td>
</tr>
<tr>
<td>9</td>
<td><a href="http://images.search.yahoo.com/images/view?back=http://Images.search.yahoo.com/search/images%3Fp%3Dsatellite%2Btv%2Bboat%2B685%26n%3D21%26ei%3DUTF-8%26y%3DSearch%26xargs%3D0%26psstart%3D0%26ty%3Dyp%26r%3D1%26h%3Dydp%26i%3D701-sixx%3D556&amp;h=468&amp;w=468&amp;url=http://www.camos.co.uk/images/camps/landboat2.jpg&amp;url2=http://www.camos.co.uk/inland.php">http://images.search.yahoo.com/images/view?back=http://Images.search.yahoo.com/search/images%3Fp%3Dsatellite%2Btv%2Bboat%2B685%26n%3D21%26ei%3DUTF-8%26y%3DSearch%26xargs%3D0%26psstart%3D0%26ty%3Dyp%26r%3D1%26h%3Dydp%26i%3D701-sixx%3D556&amp;h=468&amp;w=468&amp;url=http://www.camos.co.uk/images/camps/landboat2.jpg&amp;url2=http://www.camos.co.uk/inland.php</a></td>
</tr>
<tr>
<td>15</td>
<td><a href="http://www.dishnetwork.com/">http://www.dishnetwork.com/</a></td>
</tr>
<tr>
<td>17</td>
<td><a href="http://www.entropy.com/products/dbs.htm">http://www.entropy.com/products/dbs.htm</a></td>
</tr>
<tr>
<td>20</td>
<td><a href="http://www.lyhoma.com/funny-picture-1226678128.html">http://www.lyhoma.com/funny-picture-1226678128.html</a></td>
</tr>
<tr>
<td>21</td>
<td><a href="http://www.lyngsat.com/america.html">http://www.lyngsat.com/america.html</a></td>
</tr>
<tr>
<td>Ref #</td>
<td>Source Material</td>
</tr>
<tr>
<td>-------</td>
<td>-----------------</td>
</tr>
<tr>
<td>22</td>
<td><a href="http://www.n2yo.com/satellites/?c=34">http://www.n2yo.com/satellites/?c=34</a></td>
</tr>
<tr>
<td>26</td>
<td><a href="http://www.satbeams.com/satellites/">http://www.satbeams.com/satellites/</a></td>
</tr>
<tr>
<td>29</td>
<td><a href="http://www.scottandmichelle.net/Scott/SPOTS2.png">http://www.scottandmichelle.net/Scott/SPOTS2.png</a></td>
</tr>
<tr>
<td>30</td>
<td><a href="http://www.solidsignal.com/pview.asp?mc=02&amp;amp;mc=02&amp;amp;ds=DISH1000.2&amp;amp;ds=DISH-Netwod-Dish10002-Triple-LNB-HighDefinition-Compatible-(VOOM)-Dish-Antenna-(DISH1000.2)&amp;amp;ds=DISH%20Network%20Dishes&amp;amp;sku=753960009391">http://www.solidsignal.com/pview.asp?mc=02&amp;amp;mc=02&amp;amp;ds=DISH1000.2&amp;amp;ds=DISH-Netwod-Dish10002-Triple-LNB-HighDefinition-Compatible-(VOOM)-Dish-Antenna-(DISH1000.2)&amp;amp;ds=DISH%20Network%20Dishes&amp;amp;sku=753960009391</a></td>
</tr>
<tr>
<td>31</td>
<td><a href="http://www.solidsignal.com/pview.asp?mc=02&amp;amp;ds=DISH1000Plus&amp;amp;ds=DISH">http://www.solidsignal.com/pview.asp?mc=02&amp;amp;ds=DISH1000Plus&amp;amp;ds=DISH</a> Network-Dish1000+-Local-HighDefinition-Compatible-Dish-Antenna-(DISH1000+-)&amp;ds=DISH%20Network%20Dishes&amp;sku=</td>
</tr>
<tr>
<td>33</td>
<td><a href="http://www.solidsignal.com/pview.asp?mc=02&amp;amp;ds=KIT-500TWIN-DPP&amp;amp;ds=DISH-Network-Dish500-Antenna-and-DishProPLUS-Twin-(KIT500TWIN(DPP)-138159)&amp;amp;ds=DISH%20Network%20Dishes&amp;amp;sku=">http://www.solidsignal.com/pview.asp?mc=02&amp;amp;ds=KIT-500TWIN-DPP&amp;amp;ds=DISH-Network-Dish500-Antenna-and-DishProPLUS-Twin-(KIT500TWIN(DPP)-138159)&amp;amp;ds=DISH%20Network%20Dishes&amp;amp;sku=</a></td>
</tr>
<tr>
<td>34</td>
<td><a href="http://www.solidsignal.com/pview.asp?mc=02&amp;amp;ds=DISH1000.4&amp;amp;ds=DISH">http://www.solidsignal.com/pview.asp?mc=02&amp;amp;ds=DISH1000.4&amp;amp;ds=DISH</a> Network-Dish1000.4-Triple-LNB-HighDefinition-Compatible-(VOOM)-Dish-Antenna-(DISH1000.4)&amp;ds=DISH%20Network%20Dishes&amp;sku=</td>
</tr>
<tr>
<td>35</td>
<td><a href="http://www.wtvbew.com/photo.htm">http://www.wtvbew.com/photo.htm</a></td>
</tr>
<tr>
<td>36</td>
<td><a href="http://img.photobucket.com/albums/v699/xuan/phased_array_illus.jpg">http://img.photobucket.com/albums/v699/xuan/phased_array_illus.jpg</a></td>
</tr>
<tr>
<td>37</td>
<td>NASA TM-X55492</td>
</tr>
<tr>
<td>38</td>
<td><a href="http://www.fialist.com">www.fialist.com</a></td>
</tr>
<tr>
<td>39</td>
<td><a href="http://www.geo-orbit.org">www.geo-orbit.org</a></td>
</tr>
<tr>
<td>41</td>
<td>U.S. Patent Numbers: 4207431, 5758260, 6082422, 6118999, 6173178, 6233451, 6704543, 6965755</td>
</tr>
<tr>
<td>42</td>
<td><a href="http://www.winegard.com">www.winegard.com</a></td>
</tr>
</tbody>
</table>