Design and Developers Forum: Application and Design of In-Building RF Distribution Systems

Part 1

by Leo Holzenthal Jr., PE, M S Benbow & Associates

Ahmed Hminy, Andrew Wireless Solutions

Ali Nemati, Dallas-Fort Worth International Airport

GlobeCom 2008: In-Building RF Distribution Systems

1. Agenda – Part 1

1. Wireless Communications Spectrum 101

1. Introduction
2. Paging Spectrum
3. Two-Way Radio Spectrum
4. Commercial (Franchise) Wireless Telephone Carrier Spectrum

- New Spectrum opening for two-way operation

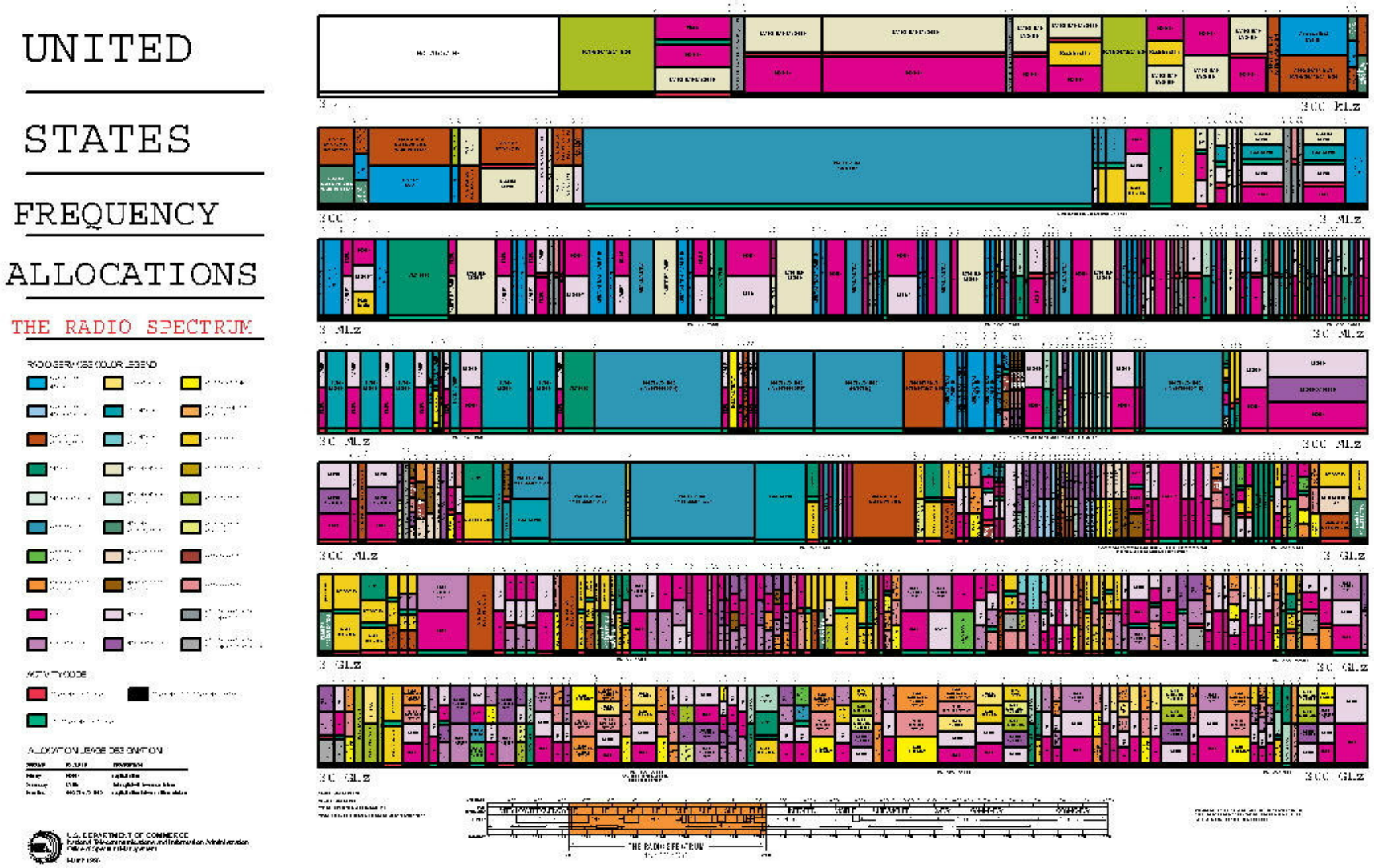
GlobeCom 2008: In-Building RF Distribution Systems

1. Agenda
2. *What is DAS?*
   1. A system designed to put signal inside of structures where it cannot penetrate from outside sources, or where outdoor sources do not exist
   2. Distributed antenna system
   3. In building wireless system
   4. BDA system
   5. many other trade names
3. *Why?*
   1. Better Quality of service
   2. Continunity of Service
   3. Public Safety- Reduced human exposure to RF radiation
   4. Increased commercial revenue

There is much spectrum available for use in the US that provides connectivity to the public and commercial market. Differences in the bandplans for each spectum allocation create difficulties in the design of RF distribution systems. Some of these differences are:

- **Channel Bandwidth**
- **Channel Guard Band width**
- **Frequency propagation**
- **Transmit / Receive frequency spacing**

GlobeCom 2008: In-Building RF Distribution Systems



Wireless Paging

Paging Radio Frequency Spectrum of Interest:

- 35 Mhz
- 43 Mhz
- 152-159 Mhz (two-way)
- 454 Mhz (two-way)
- 935 Mhz

Paging (Lower) Bandplan

Paging 35 MHz

Channel (License Suffix)	Frequency Band
CA	35.19 - 35.21
CB	35.21 - 35.23
CC	35.23 - 35.25
CD	35.25 - 35.27
CE	35.29 - 35.31
CF	35.33 - 35.35
CG	35.37 - 35.39
CH	35.41- 35.43
CI	35.45 - 35.47
CJ	35.49 - 35.51
CK	35.53 - 35.55
CL	35.55 - 35.57
CM	35.57 - 35.59
CN	35.59 - 35.61
CO	35.61- 35.63
CP	35.65 - 35.67

Paging 43 MHz

Channel (License Suffix)	Frequency Band
DA	43.19 - 43.21
DB	43.21 - 43.23
DC	43.23 - 43.25
DD	43.25 - 43.27
DE	43.29 - 43.31
DF	43.33 - 43.35
DG	43.37 - 43.39
DH	43.41 - 43.43
DI	43.45 - 43.47
DJ	43.49 - 43.51
DK	43.53 - 43.55
DL	43.55 - 43.57
DM	43.57 - 43.59
DN	43.59 - 43.61
DO	43.61 - 43.63
DP	43.65 - 43.67

Paging 152 & 158 MHz Unpaired

Channel (License Suffix)	Frequency Band
EA	152.230 - 152.250
EB	152.830 - 152.850
EC	158.090 - 158.110
ED	158.690 - 158.710

Note: Refer to next page for 152-159 MHz (Paired)

Paging (Lower) Bandplan (cont.)

152-159 MHz (Paired)

40 kHz channels*
18 paired center frequencies available for auction in each EA (see Channel Listing)

454 MHz (Paired)

40 kHz channels*
26 paired center frequencies available for auction in each EA (see Channel Listing)

Paging 152-159 MHz Paired

Channel (License Suffix)	Frequency Band
FA	152.015-152.045 / 158.475-158.505
FB	152.045-152.075 / 158.505-158.535
FC	152.075-152.105 / 158.535-158.565
FD	152.105-152.135 / 158.565-158.595
FE	152.135-152.165 / 158.595-158.625
FF	152.165-152.195 / 158.625-158.655
FG	152.195-152.225 / 158.655-158.685
FH	152.495-152.525 / 157.755-157.785
FI	152.525-152.555 / 157.785-157.815
FJ	152.555-152.585 / 157.815-157.845
FK	152.585-152.615 / 157.845-157.875
FL	152.615-152.645 / 157.875-157.905
FM	152.645-152.675 / 157.905-157.935
FN	152.675-152.705 / 157.935-157.965
FO	152.705-152.735 / 157.965-157.995
FP	152.735-152.765 / 157.995-158.025
FQ	152.765-152.795 / 158.025-158.055
FR	152.795-152.825 / 158.055-158.085

Note: Refer to previous page for 152-158 MHz (Unpaired)

