WiMedia Convergence Architecture

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Intel

Agenda

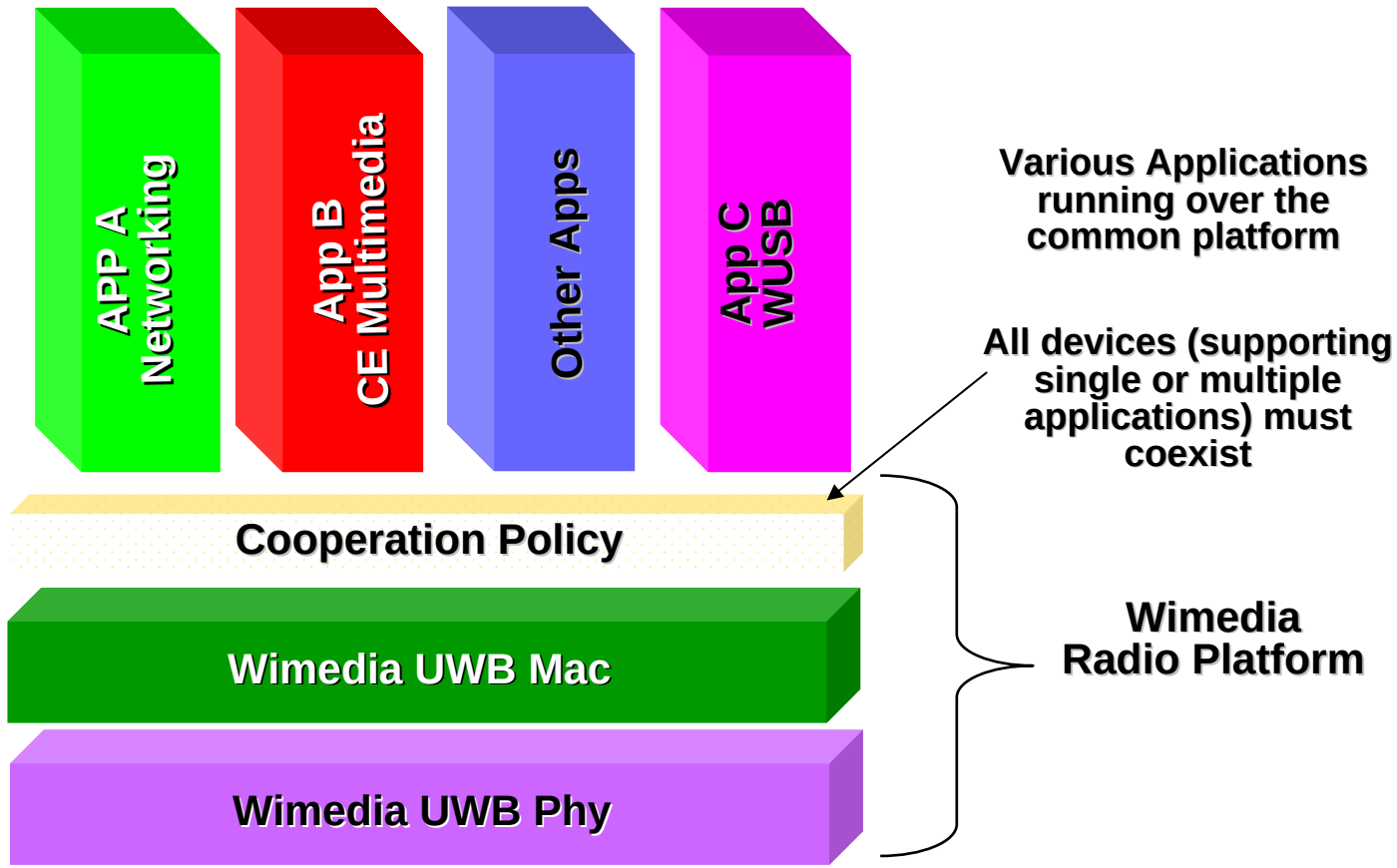
- WiMedia Platform
- Cooperation Policy
  - Interference Management
    - Channel Selection
    - Transmit Power Control
  - Bandwidth Sharing
    - Bandwidth Limits
    - Form of Reservations
- Conclusions

Specification

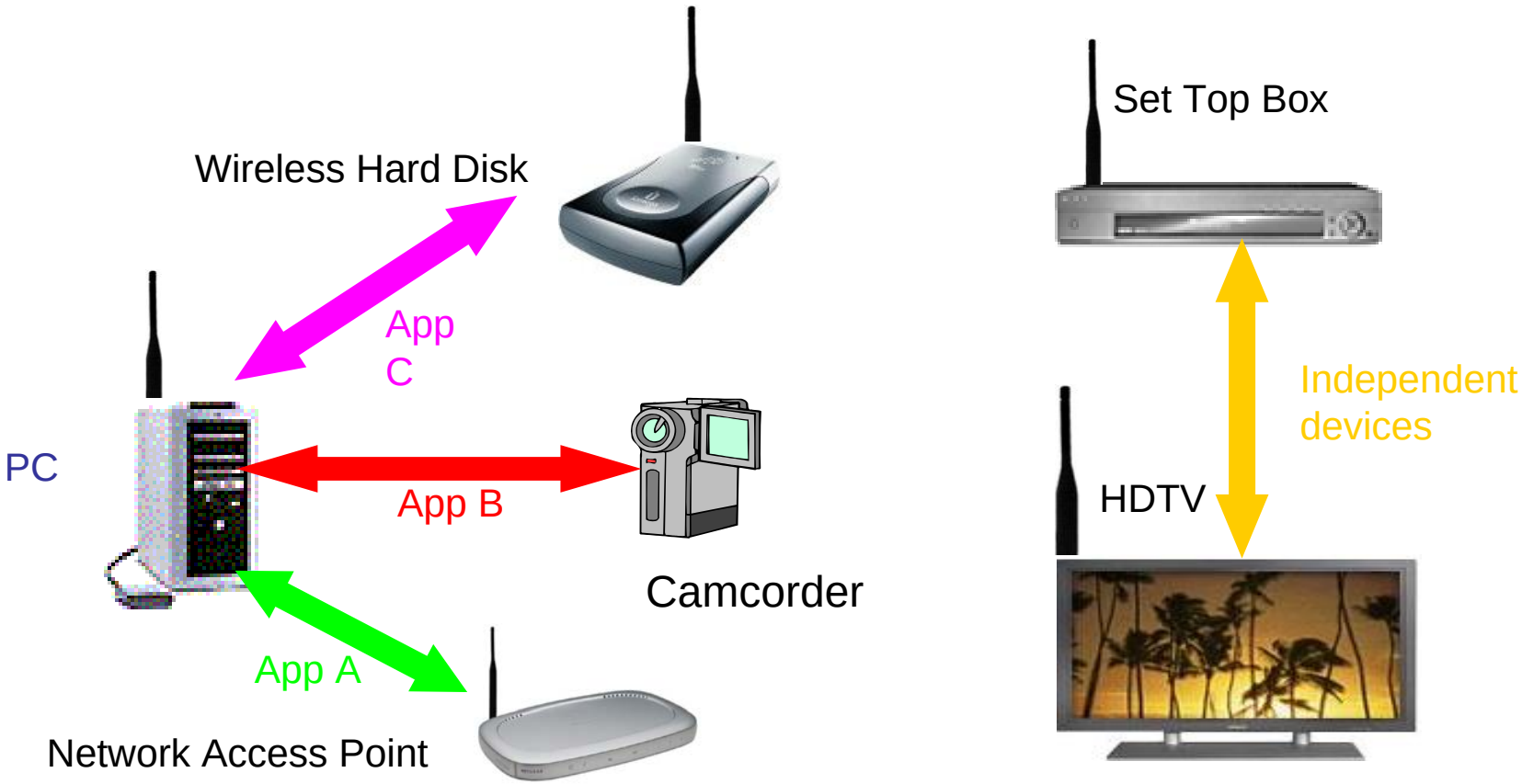
This presentation is based on a pre-release version of the WiMedia Convergence Architecture specification. The content is subject to change.

WiMedia Platform

1. Implements over-the-air muxing of app stack traffic
2. ***Local*** arbitration of bandwidth requests
3. Implementation details are platform specific



WiMedia Platform – Device View



When more independent close proximity devices appear, how do all these devices cooperate to share spatial capacity?

Cooperation Policy

- Interference management
  - If one or more devices would be adversely affected if all devices operate independently, when & how do multiple independent devices cooperate?
- Bandwidth sharing
  - Once multiple independent devices have cooperated to mitigate interference problems, how do they share bandwidth?

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Channel Selection – Device Class Definitions

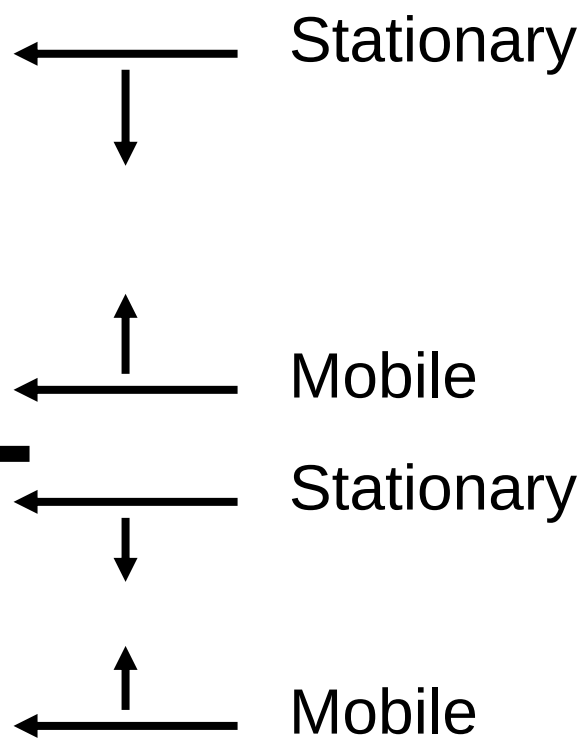
- Stationary
  - Running off of AC Power
- Mobile
  - Running off of Battery Power

Bandgroup 1 Frequency Bands

Bandgroup	Band ID	Lower Frequency (MHZ)	Center Frequency (MHZ)	Upper Frequency (MHZ)
1	1	3168	3432	3696
1	2	3696	3960	4224
1	3	4224	4488	4752

Bandgroup 1 Channels

		Band ID					
Channel Number	TFC Number						
9	1	1	2	3	1	2	3
10	2	1	3	2	1	3	2
11	3	1	1	2	2	3	3
12	4	1	1	3	3	2	2
13	5	1	1	1	1	1	1
14	6	2	2	2	2	2	2
15	7	3	3	3	3	3	3



Channel Selection Policy

- A device may transmit on any channel if it has a functional requirement to communicate with a device already on that channel. Otherwise …
- A mobile device must and a stationary device should select the first channel with sufficient availability from either the TFI or FFI channel list.
- Choosing an FFI or TFI channel is up to the device. WiMCA may look at additional policy in this area as more experimental data becomes available on how TFI and FFI channels interact.

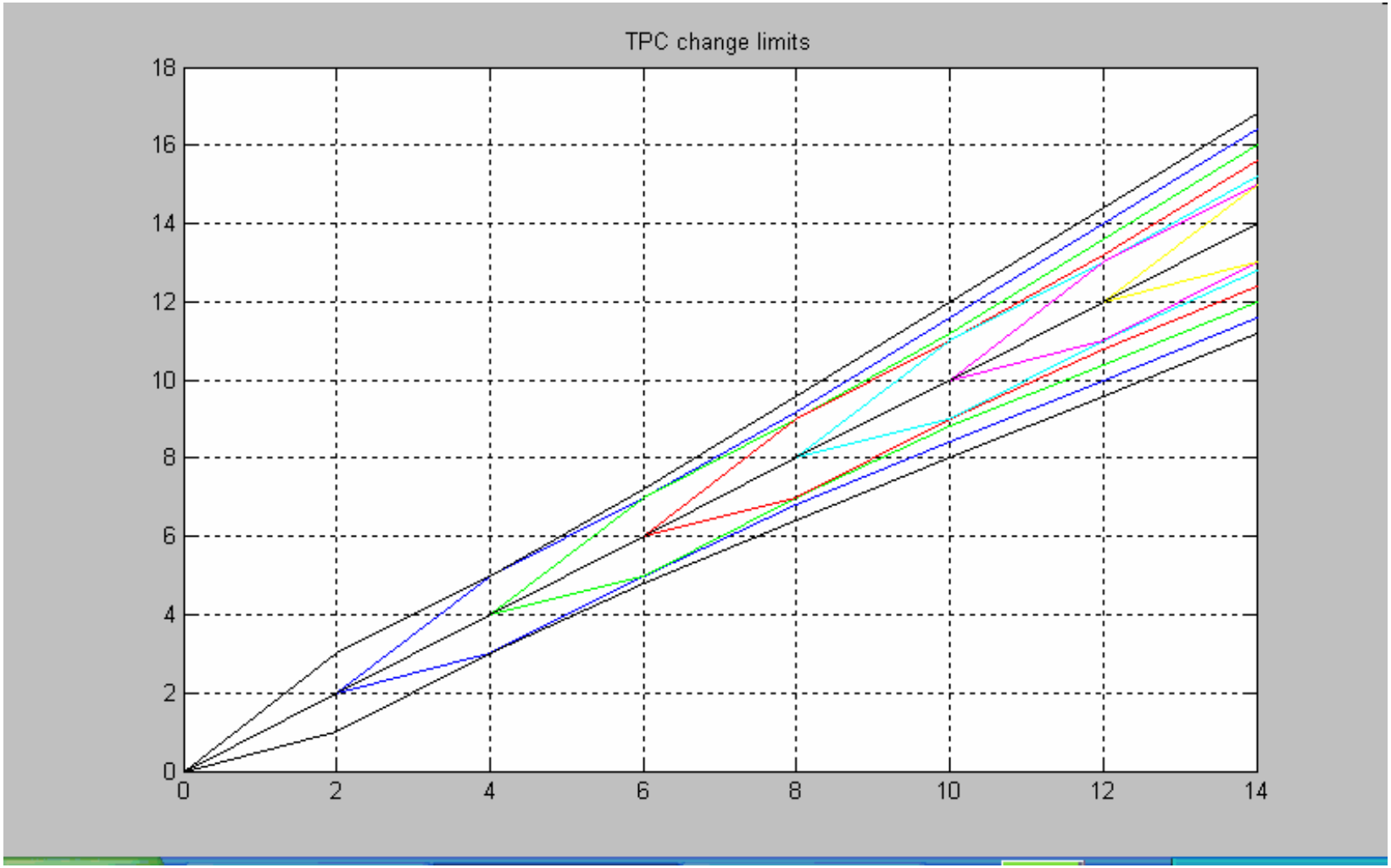
Transmit Power Control Physical Requirements

