



BEACON ALIGNMENT IMPLEMENTATION

FOR

ROBUST MULTIPLE PICO NET OPERATION

Suggestion:

1. Download File and save on your local drive
2. View slides in Full Screen Mode.

MeshDynamics

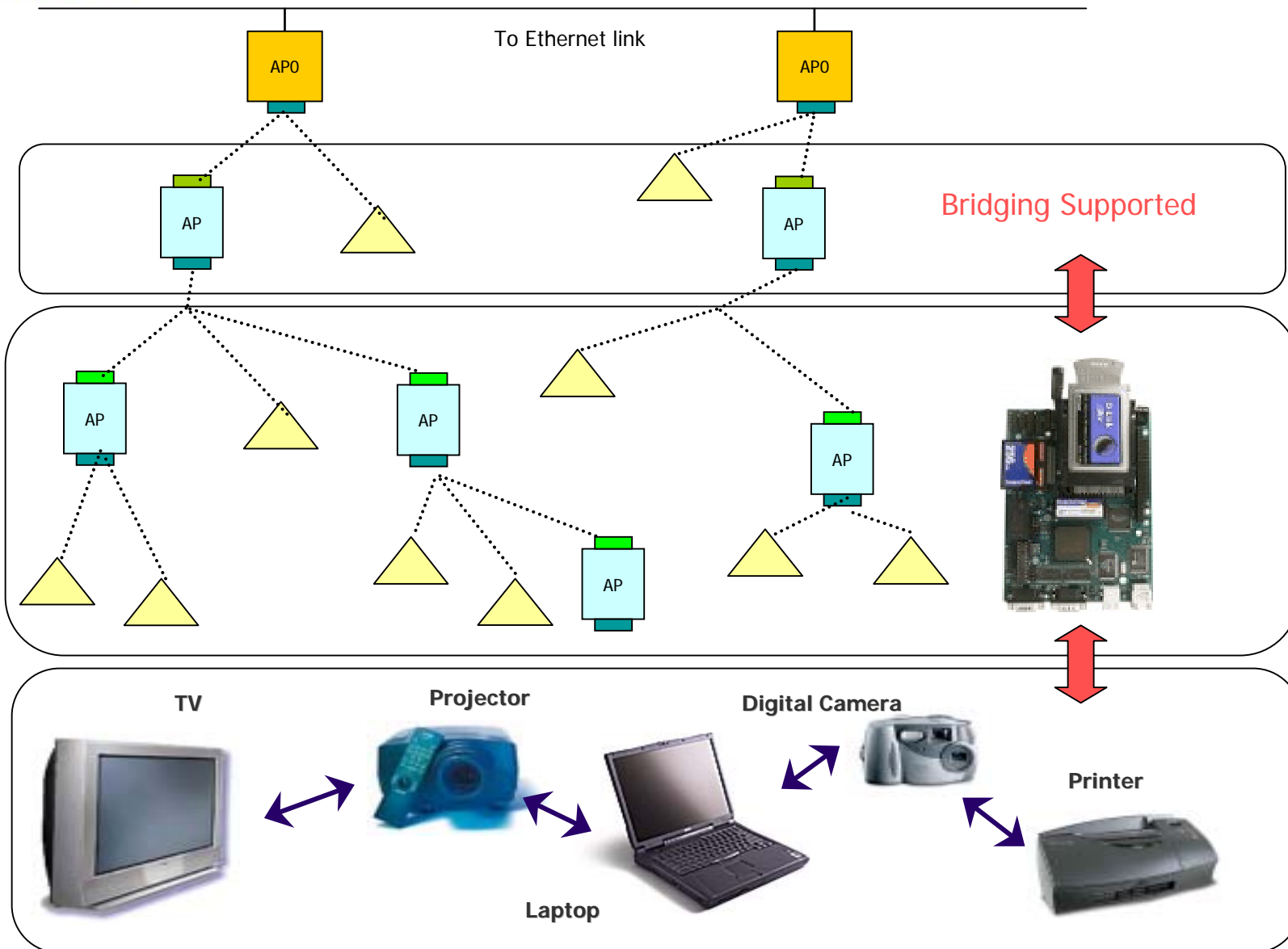
- Wireless LAN/MAN/PAN OEM solution provider
- Subsidiary of Advanced Cybernetics Group, Inc.
- Website: www.meshdynamics.com