* These are paired channels of 20kHz each

Paging 454 MHz Paired

Channel (License Suffix)	Frequency Band
GA	454.0125-454.0375 / 459.0125-459.0375
GB	454.0375-454.0625 / 459.0375-459.0625
GC	454.0625-454.0875 / 459.0625-459.0875
GD	454.0875-454.1125 / 459.0875-459.1125
GE	454.1125-454.1375 / 459.1125-459.1375
GF	454.1375-454.1625 / 459.1375-459.1625
GG	454.1625-454.1875 / 459.1625-459.1875
GH	454.1875-454.2125 / 459.1875-459.2125
GI	454.2125-454.2375 / 459.2125-459.2375
GJ	454.2375-454.2625 / 459.2375-459.2625
GK	454.2625-454.2875 / 459.2625-459.2875
GL	454.2875-454.3125 / 459.2875-459.3125
GM	454.3125-454.3375 / 459.3125-454.3375
GN	454.3375-454.3625 / 459.3375-459.3625
GO	454.3625-454.3875 / 459.3625-459.3875
GP	454.3875-454.4125 / 459.3875-459.4125
GQ	454.4125-454.4375 / 459.4125-459.4375
GR	454.4375-454.4625 / 459.4375-459.4625
GS	454.4625-454.4875 / 459.4625-459.4875
GT	454.4875-454.5125 / 459.4875-459-5125
GU	454.5125-454.5375 / 459.5125-459.5375
GV	454.5375-454.5625 / 459.5375-459.5625
GW	454.5625-454.5875 / 459.5625-459.5875
GX	454.5875-454.6125 / 459.5875-459.6125
GY	454.6125-454.6375 / 459.6125-459.6375
GZ	454.6375-454.6625 / 459.6375-459.6625

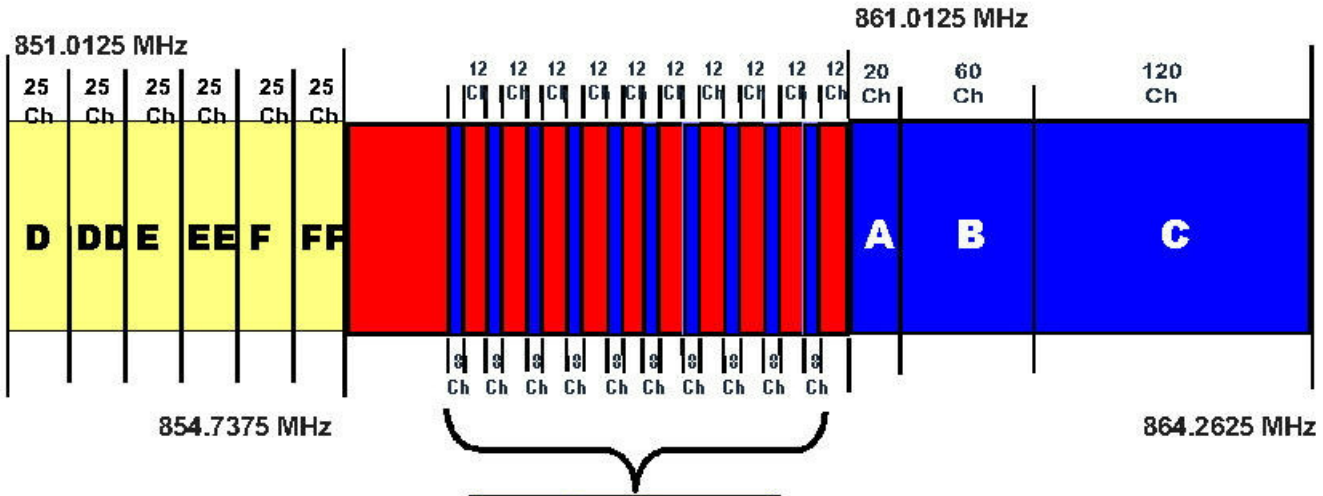
Two - Way Radio

Two-Way Radio Frequency Spectrum of Interest:

- 34-39 MHz
- 150 MHz Band
- 220 MHz Band
- 430-512 MHz Band
- 700 MHz Band (under construction)
- 806-869 MHz Band
- 896-935 MHz Band

GlobeCom 2008: In-Building RF Distribution Systems

Auctions 34 & 36 Specialized Mobile Radio Bandplan

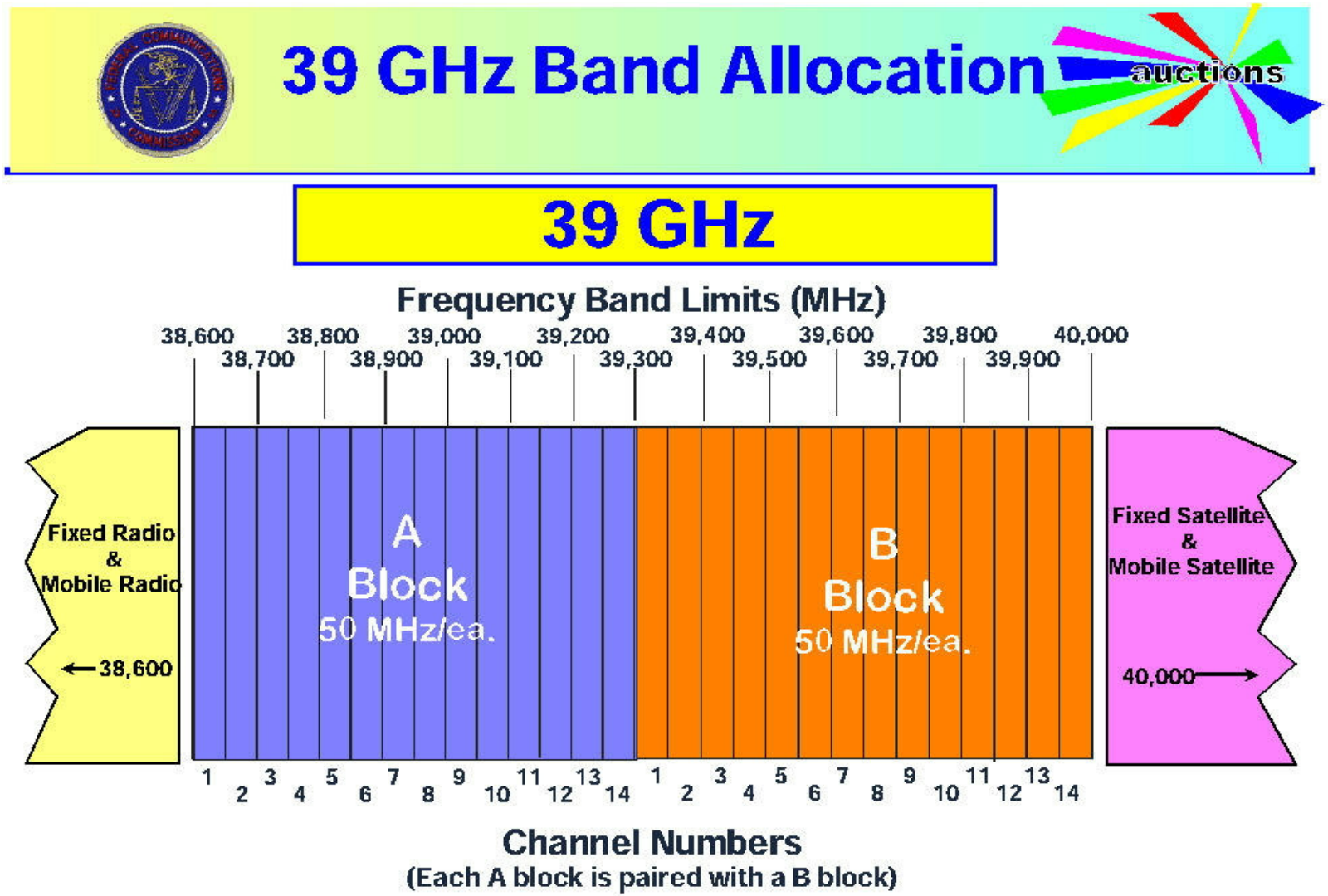


Block	Channels
G	201,241,281,321,361
H	202,242,282,322,362
I	203,243,283,323,363
J	204,244,284,324,364
K	205,245,285,325,365
L	206,246,286,326,366
M	207,247,287,327,367
N	208,248,288,328 ,368
O	221,261,301,341,381
P	222,262,302,342,382
Q	223,263,303,343,383
R	224,264,304,344,384
S	225,265,305,345,385
T	226,266,306,346,386
U	227,267,307,347,387
V	228,268,308,348,388