- 2 dB Step Size
- Number of Steps
  - 6 from TFI Base Power (12 DB Range Nominal)
  - 4 from FFI Base Power (8 DB Range Nominal)
- Accuracy
  - Max +- (1 dB/ 20%) On Power Changes
  - See Next Slide

Absolute Limits For Each Power Level

Level	TFI	FFI
0	TFI_BASE	FFI_BASE
1	TFI_BASE – (1 to 3) dB	FFI_BASE – (1 t 3) dB
2	TFI_BASE – (3 to 5) dB	FFI_BASE – (3 to 5) dB
3	TFI_BASE – (4.8 to 7.2) dB	FFI_BASE – (4.8 to 7.2) dB
4	TFI_BASE – (6.4 to 9.6) dB	FFI_BASE – (6.4 to 9.6) dB
5	TFI_BASE – (8 to 12) dB	
6	TFI_BASE – (9.6 to 14.4) dB	
7	TFI_BASE – (11.2 to 16.8) dB	

Power Level Accuracy Requirements



TPC Proposal Summary

- WiMCA compliant devices shall support TPC
- A WiMCA compliant link shall use the minimum transmit power necessary to maintain the link.
- WiMedia Compliance may set some requirements for demonstrated use of TPC in operation

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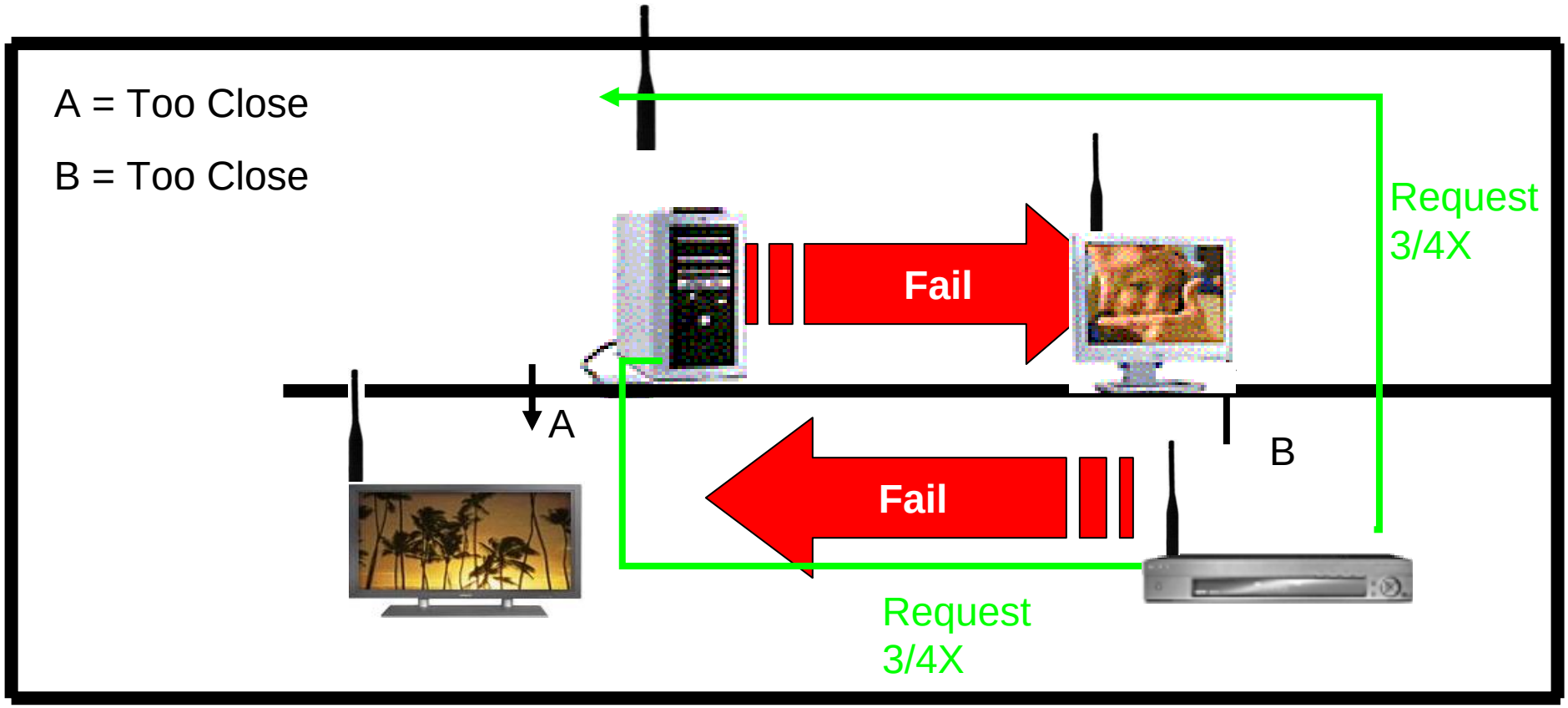
Meet Joe User

Joe runs a graphics art business out of his home office.

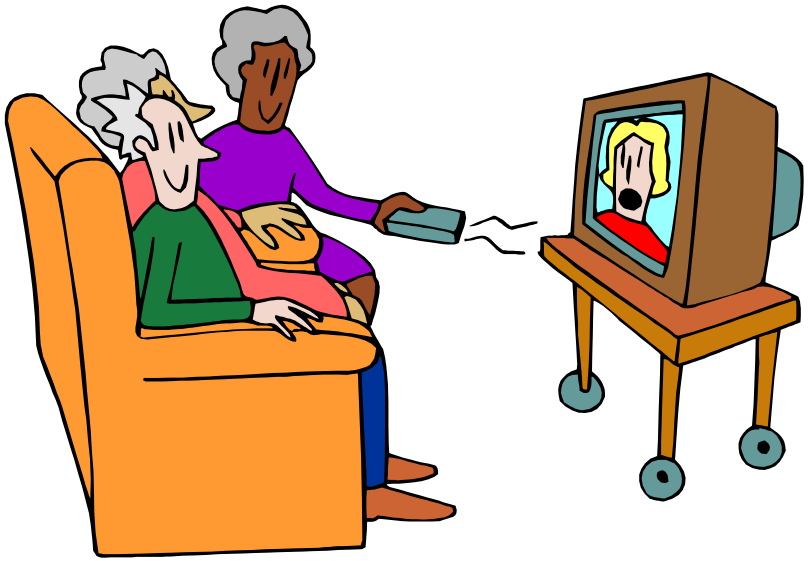
PC monitor resolution Is critical

More Bandwidth Required Than Available At Joe's House



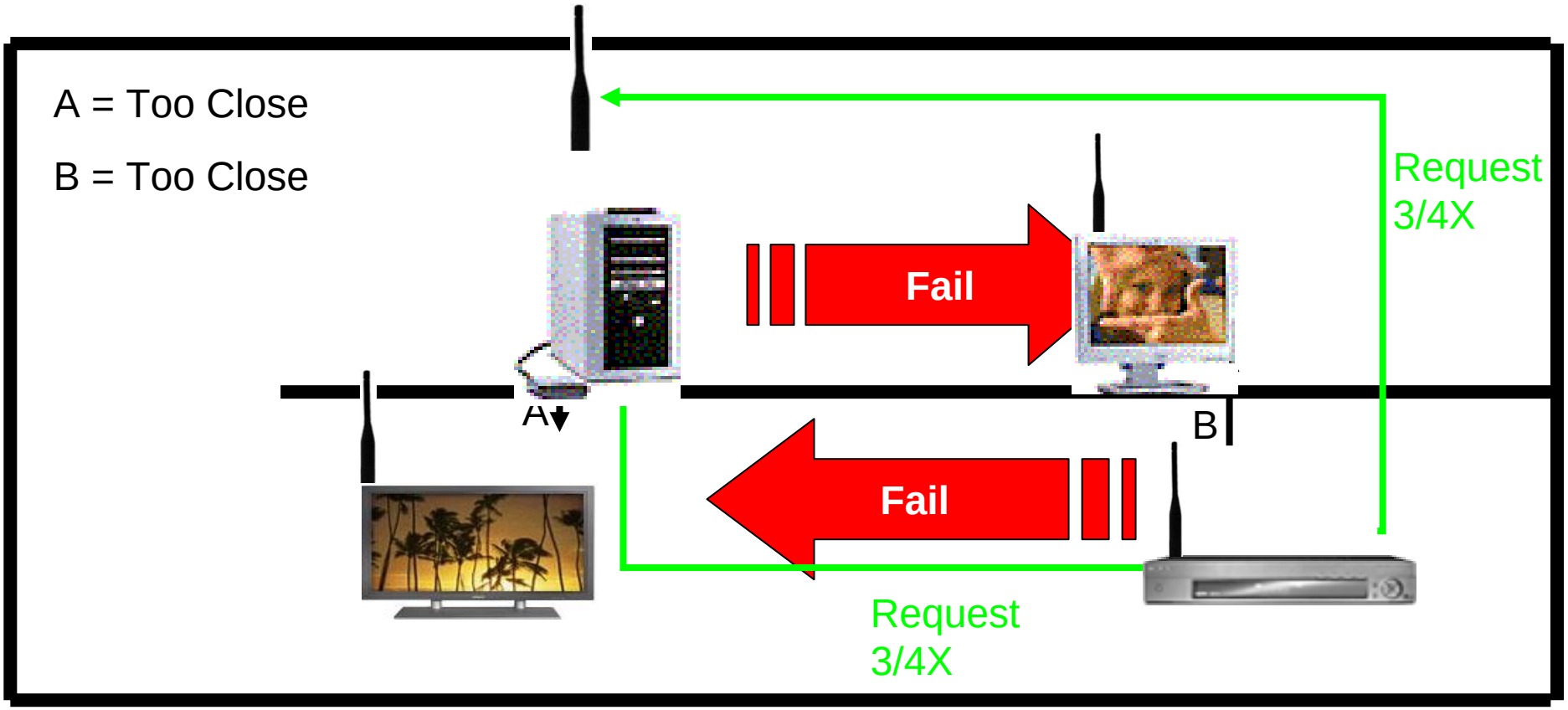
Joe Always Wants His Monitor To Get Maximum Resolution.
How Does Joe Get What Joe Wants?