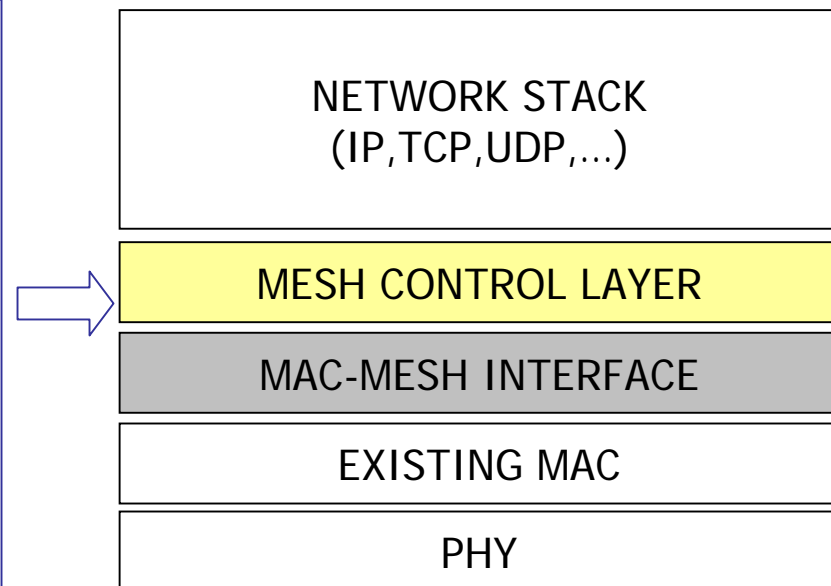
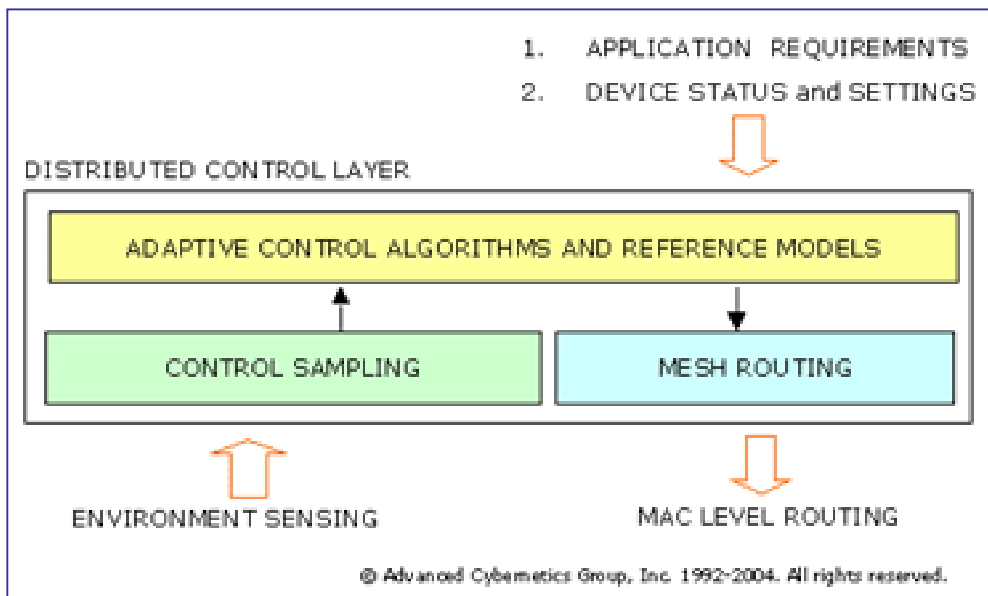
Advanced Cybernetics Group, Inc.