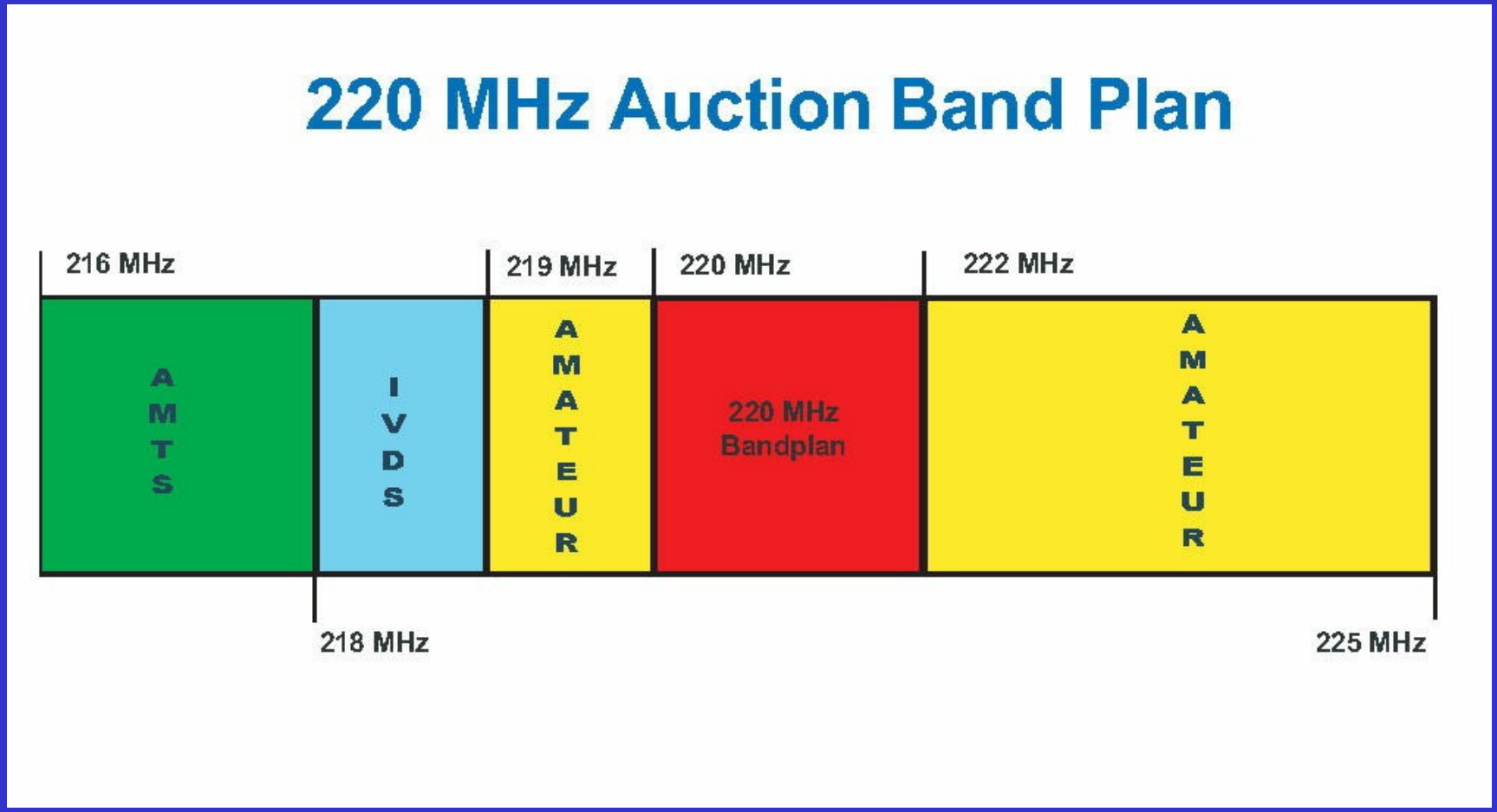
General Category Pool

SMR Category Pool

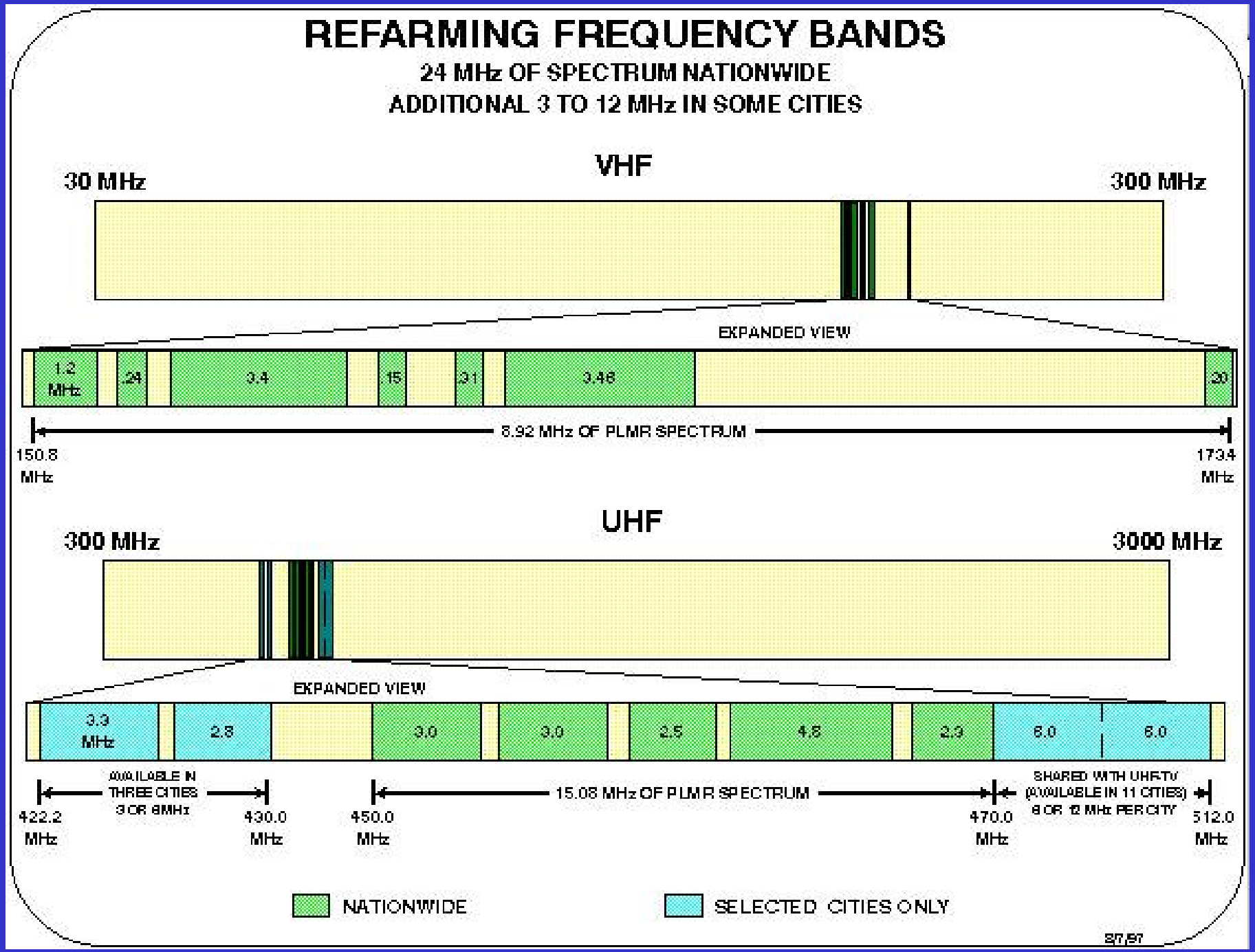
Public Safety, Industrial/Land Transportation & Business Pools