Meet Jane User



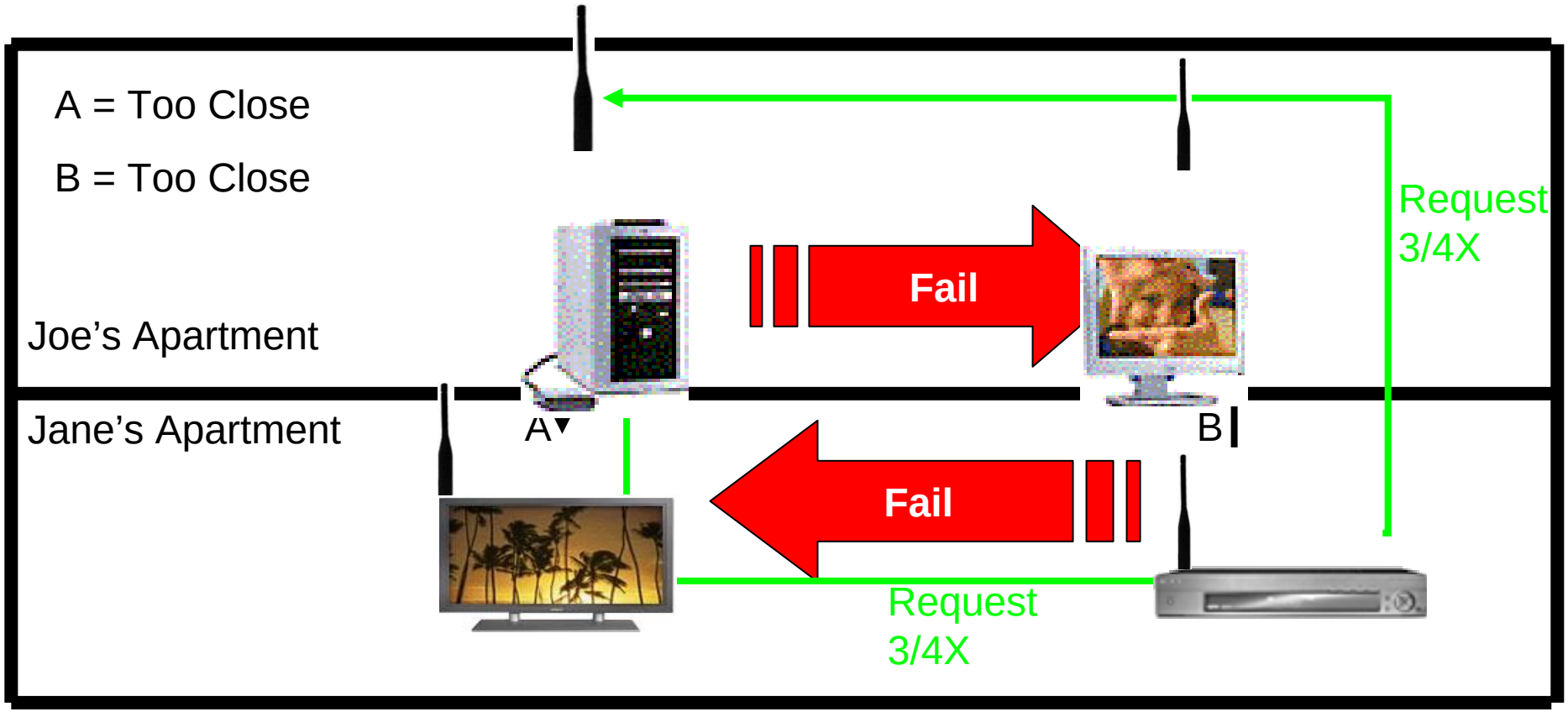
Jane is a videophile that cares passionately about HDTV resolution

More Bandwidth Required Than Available At Jane's House



Jane Always Wants Her HDTV To Be Operating At Maximum Resolution. How Does Jane Get What She Wants?

Multiple Users



Now What? Only Fair Outcome Is ½ Each?

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WiMCA Allocation Limits Policy

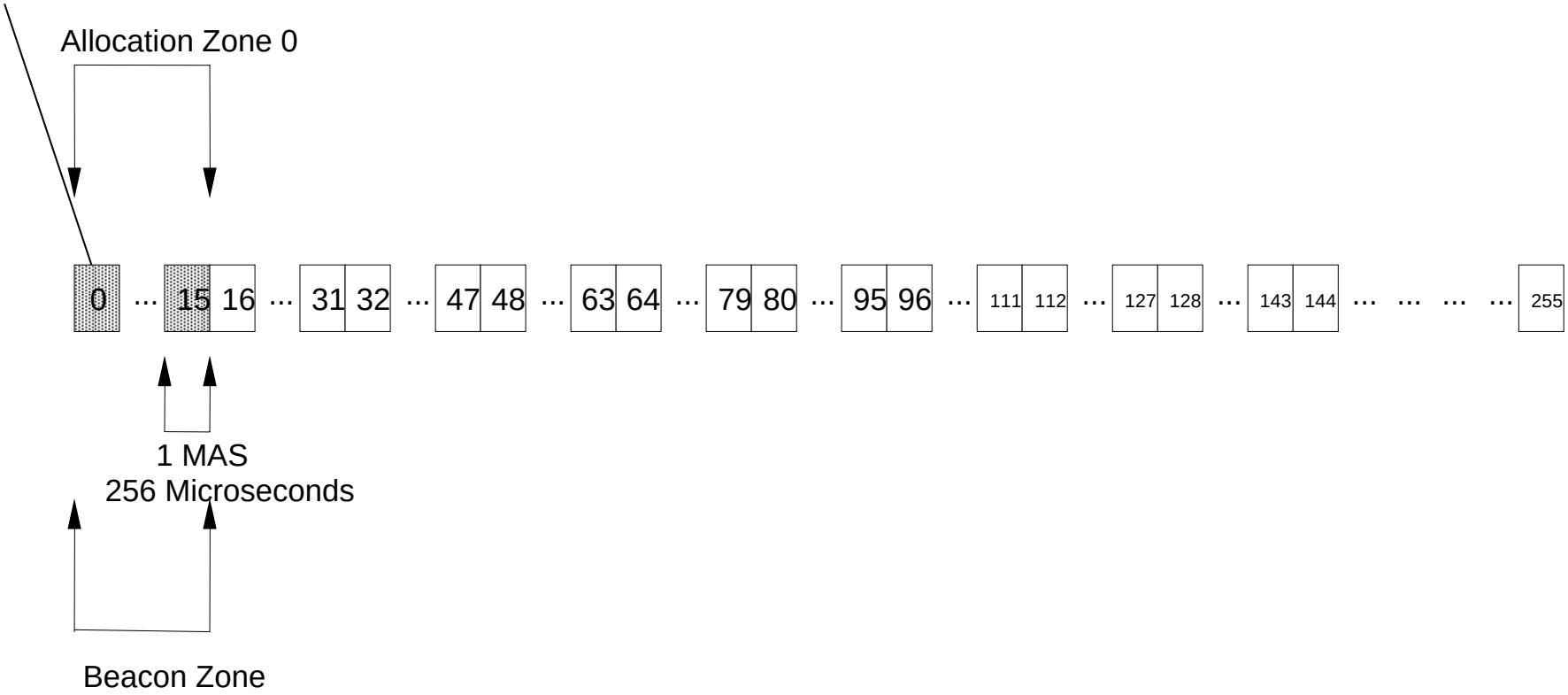
- A device can take any reservation at any time
- A device can not maintain more than approximately half the MAS in a reservation under contention
- Devices should be able to provide some level of functionality with approximately half the bandwidth on the channel
- Policy is designed to allow at least two pairs of devices to operate on the same channel in most circumstances
- Addressing how bandwidth should be shared between multiple pairs of the same user's devices is outside the scope of WiMCA

Device Reservation Types

- Low Latency devices prefer or need MAS that are evenly spaced throughout the superframe.
- Power Conscious devices prefer a small number of groups of contiguous MAS.
- There are devices that have both power and latency concerns.
- How do all these devices coexist on the same channel?

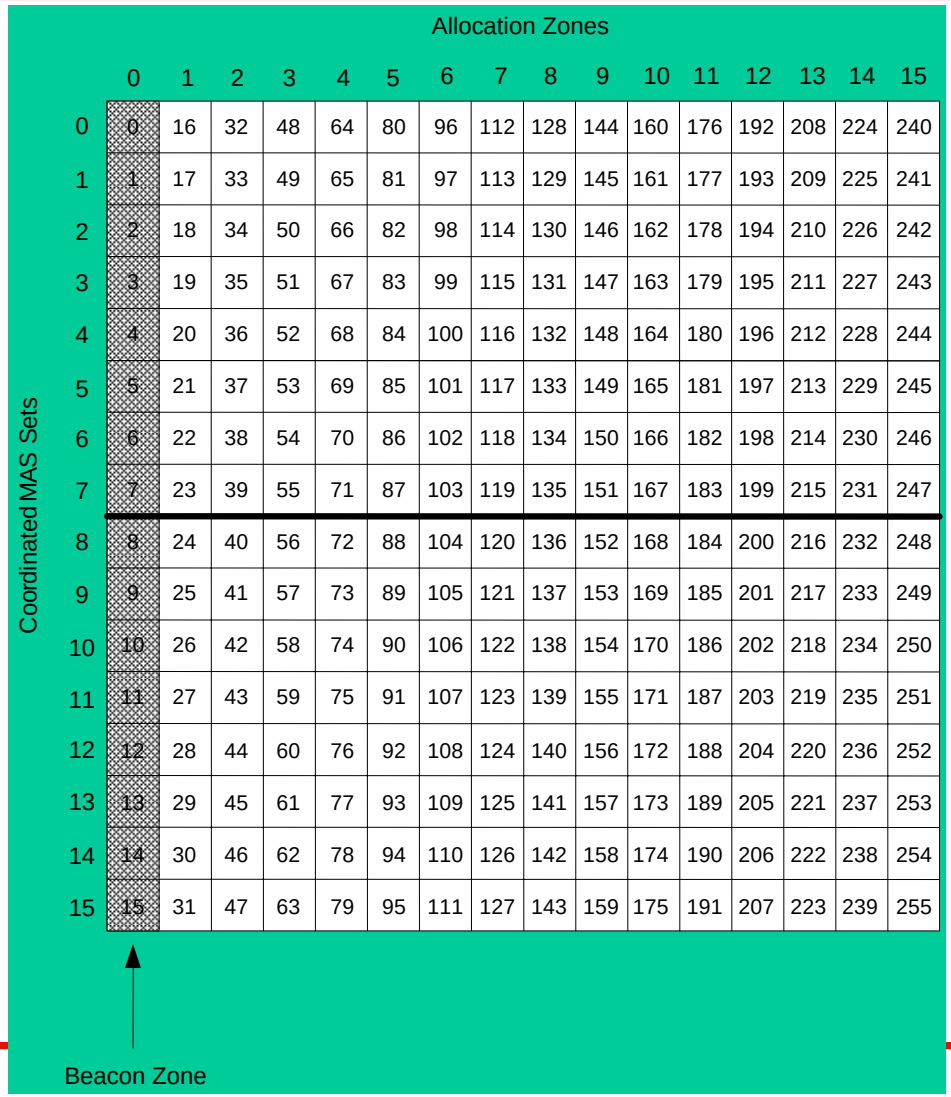
Superframe – 1D View

Start of Beacon Period



1D view of Superframe is difficult to use in describing full bandwidth allocation strategies

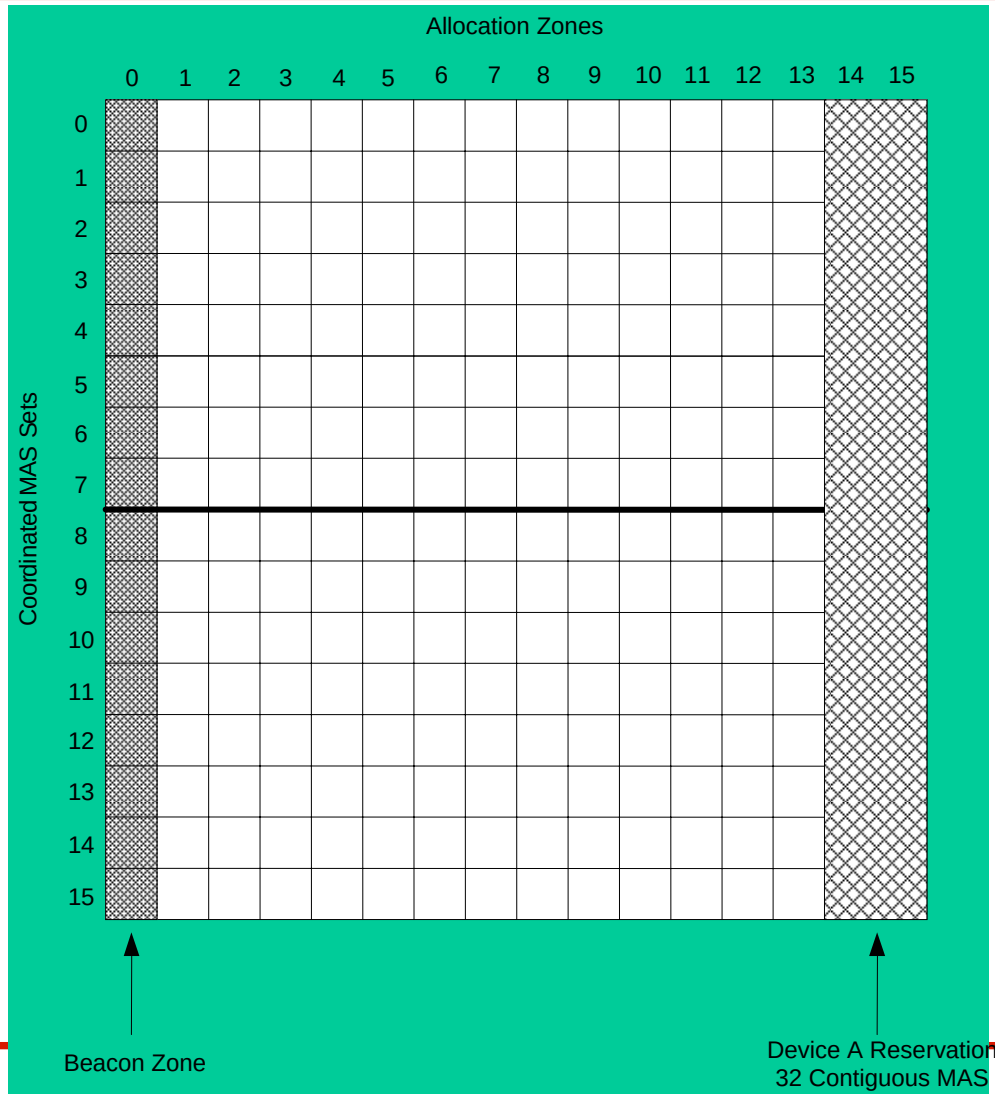
Superframe – 2D View



	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	0	16	32	48	64	80	96	112	128	144	160	176	192	208	224	240
1	1	17	33	49	65	81	97	113	129	145	161	177	193	209	225	241
2	2	18	34	50	66	82	98	114	130	146	162	178	194	210	226	242
3	3	19	35	51	67	83	99	115	131	147	163	179	195	211	227	243
4	4	20	36	52	68	84	100	116	132	148	164	180	196	212	228	244
5	5	21	37	53	69	85	101	117	133	149	165	181	197	213	229	245
6	6	22	38	54	70	86	102	118	134	150	166	182	198	214	230	246
7	7	23	39	55	71	87	103	119	135	151	167	183	199	215	231	247
8	8	24	40	56	72	88	104	120	136	152	168	184	200	216	232	248
9	9	25	41	57	73	89	105	121	137	153	169	185	201	217	233	249
10	10	26	42	58	74	90	106	122	138	154	170	186	202	218	234	250
11	11	27	43	59	75	91	107	123	139	155	171	187	203	219	235	251
12	12	28	44	60	76	92	108	124	140	156	172	188	204	220	236	252
13	13	29	45	61	77	93	109	125	141	157	173	189	205	221	237	253
14	14	30	46	62	78	94	110	126	142	158	174	190	206	222	238	254
15	15	31	47	63	79	95	111	127	143	159	175	191	207	223	239	255

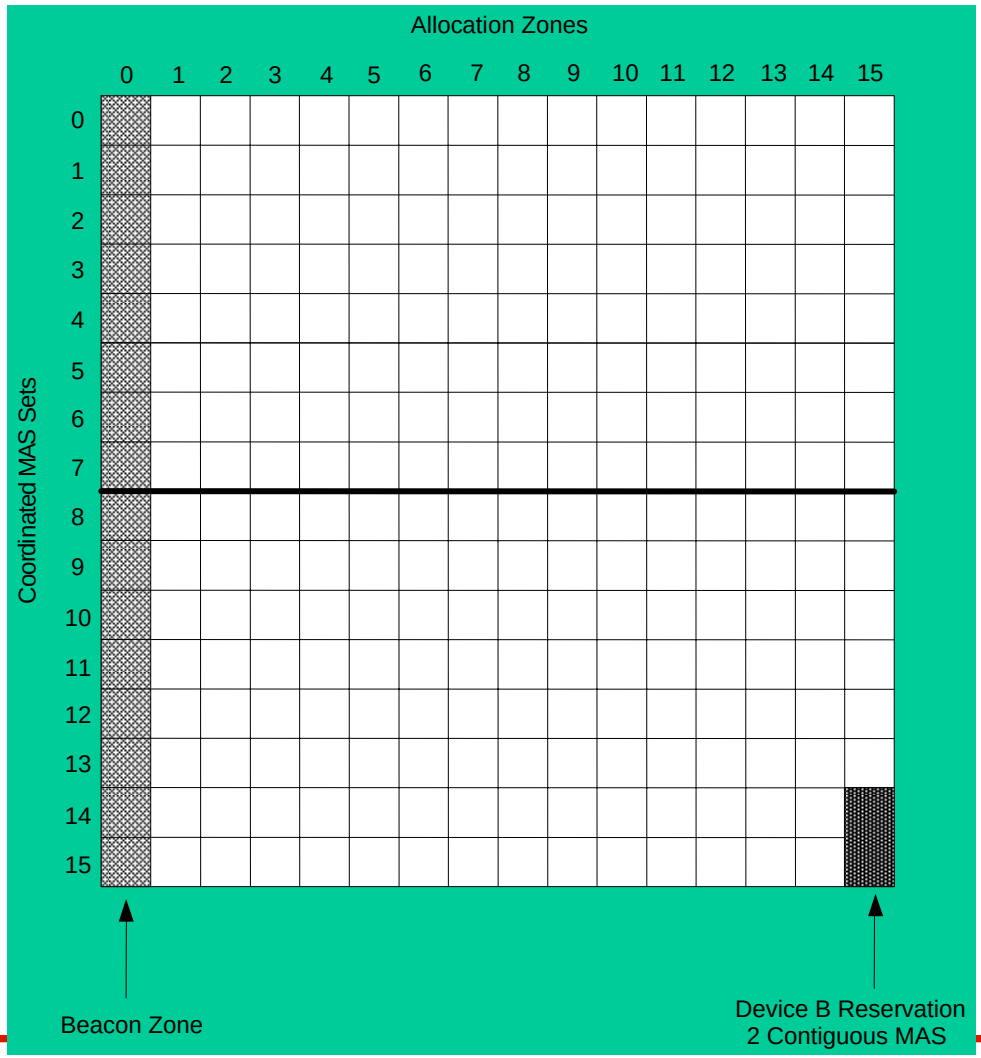
- MAS numbers increase with time from 0 to 255
- Columns contain 16 consecutive MAS (Allocation Zone)
- Rows contain 16 evenly spaced MAS in superframe (Coordinated MAS Set)

Low Latency Devices



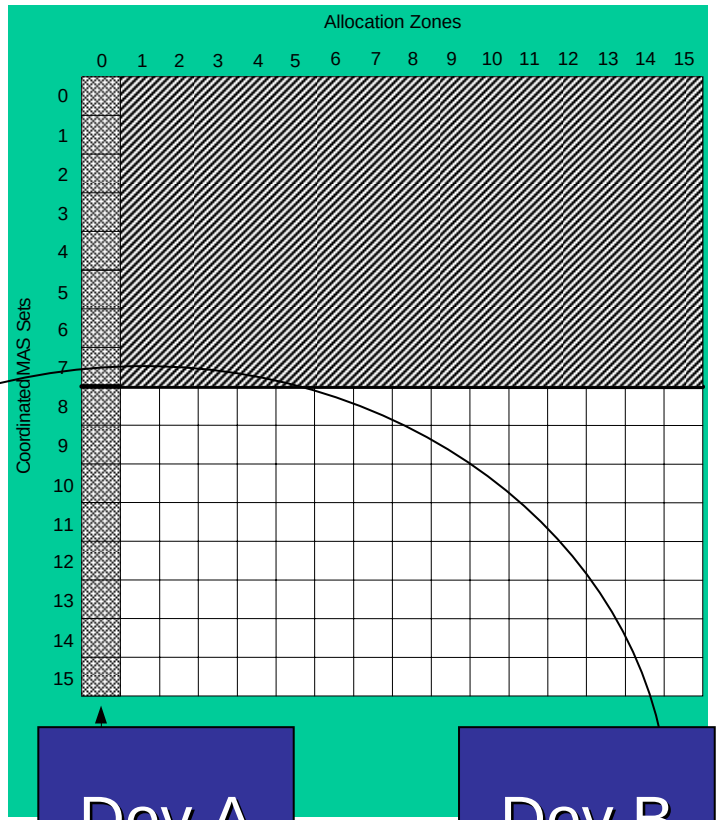
- Some power conscious devices prefer large contiguous reservations
- Large contiguous reservations can make a sparsely occupied channel unusable for devices with small service interval requirements

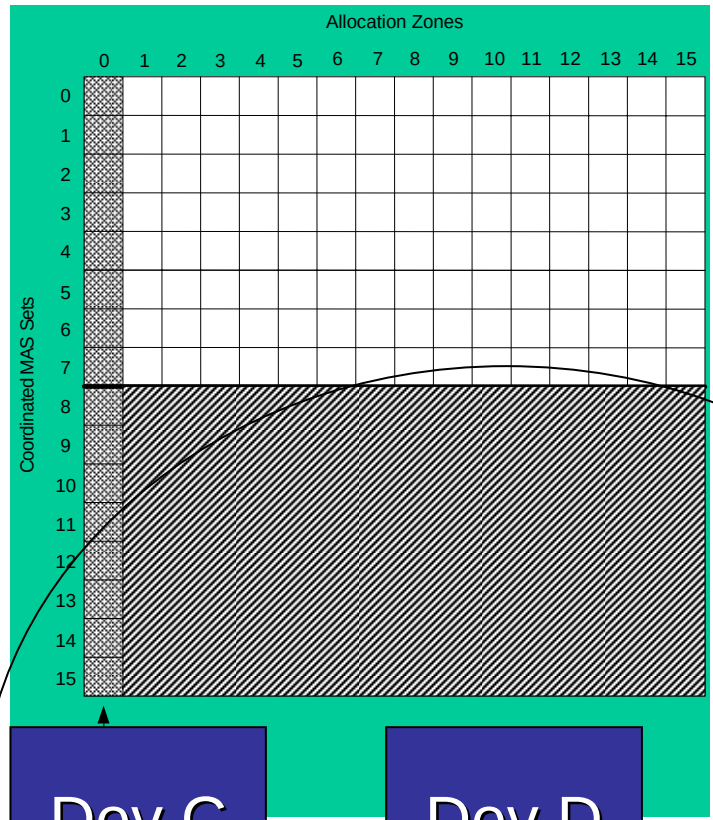
Power Conscious Devices



- Device B is power conscious and prefers to refer last 2 contiguous MAS in superframe
- Device B takes 2 MAS to power on from deep sleep state.
- Other positions in superframe require powering on/off twice
- Power conscious devices must be able to choose the optimal reservation if there is no contention

PCA





Dev A

Dev B

PCA

Dev C

Dev D

Device B and Device C are unable to communicate via PCA even though half of the superframe is unreserved from each device's perspective

MAS Allocation Policy Principle #1

- Any available reservation may be made at any time. There are a variety of rules that indicate when a portion of a reservation must be moved or dropped under contention.
- Example
  - On an empty channel a hard drive backup must be able to utilize the entire channel for optimal performance until there is contention.

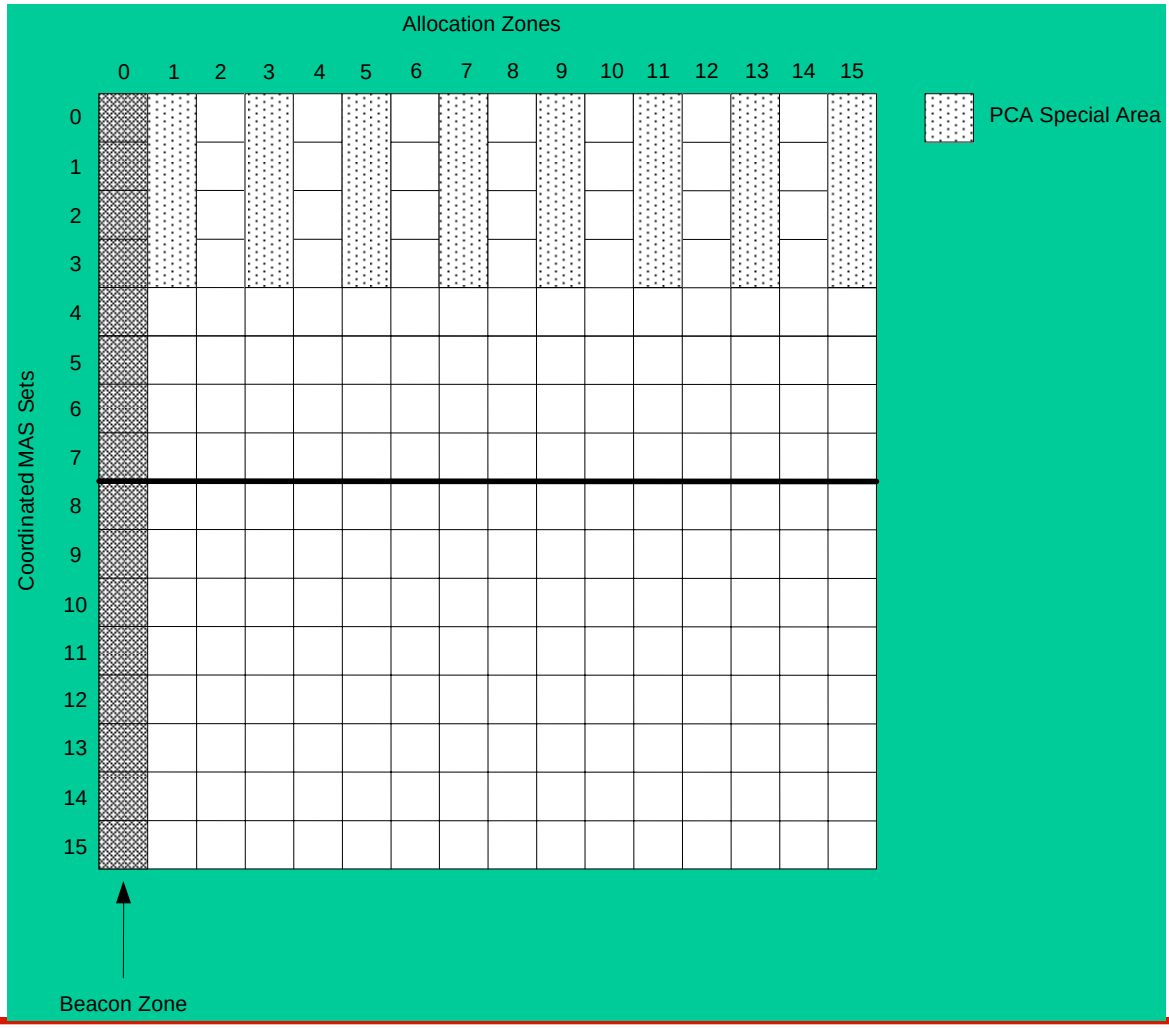
MAS Allocation Principle #2

- A device must have a deterministic way to know when it may obtain MAS from another through contention.
- Options
  - Device advertise MAS that are subject to pre-emption in their beacons
  - Rules provide unambiguous definitions (from all device perspectives) of when a MAS is subject to preemption.