39 GHz Band Allocation
auctions
39 GHz
Frequency Band Limits (MHz)
38,600
38,700
38,800
38,900
39,000
39,100
39,200
39,300
39,400
39,500
39,600
39,700
39,800
39,900
40,000
Fixed Radio
&
Mobile Radio
38,600
A
Block
50 MHz/ea.
B
Block
50 MHz/ea.
Fixed Satellite
&
Mobile Satellite
40,000
1 2 3 4 5 6 7 8 9 10 11 12 13 14
1 2 3 4 5 6 7 8 9 10 11 12 13 14
Channel Numbers
(Each A block is paired with a B block)

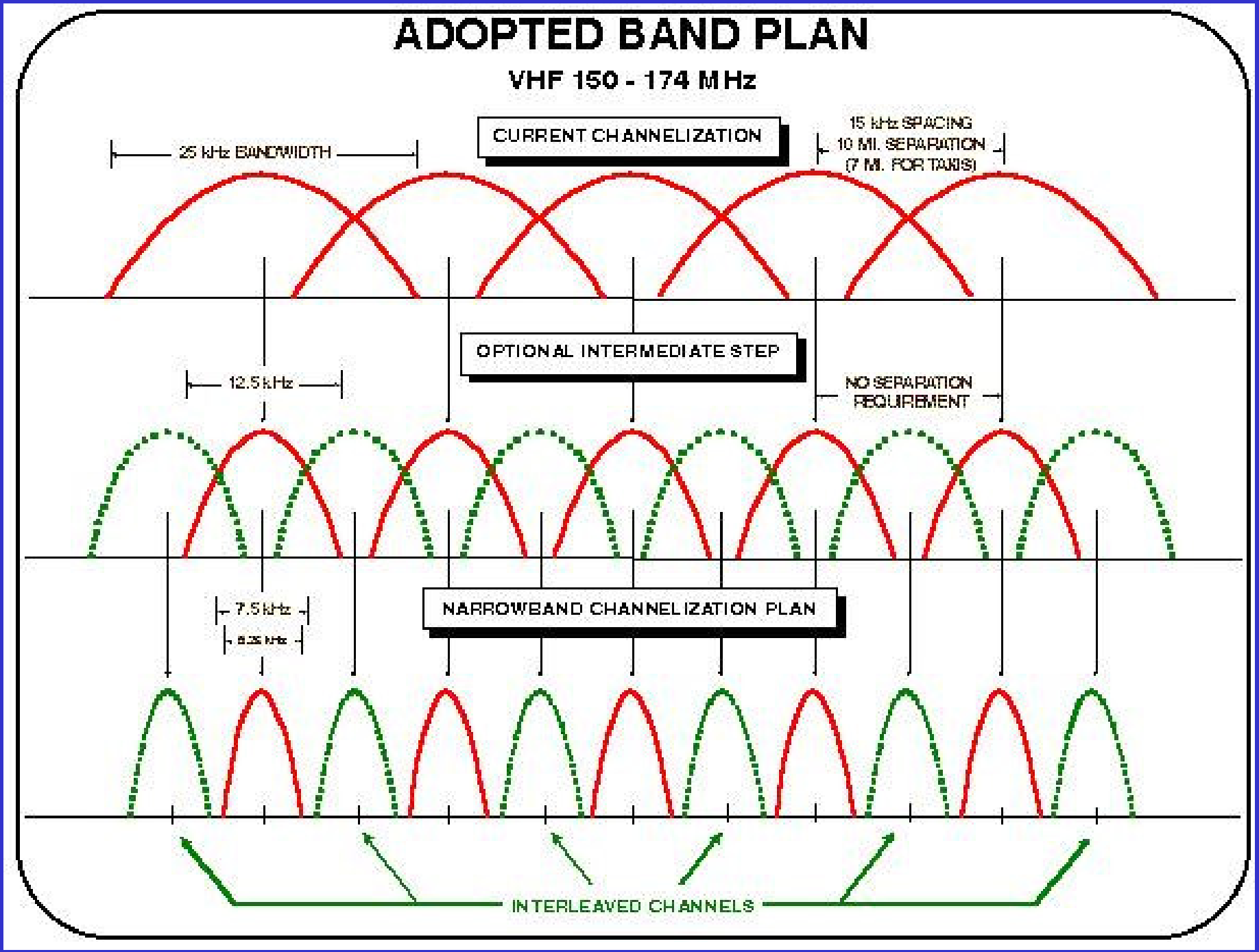
GlobeCom 2008: In-Building RF Distribution Systems



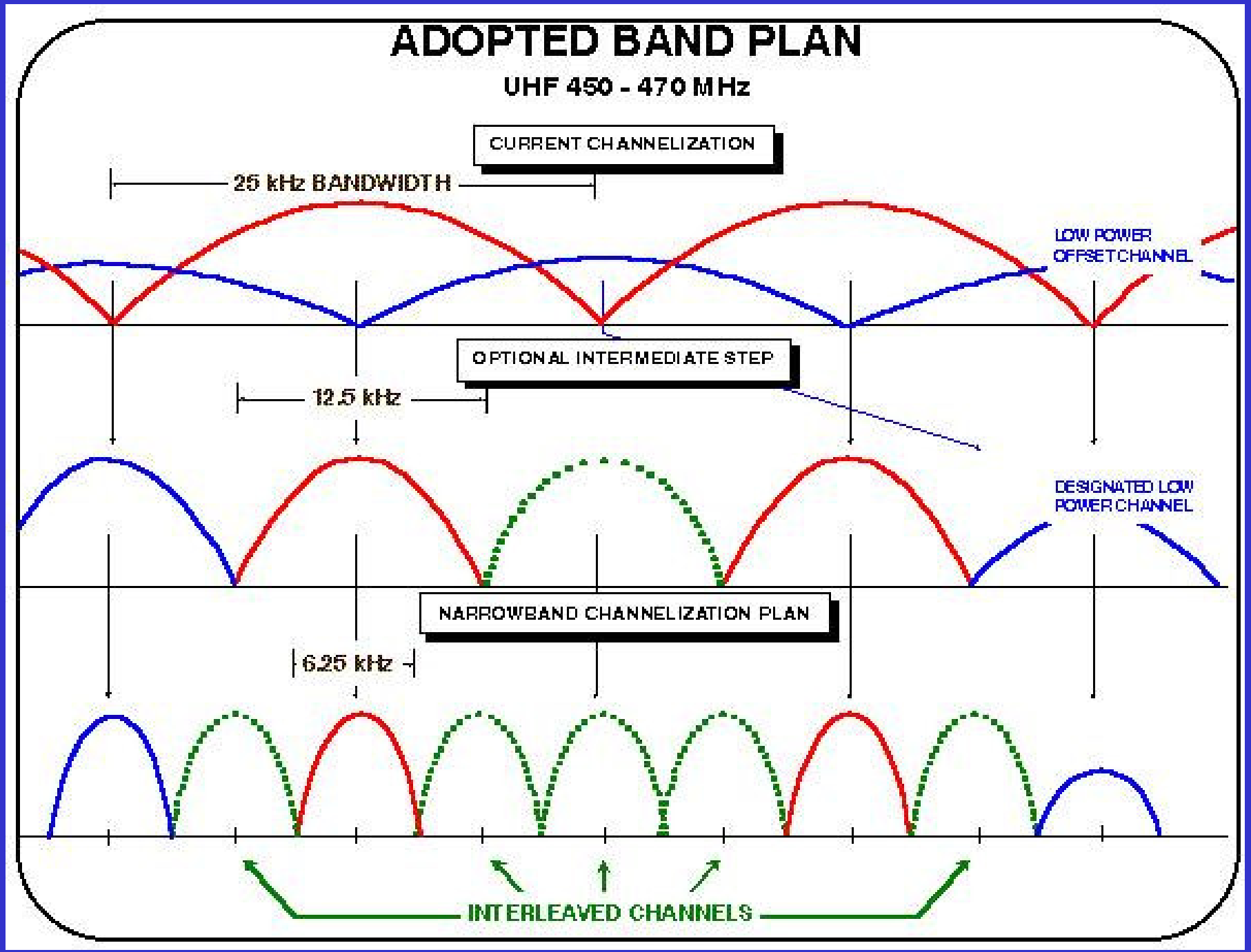
GlobeCom 2008: In-Building RF Distribution Systems