Mass Allocation Policy

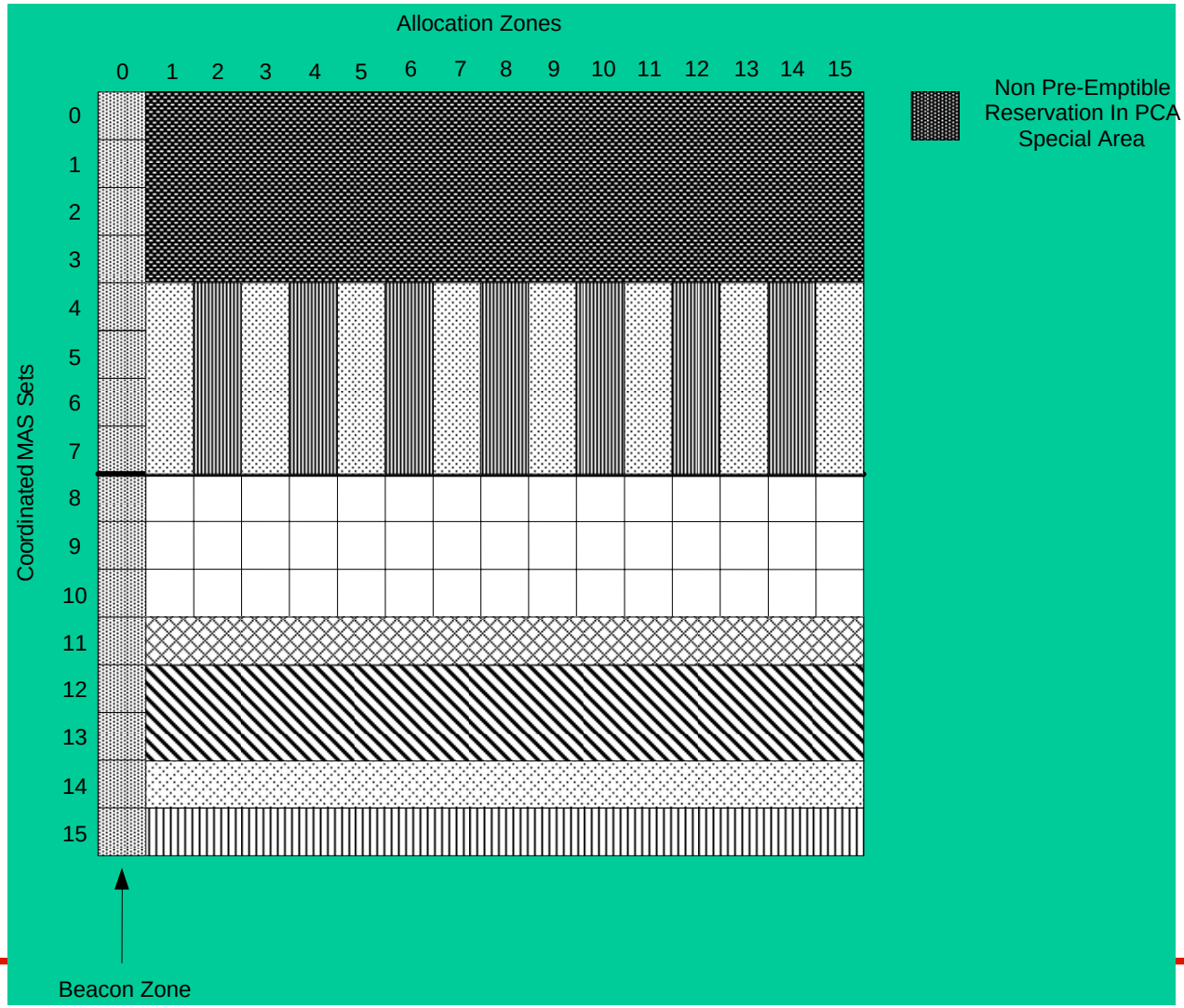
- A number of options are still being considered for final Mas Allocation policy in the WiMCA working group.
- The remainder of this presentation presents examples for a very flexible policy that is under consideration.
- There are a number of other policies under consideration with similar intents that provide less flexibility but simply device implementation requirements.

PCA Area



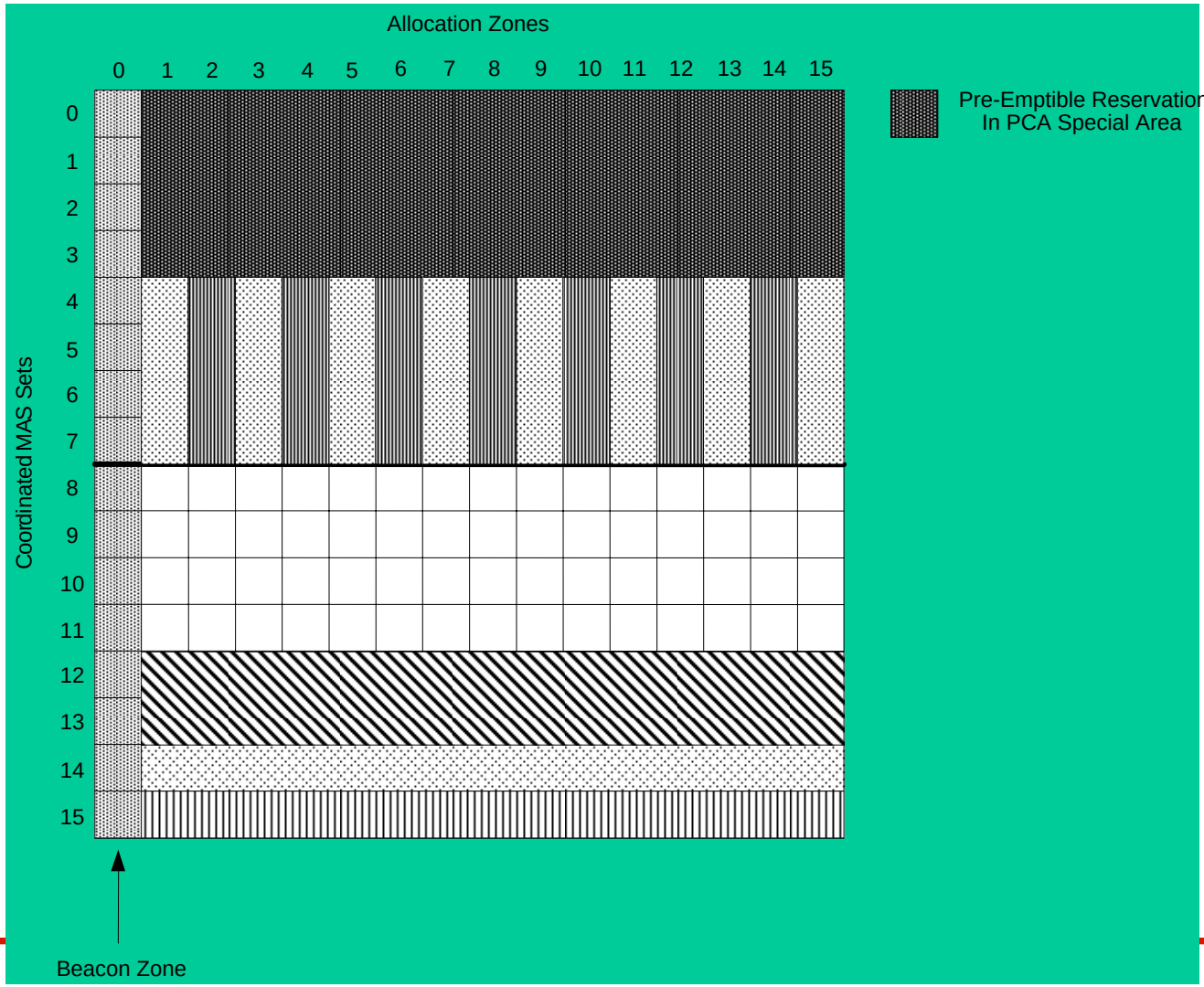
- PCA Reservations outside the PCA area count against reservation limits
- Some MAS reserved within the PCA area do not count toward reservation limits
- Non PCA reservations may be made in the PCA area but they may be subject to preemption . . .

PCA Area Reservation Example



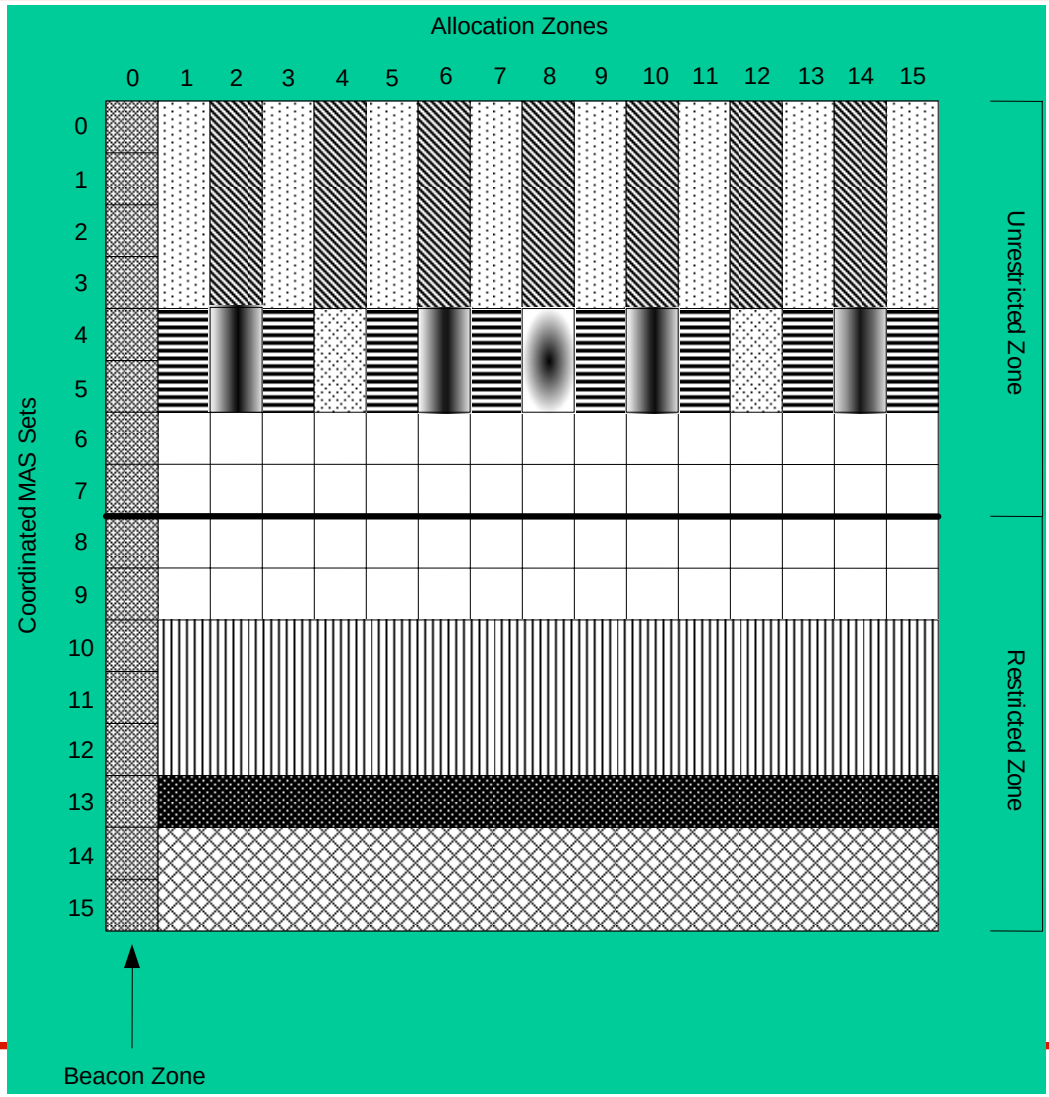
- A device may take a non PCA reservation in the PCA area.
- A reservation occupying part of the PCA area is preemptible if the same size and shape for the entire reservation is available in another location in the superframe.
- Reservation in this example is not subject to preemption.

PCA Area Reservation Example 2



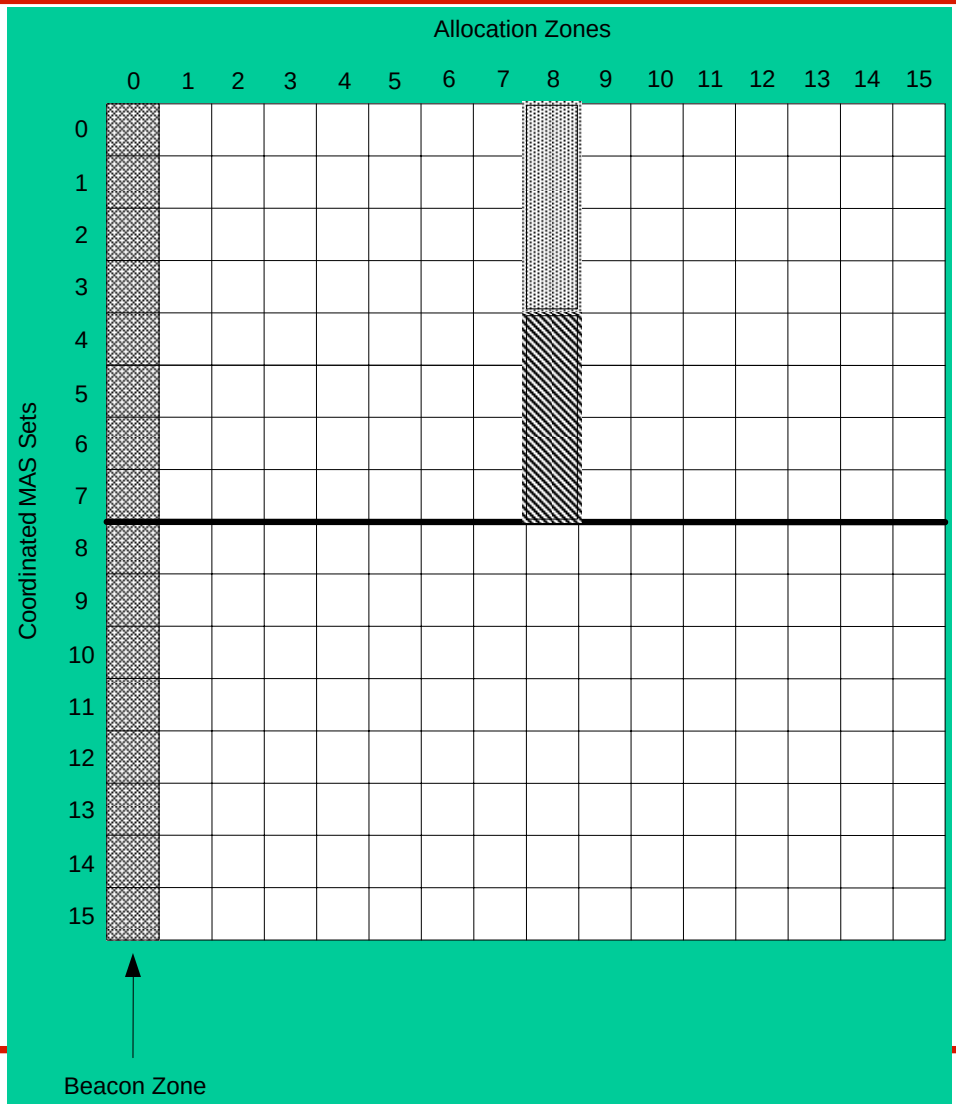
- Non PCA reservation in PCA area is subject to preemption because the same size and shape reservation is available elsewhere
- Device has two options:
  - Mark reservation subject to premption
  - Move reservation

Unrestricted and Restricted Zones



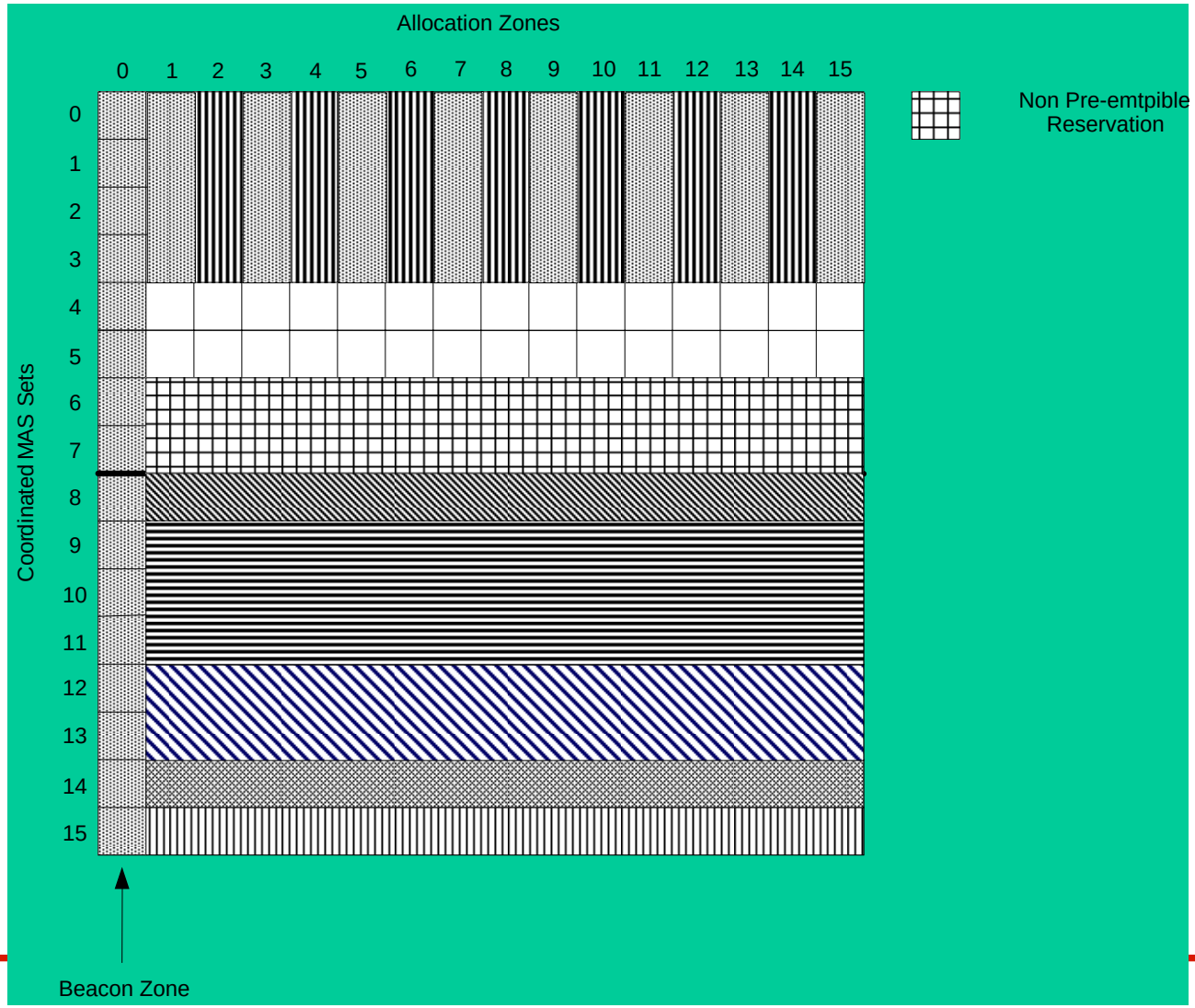
- The superframe is divided equally into unrestricted and restricted zones by default.
- The unrestricted zone favors contiguous reservations that use 1, 2, 4, or 8 columns.
- The restricted zone favors reservations that use multiples of complete horizontal rows.

Rebalancing - Unrestricted



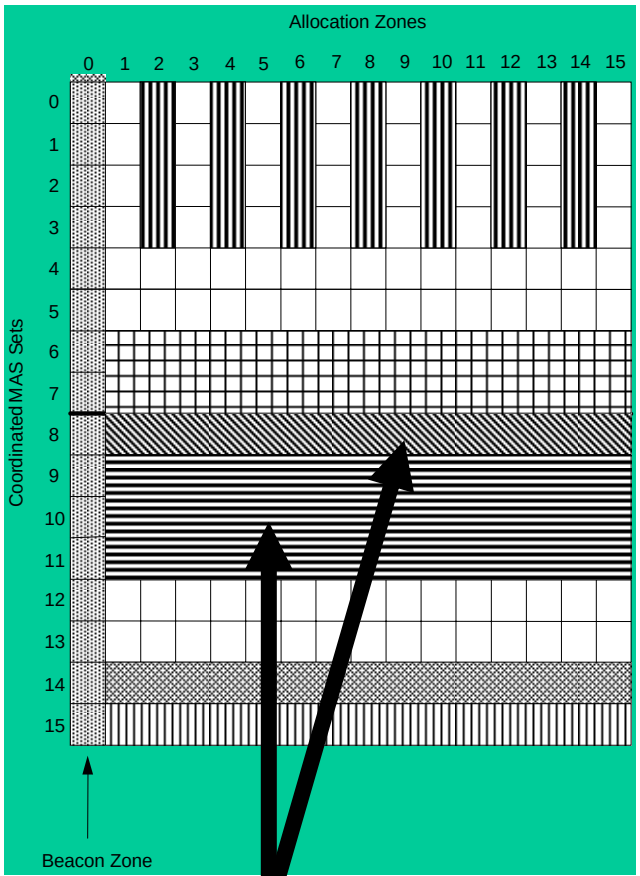
- A column in an unrestricted reservation is subject to preemption if it can be moved up in the allocation zone – unless the move would place part of the column in the PCA area.
- The column can move up or mark the appropriate part of the column subject to preemption.

Rebalancing Unrestricted

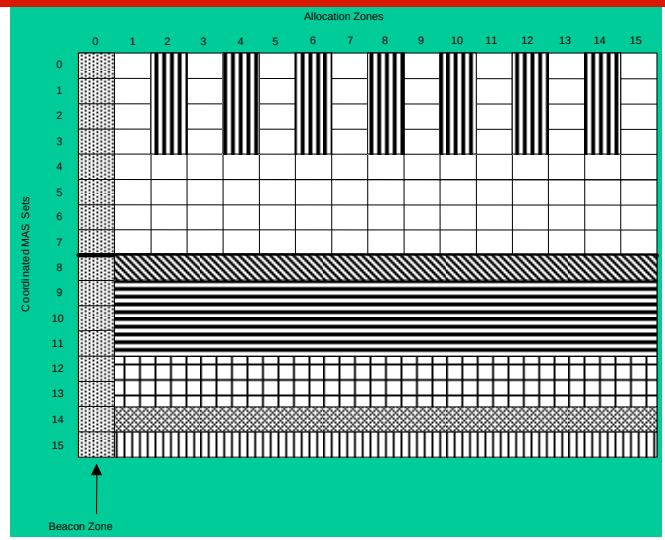


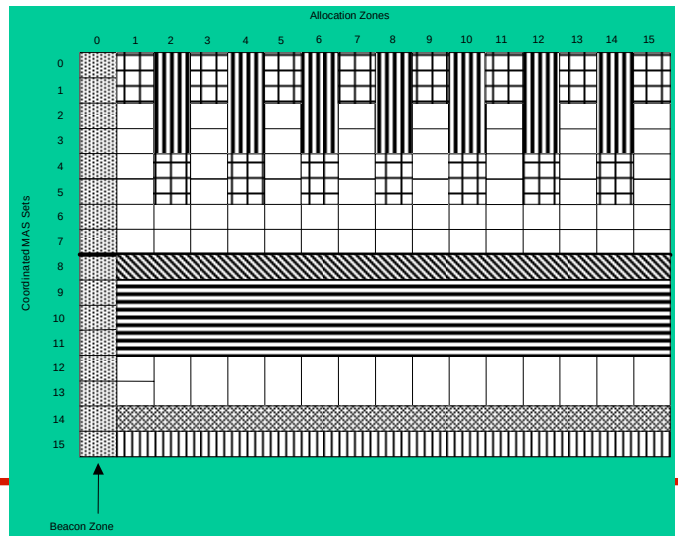
- A restricted reservation is not subject to preemption when columns can move up