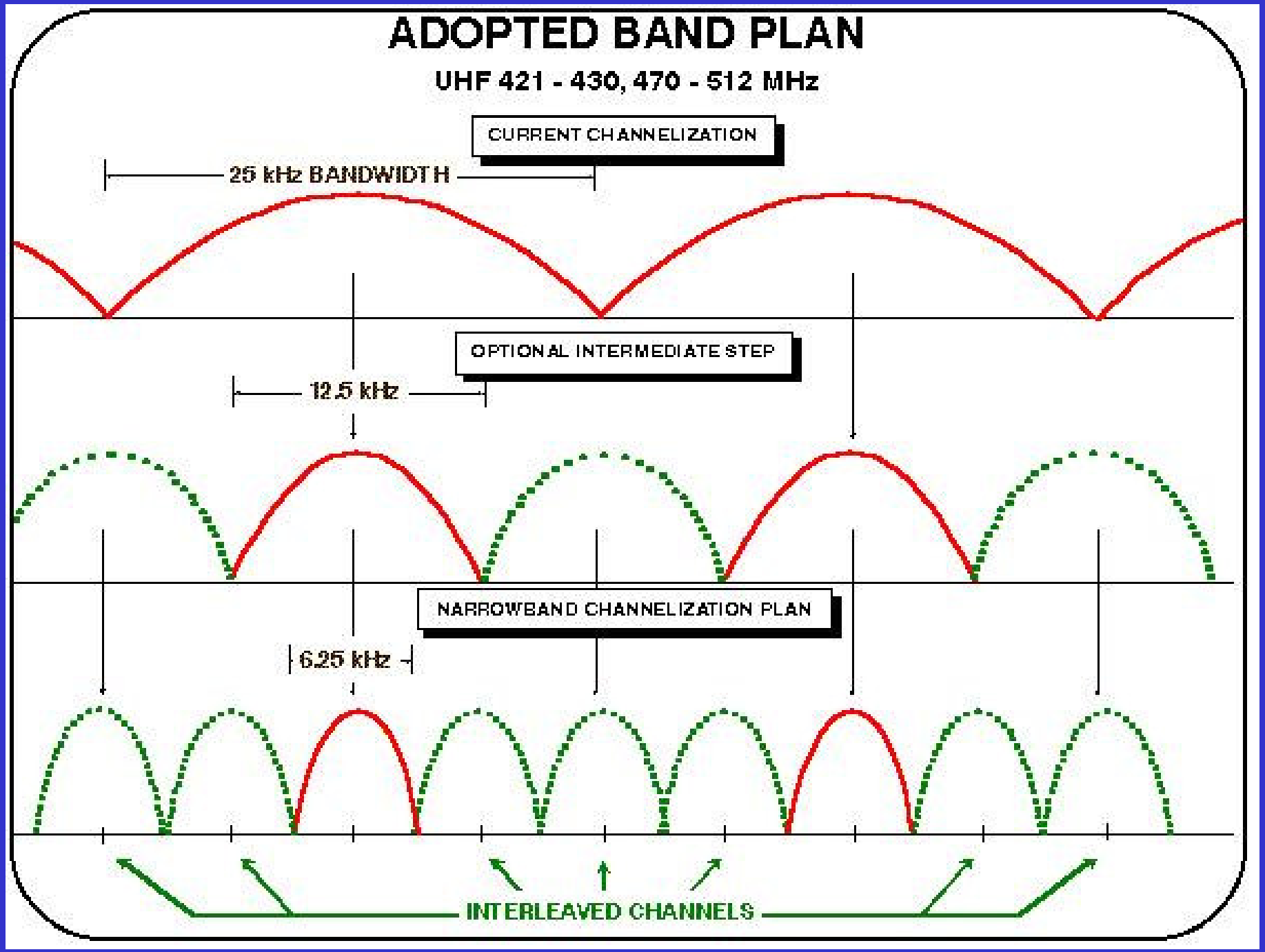
GlobeCom 2008: In-Building RF Distribution Systems



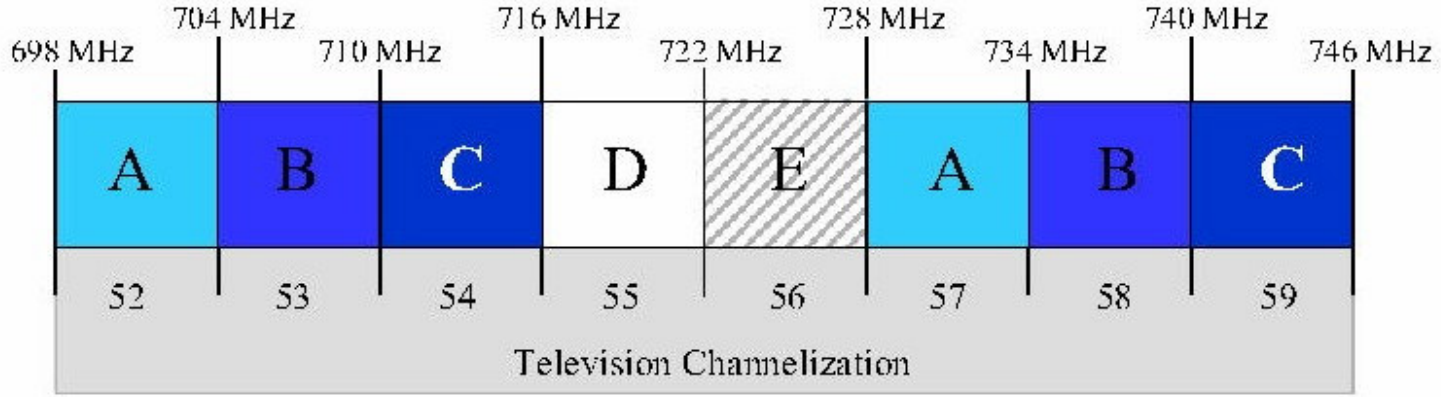
GlobeCom 2008: In-Building RF Distribution Systems



GlobeCom 2008: In-Building RF Distribution Systems

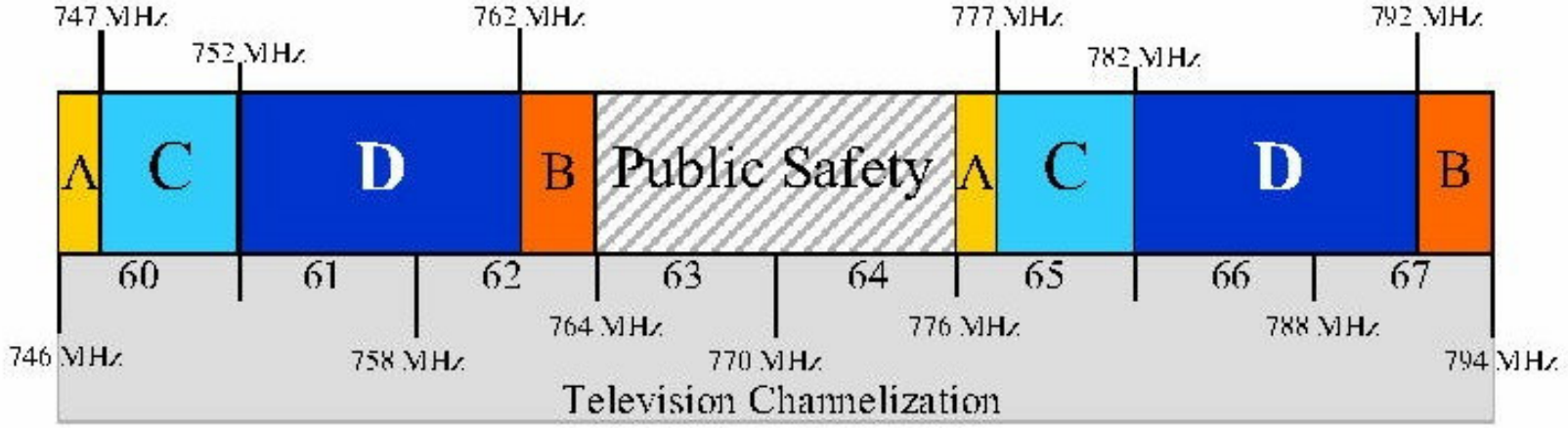


Lower 700 MHz Bandplan



Block	Frequencies (MHz)	Bandwidth	Pairing	Geographic Area Type	No. of Licenses
A	698-704, 728-734	12 MHz	2 x 6 MHz	700 MHz EAG	6
B	704-710, 734-740	12 MHz	2 x 6 MHz	700 MHz EAG	6
C	710-716, 740-746	12 MHz	2 x 6 MHz	MSA/RSA	734
D	716-722	6 MHz	unpaired	700 MHz EAG	6
E	722-728	6 MHz	unpaired	700 MHz EAG	6