Rebalancing - Unrestricted

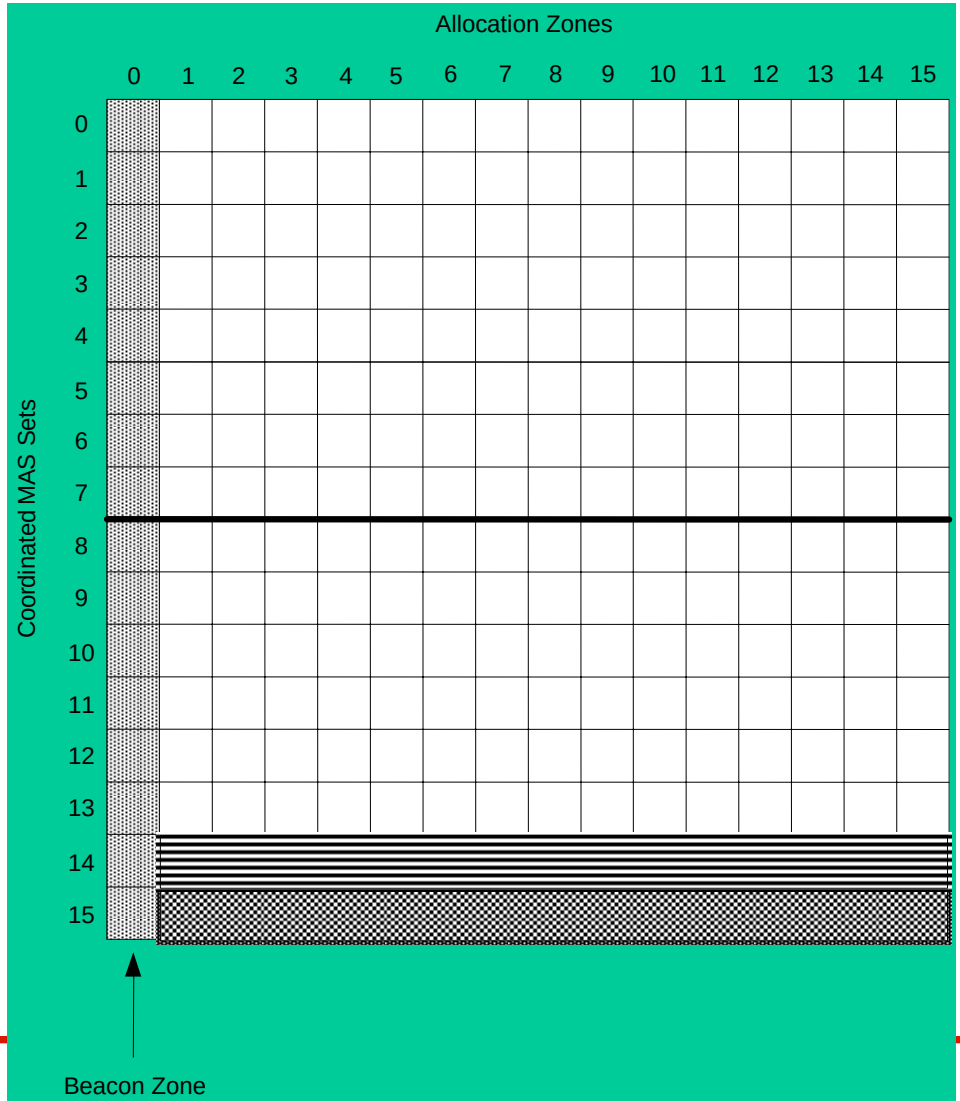


Not Movable



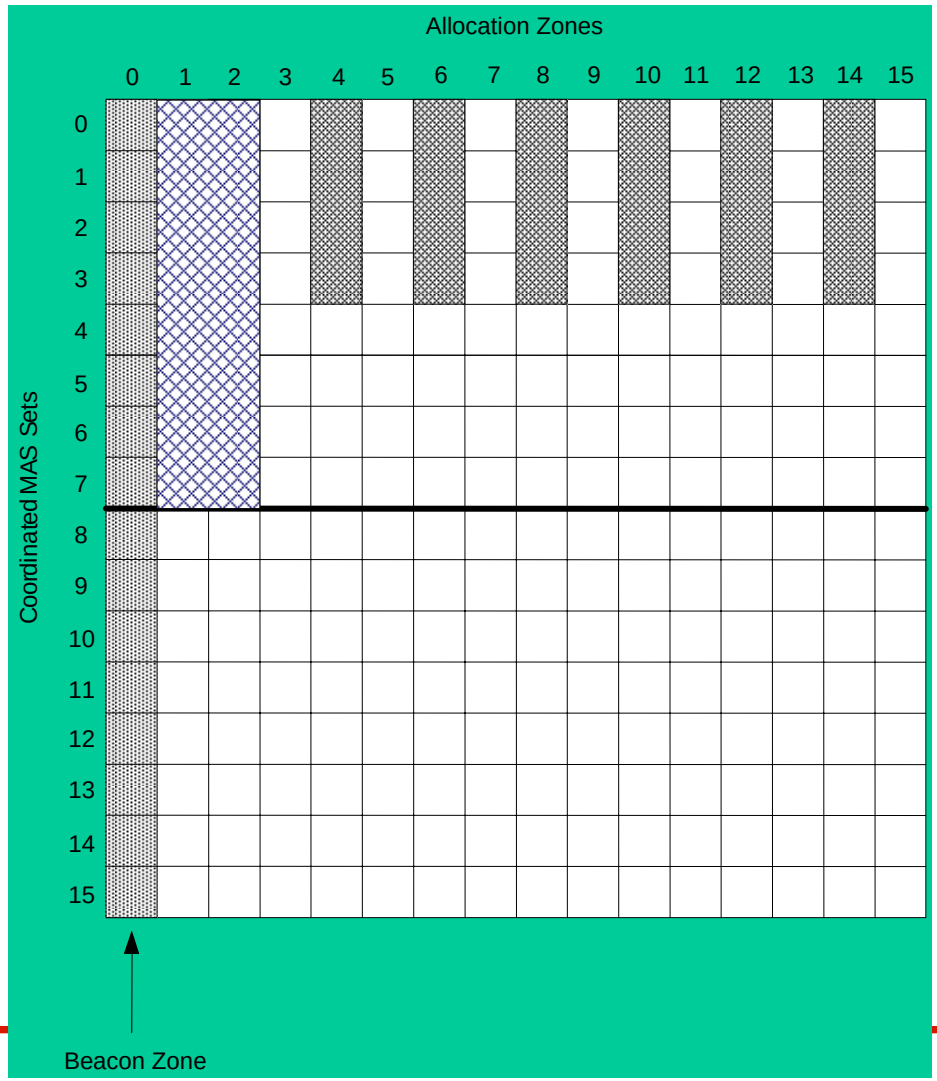


Rebalancing - Restricted



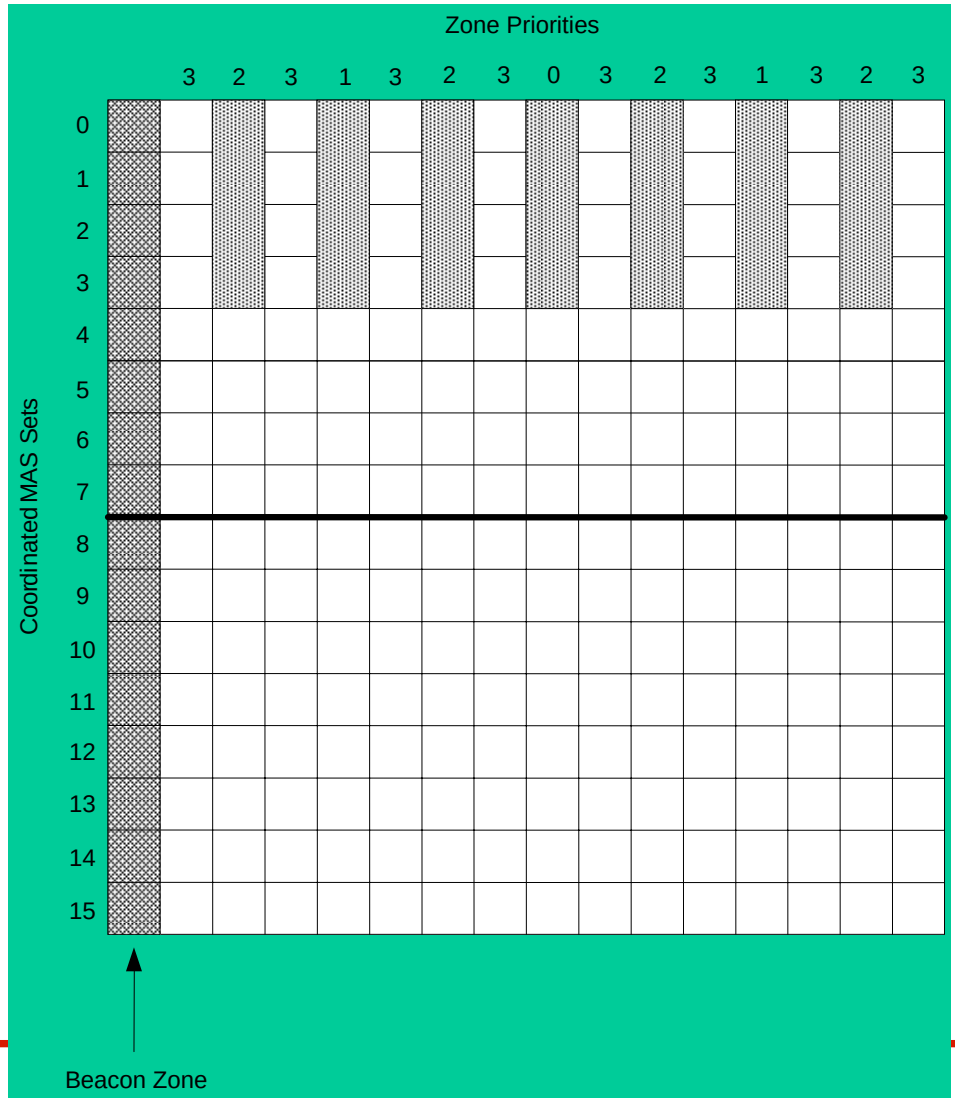
- A restricted reservation row is subject to preemption if a row is available lower in the superframe.
- The row must either move or mark itself as subject to preemption.

Unrestricted Zone Service Intervals



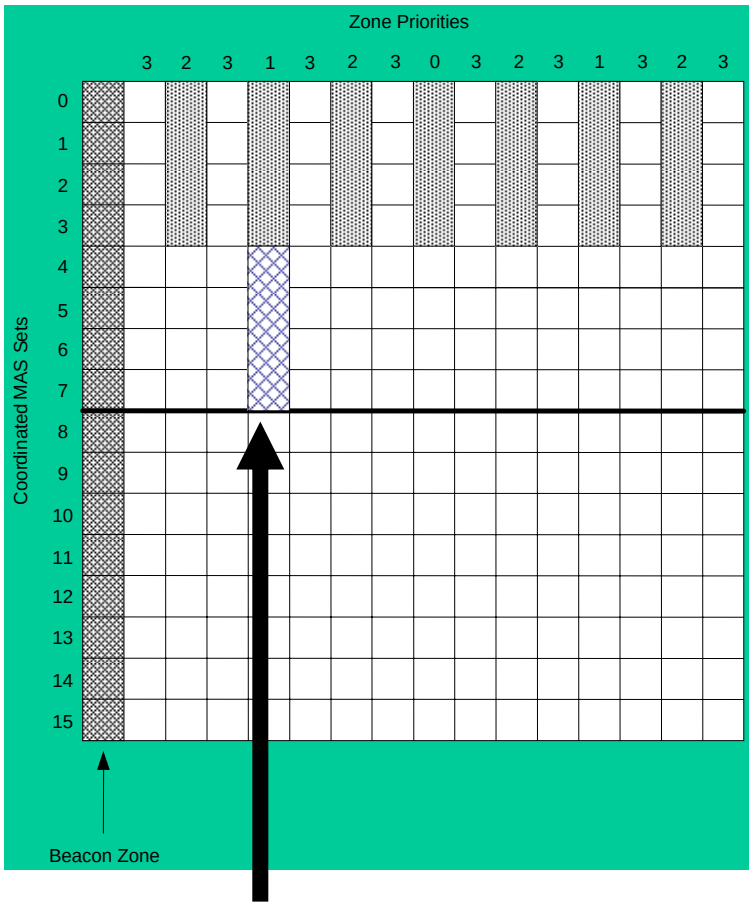
- Though applications using unrestricted reservations prefer contiguous MAS they may also care to some extent about service interval.
- A single unrestricted reservation may prevent lower service intervals for all other unrestricted reservations.

Unrestricted Zone Priorities

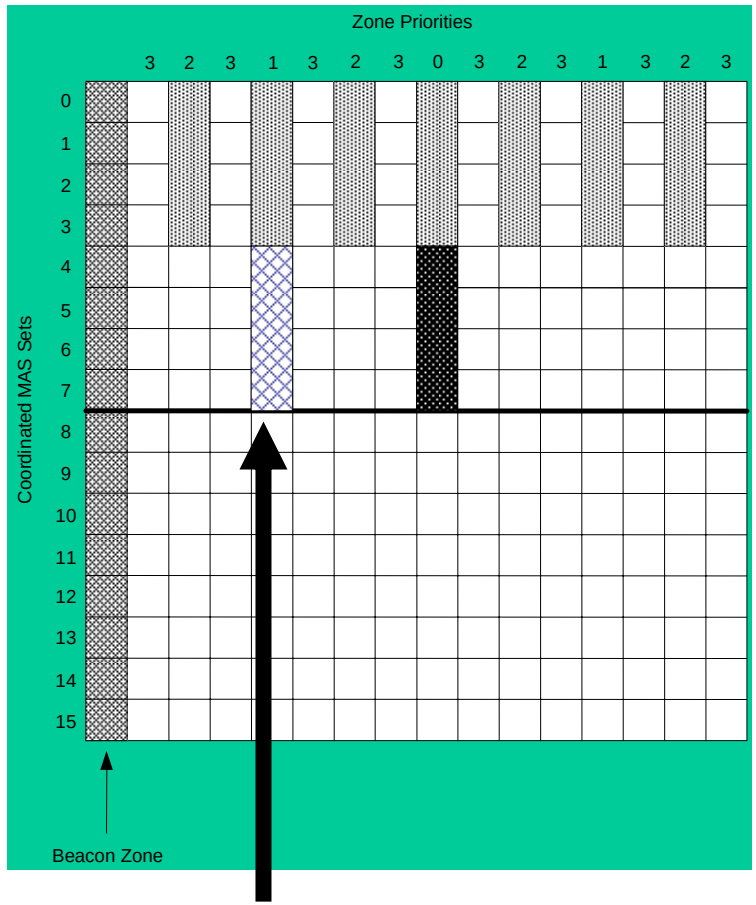


- Unrestricted zone columns have numbers from 0 to 3.
- Contiguous unrestricted reservations in each column are treated individually.
- If the same size contiguous reservation is available in a lower priority column the column must be marked subject to preemption or moved. This is based on the number of columns used in the unrestricted zone . . .

Unrestricted Zone Priority – Example 1

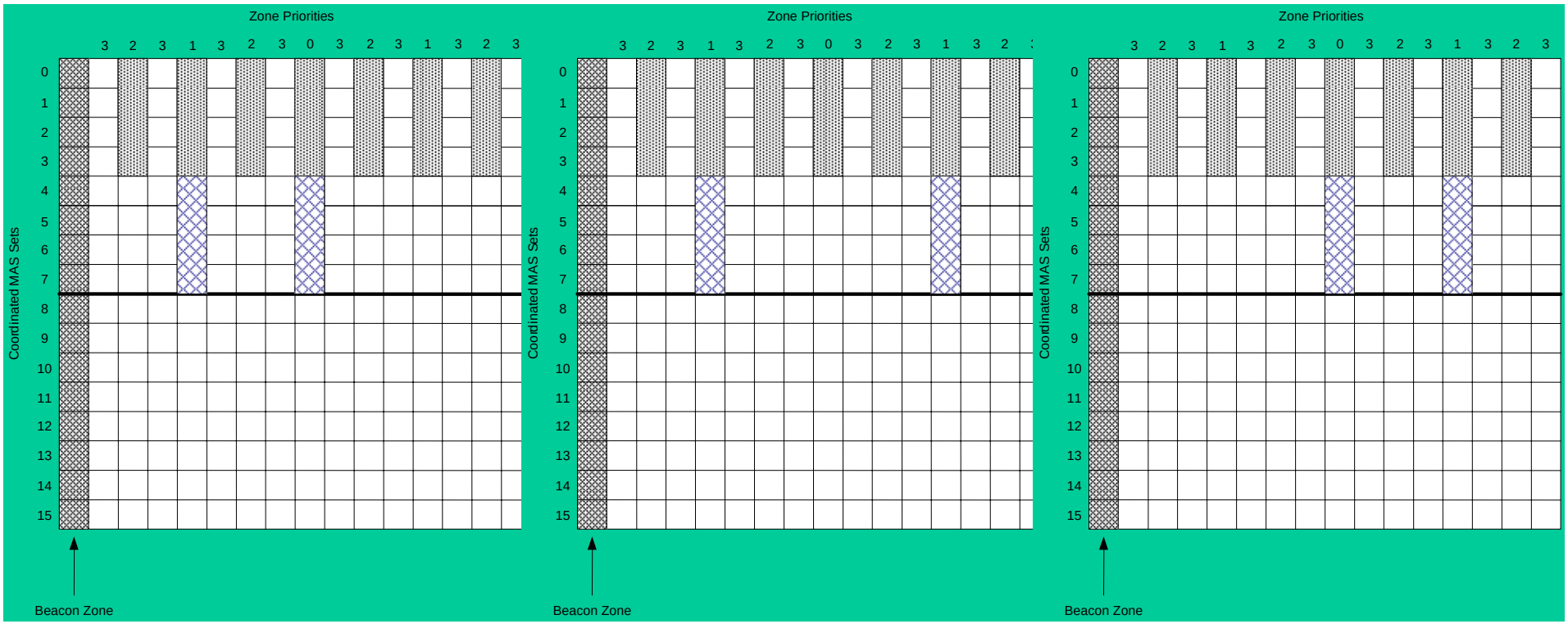


Pre-Emptible

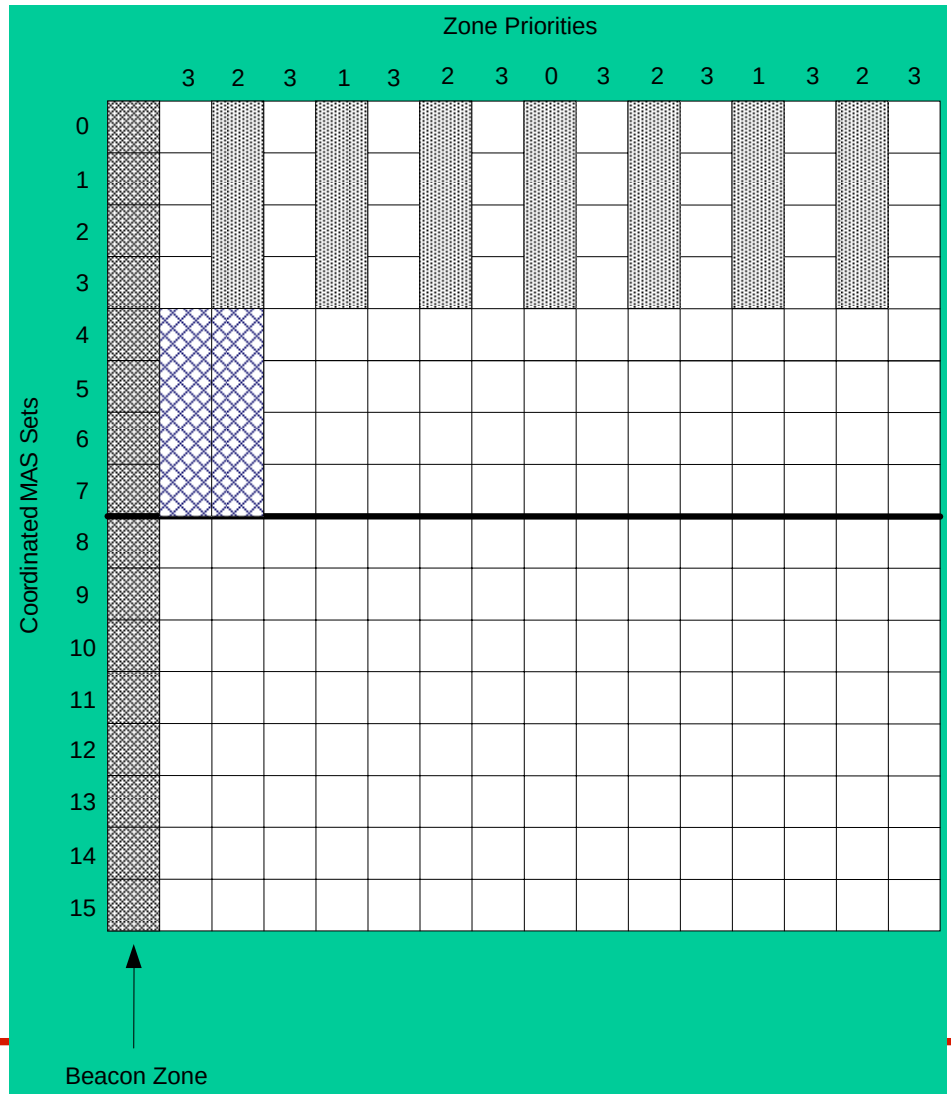


Not Pre-emptible

Unrestricted Zone K = 2
Non-Premptible Examples

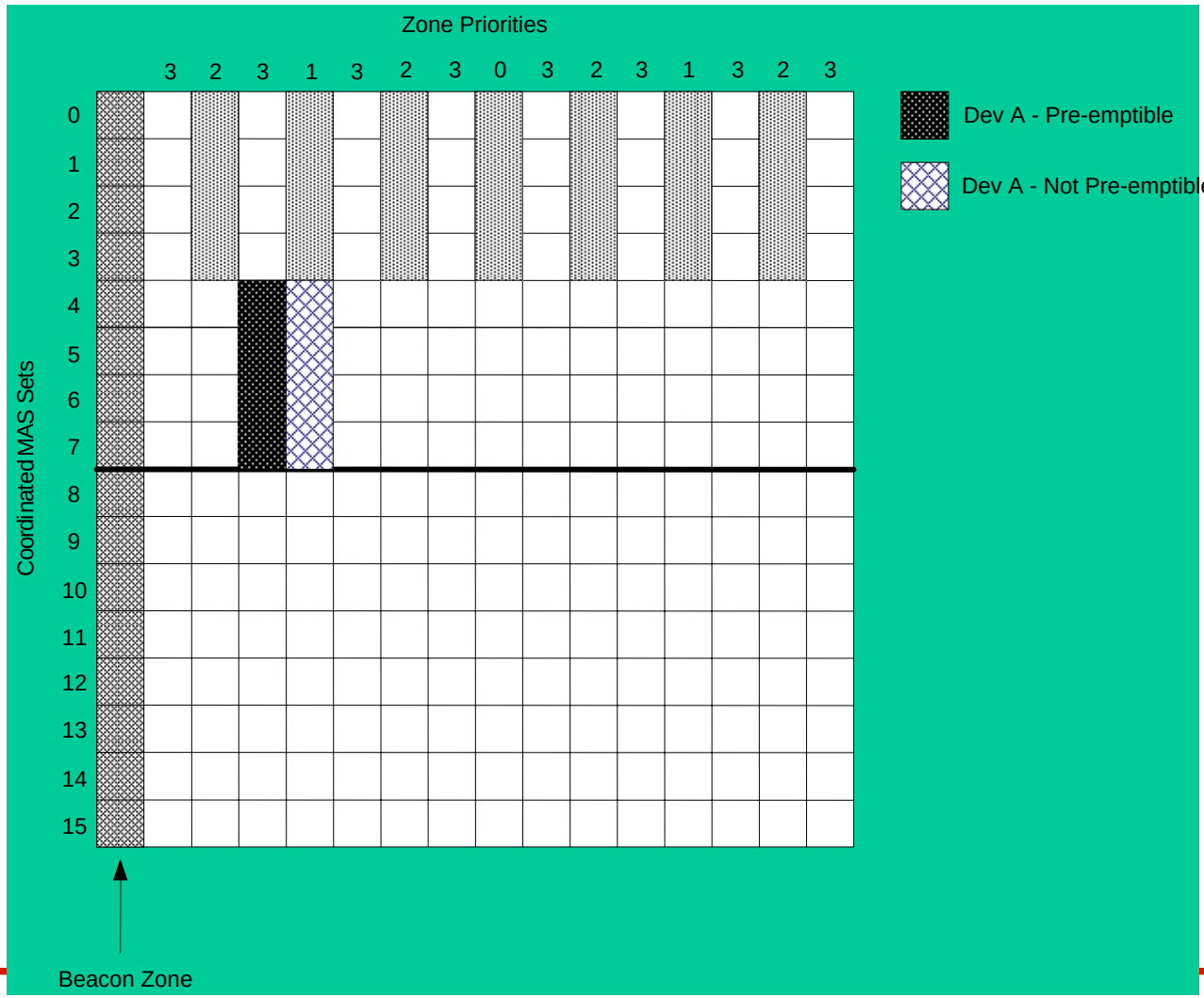


Zone Priorities K = 2 Premptible Example



- Both columns are subject to preemption.
- Both columns would still be subject to preemption if only two columns with lower zone numbers were available that were not adjacent.

Zone Priorities K = 2 Partially Pre-emptible Example



- Both columns reserved by the same device.
- The device is using K = 2 columns in the reservation so using zone 1 or 0 is not subject to premption.
- The column placed in zone 3 is subject to preemption.

Conclusions/Summary

- WiMCA focuses on policy for how multiple devices interact.
- The policy deals with aspects of device behavior that can adversely affect the performance and/or ability to function for other devices
- Interference Mitigation
  - Channel Selection
  - Transmit Power Control
- Bandwidth Sharing
  - Absolute Size Limits (50% Rule)
  - MAS Allocation Form Rules