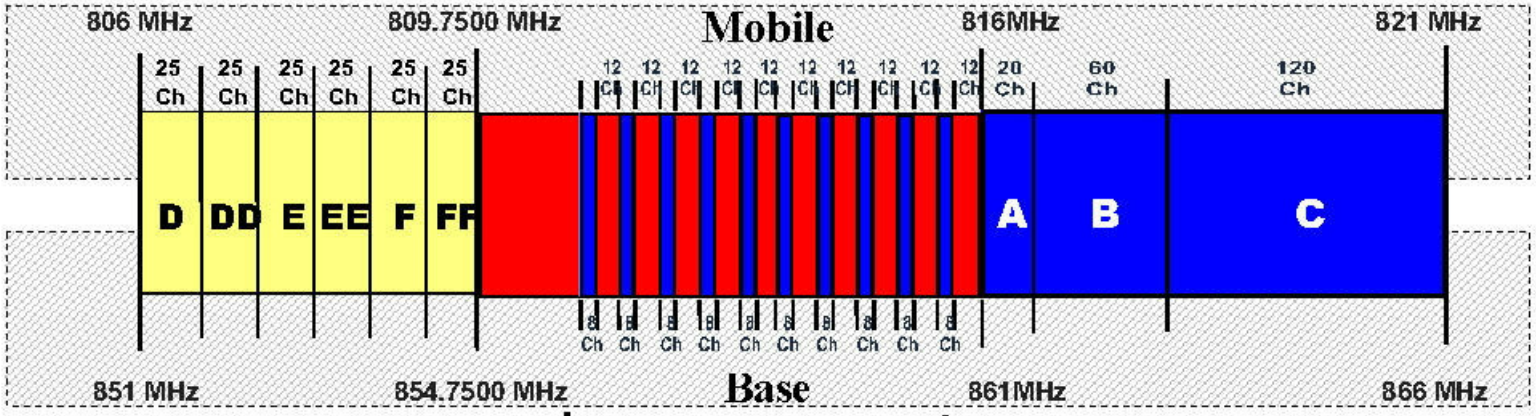
Upper 700 MHz Bandplan



Block	Frequencies (MHz)	Bandwidth	Pairing	Geographic Area Type	No. of Licenses
A (Guard Band)	746-747, 776-777	2 MHz	2 x 1 MHz	Major Economic Areas	52
B (Guard Band)	762-764, 792-794	4 MHz	2 x 2 MHz	Major Economic Areas	52
C	747-752, 777-782	10 MHz	2 x 5 MHz	700 MHz EAG	6
D	752-762, 782-792	20 MHz	2 x 10 MHz	700 MHz EAG	6

GlobeCom 2008: In-Building RF Distribution Systems

800 MHz Specialized Mobile Radio Bandplan



Block	Channels
G	201,241,281,321,361
H	202,242,282,322,362
I	203,243,283,323,363
J	204,244,284,324,364
K	205,245,285,325,365
L	206,246,286,326,366
M	207,247,287,327,367
N	208,248,288,328 ,368
O	221,261,301,341,381
P	222,262,302,342,382
Q	223,263,303,343,383
R	224,264,304,344,384
S	225,265,305,345,385
T	226,266,306,346,386
U	227,267,307,347,387
V	228,268,308,348,388

General Category Pool

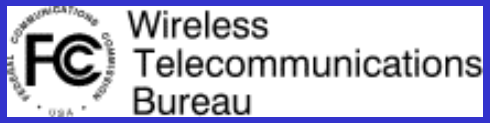
SMR Category Pool

Public Safety, Industrial/Land Transportation & Business Pools

As of 9/26/01
Per FCC 99-270

GlobeCom 2008: In-Building RF Distribution Systems

Franchised Wireless Telephone Services



Common Carrier Wireless Telephone Services

- Protected by the Wireless Communications Act of 1996
- Cellular Wireless
- Personal Communications Services - Broadband and Narrowband

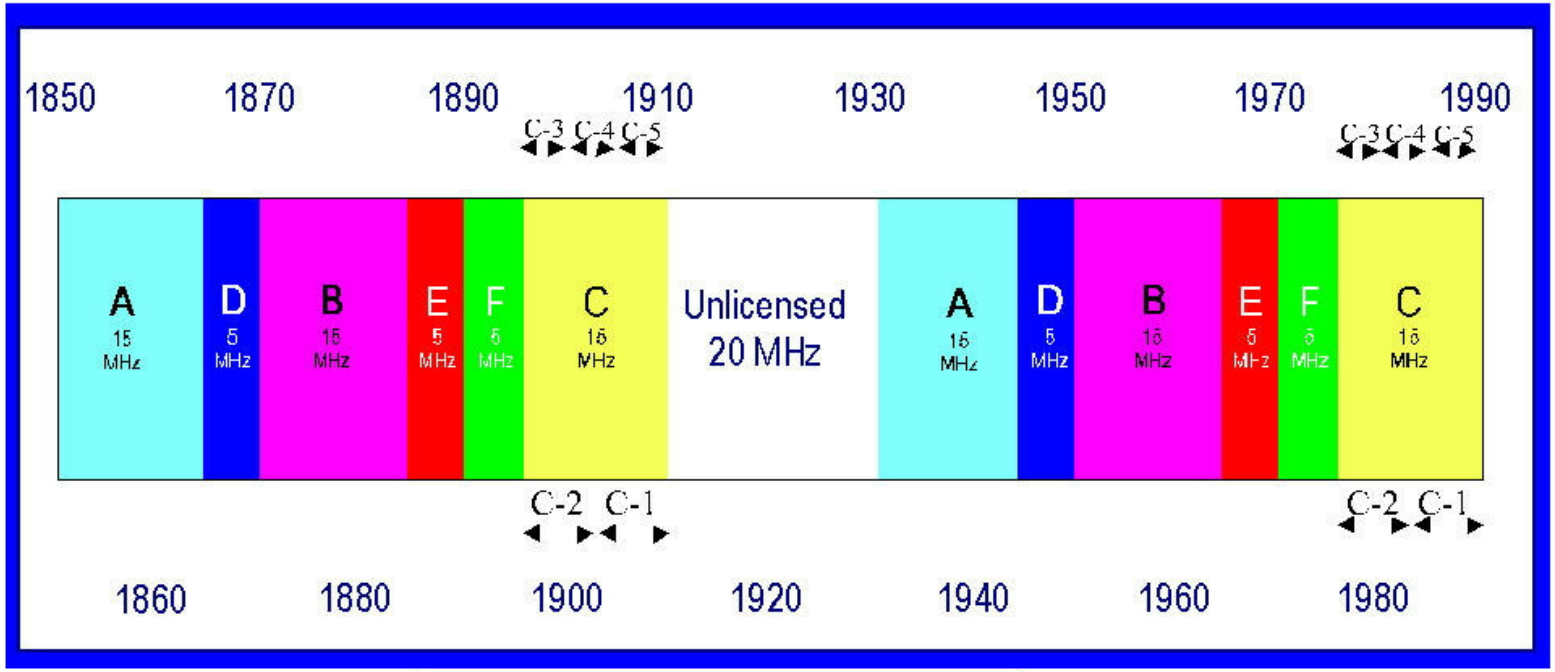
Wireless Telecommunications Bureau

Example: Franchised Wireless Telephone Services

Mobile Common Carrier License Operators in New Orleans Area				
PCS Broadband (CW)	**Licensee**	**Spectrum Pairs (MHZ)**		**Bandwidth**
A	Sprint PCS	1850-1865	1930-1945	15
B	Verizon Wireless	1870-1885	1950-1965	15
C	T-Mobile	1895-1910	1975-1990	15
D	AT&T Wireless	1865-1870	1945-1950	5
E	AT&T Wireless	1885-1890	1965-1970	5
F	AT&T Wireless	1890-1895	1970-1975	5
Cellular (CL)	**Licensee**	**Spectrum Pairs (MHZ)**		**Bandwidth**
A	AllTel	824.04-834.99	869.04-879-99	11
		845.01-846.48	890.01-891.48	1.5
B	Cingular Wireless	835.02-844.98	880.02-889.98	10
		846.51-848.97	891.51-893.97	1.5
Specialized Mobile Radio	**Licensee**	**Spectrum Pairs (MHZ)**		**Bandwidth**
N/A	Nextel Communications	806-821	855-866	25kHz each

GlobeCom 2008: In-Building RF Distribution Systems

FCC Broadband PCS Band Plan



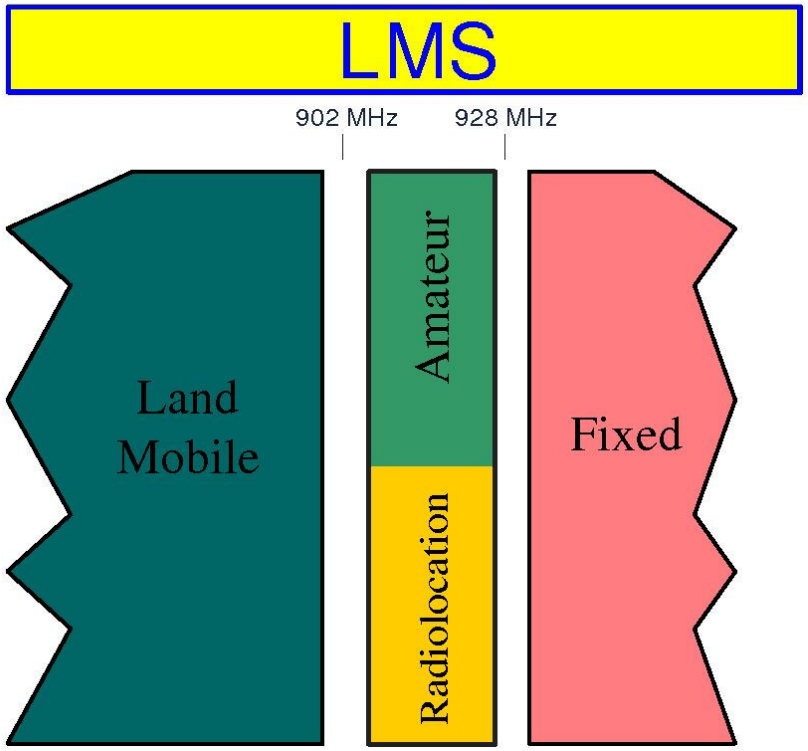
Channel Block	Bandwidth (MHz)	Frequencies
C	30	1895-1910, 1975-1990
C1	15	1902.5-1910, 1982.5-1990
C2	15	1895-1902.5, 1975-1982.5
C3	10	1895-1900, 1975-1980
C4	10	1900-1905, 1980-1985
C5	10	1905-1910, 1985-1990

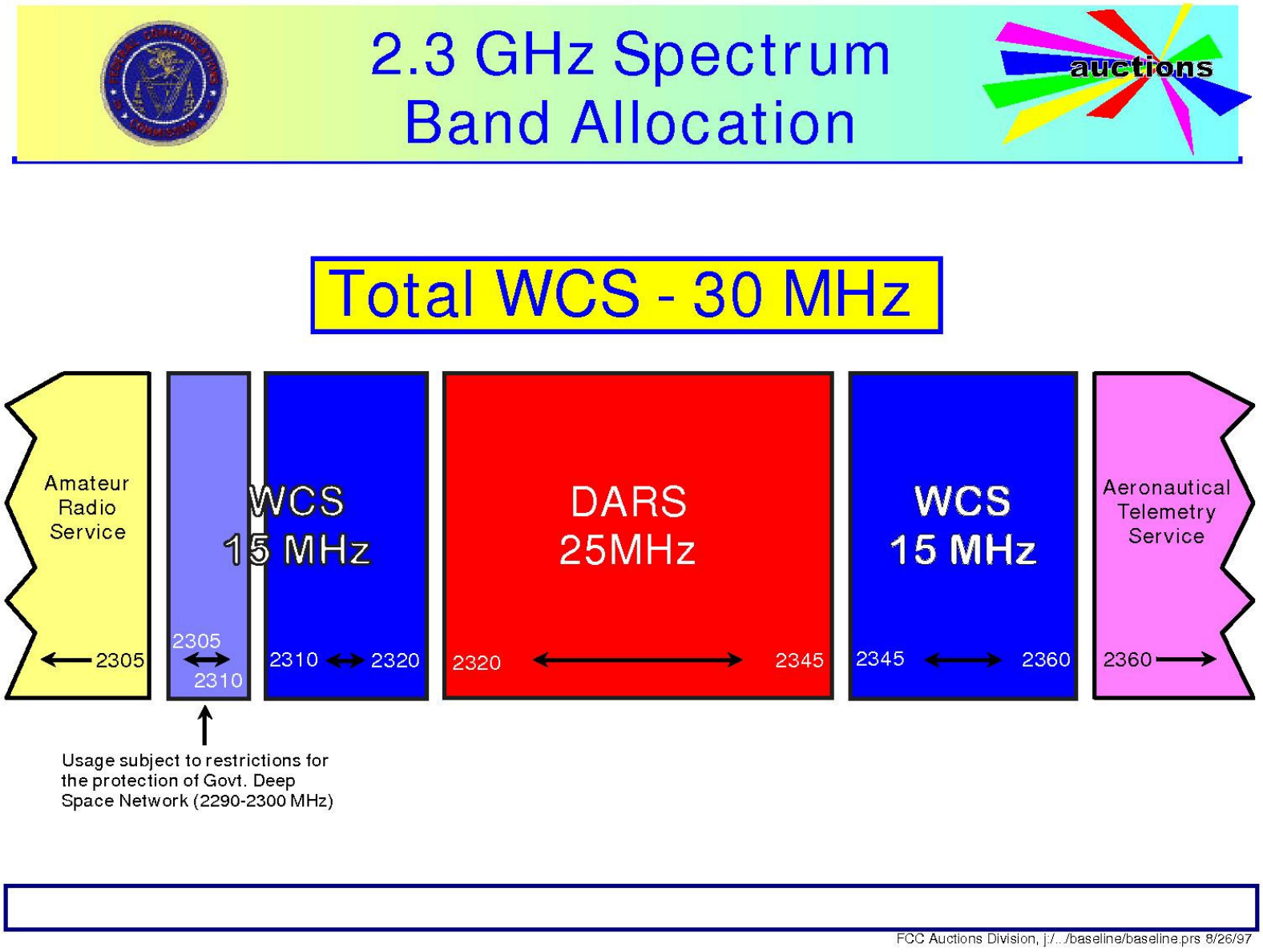
Note: Some of the original C Block licenses (Originally 30 MHz each) were split into multiplelicenses (C-1 and C-2, 15 MHz; C-3, C-4, and C-5 10 MHz).

GlobeCom 2008: In-Building RF Distribution Systems

FCC Auctions: #21

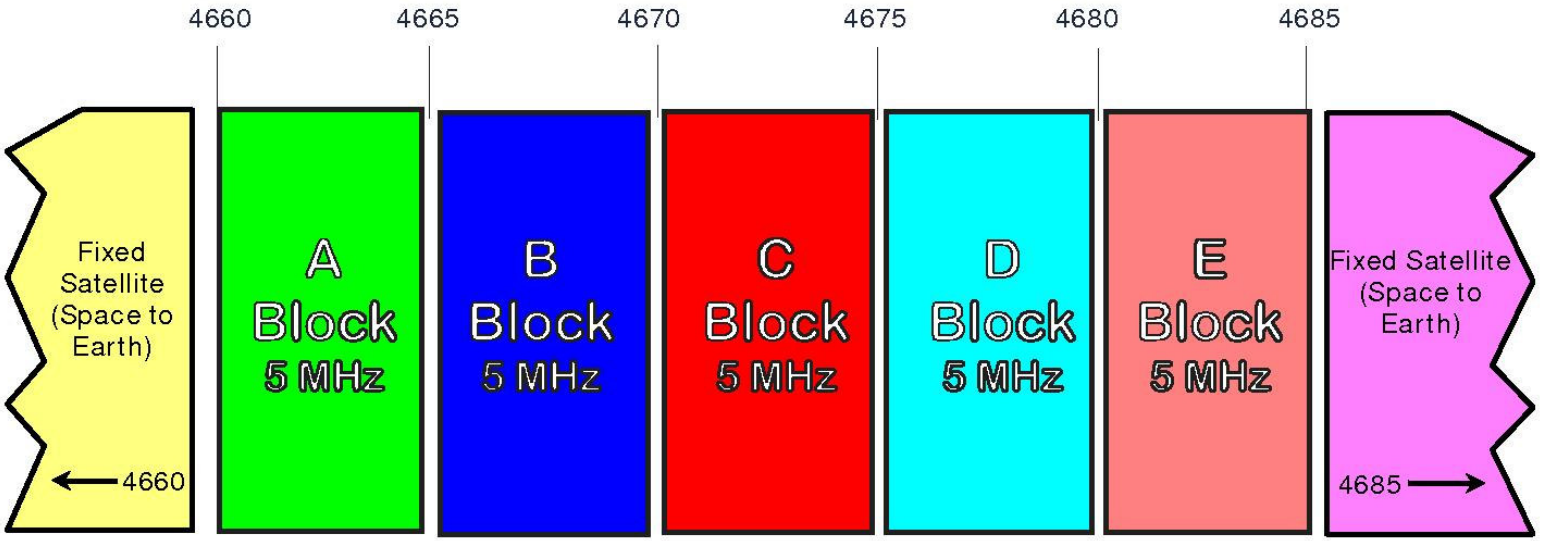
(Location & Monitoring Service)



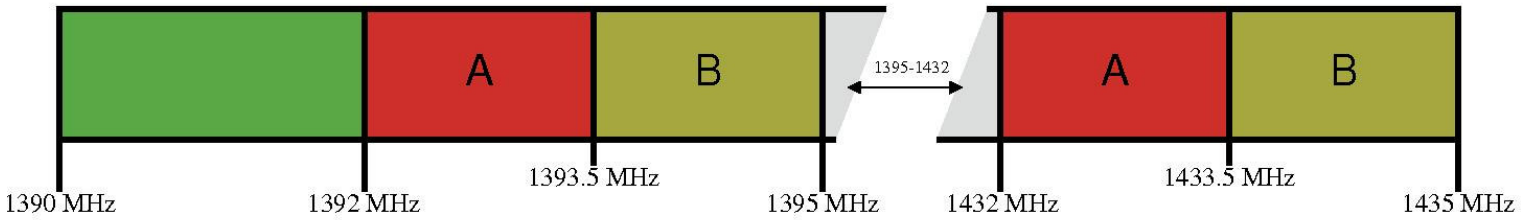

2.3 GHz Spectrum
Band Allocation
auctions
Total WCS - 30 MHz
Amateur
Radio
Service
2305
2305
2310
WCS
15 MHz
2310
2320
DARS
25MHz
2320
2345
WCS
15 MHz
2345
2360
Aeronautical
Telemetry
Service
2360
Usage subject to restrictions for
the protection of Govt. Deep
Space Network (2290-2300 MHz)
FCC Auctions Division, j:/.../baseline/baseline.prs 8/26/97

General Wireless Communications Service
Band Allocation

Total GWCS - 25 MHz



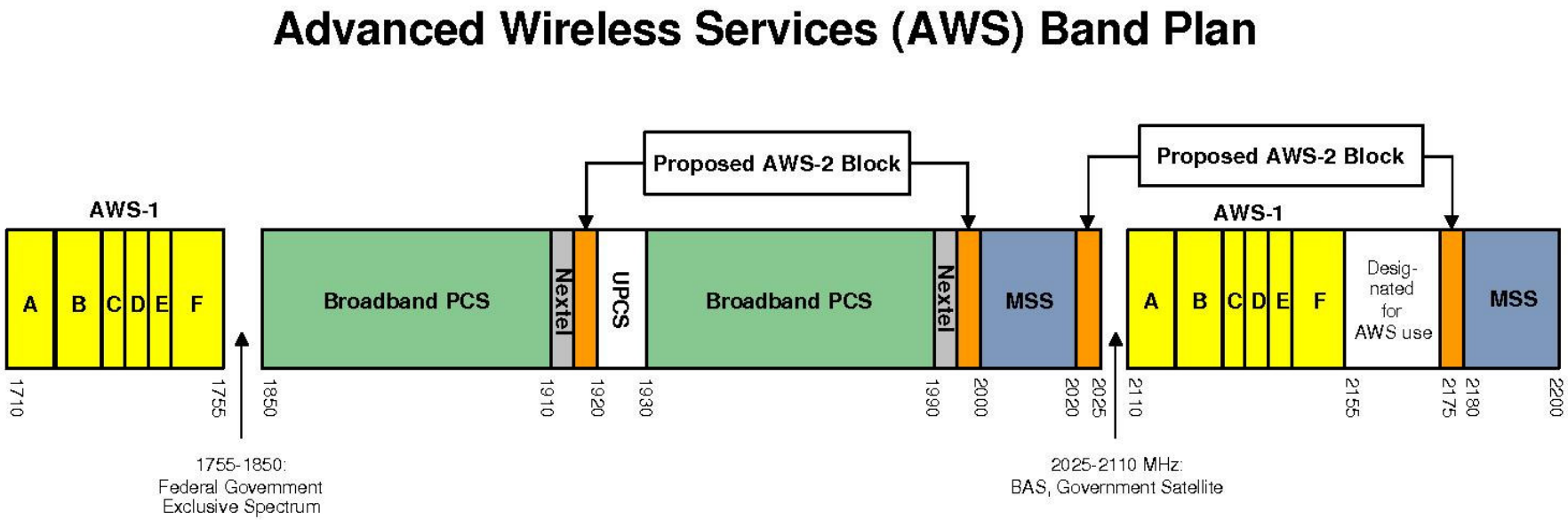
1.4 GHz Band



Block	Frequencies (MHz)	Bandwidth	Pairing	Geo. Area Type	No. of Licenses
	1390-1392	2 MHz	Unpaired	MEA	52
A	1392-1393.5/1432-1433.5	3 MHz	2 x 1.5 MHz	EAG	6
B	1393.5-1395/1433.5-1435	3 MHz	2 x 1.5 MHz	EAG	6

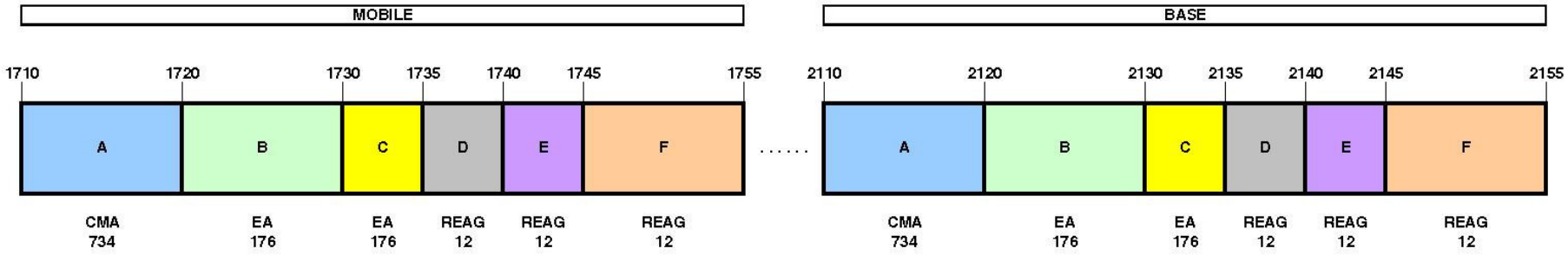
Federal Communications Commission
Wireless Telecommunications Bureau
Auctions and Spectrum Access Division
November 8, 2006

GlobeCom 2008: In-Building RF Distribution Systems



GlobeCom 2008: In-Building RF Distribution Systems

Advanced Wireless Services (AWS-1) Band Plan Detail



Block	Frequencies	Pairing	Bandwidth	Area	Licenses
A	1710-1720 and 2110-2120 MHz	2 x 10 MHz	20 MHz	CMA	734
B	1720-1730 and 2120-2130 MHz	2 x 10 MHz	20 MHz	EA	176
C	1730-1735 and 2130-2135 MHz	2 x 5 MHz	10 MHz	EA	176
D	1735-1740 and 2135-2140 MHz	2 x 5 MHz	10 MHz	REAG	12
E	1740-1745 and 2140-2145 MHz	2 x 5 MHz	10 MHz	REAG	12
F	1745-1755 and 2145-2155 MHz	2 x 10 MHz	20 MHz	REAG	12

Go to Part Two – thanks!