- Embedded Software Provider since 1992
- Proven expertise in adaptive and distributed control systems.
- Approved DoD contractor, OEM supplier for Adept, IBM, Staubli.
- Website: www.advancedcybernetics.com















































MeshControl™ Overlay Offerings



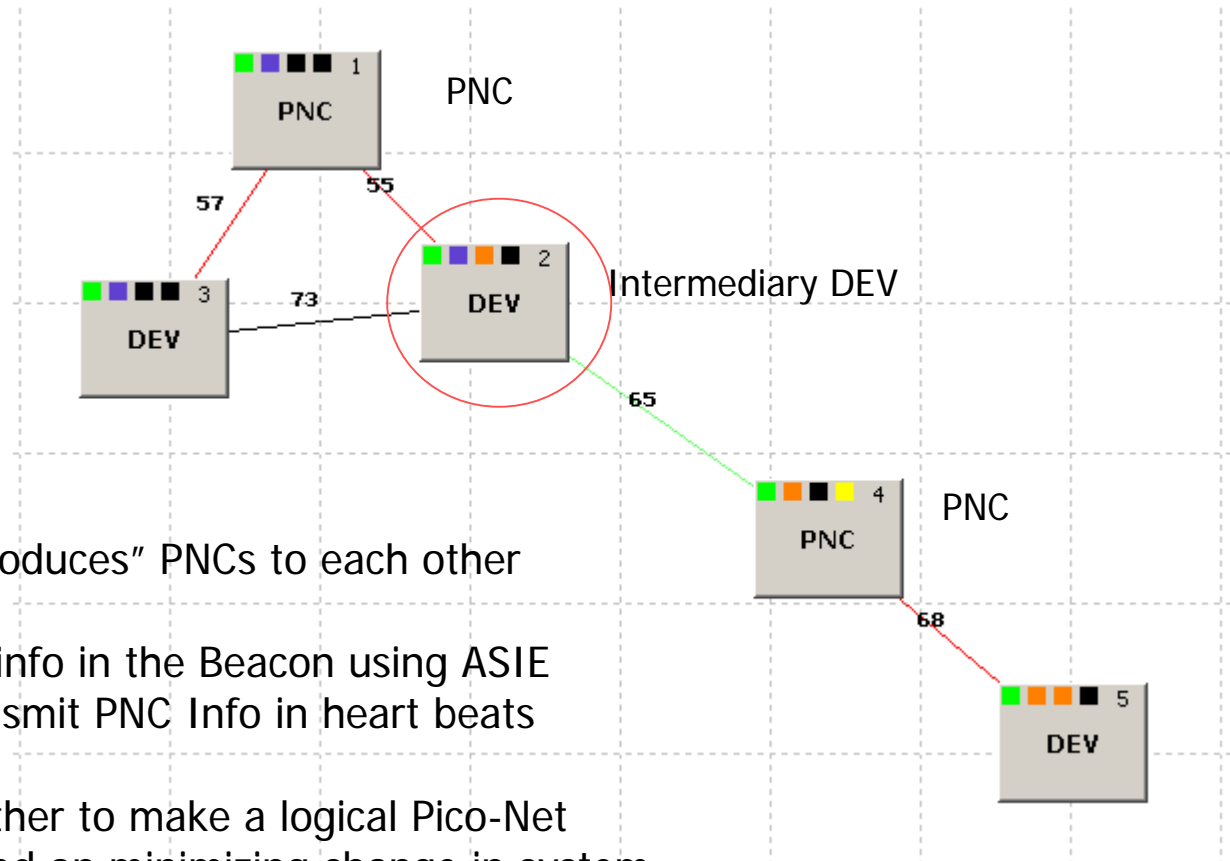


- Software only solution, 60KB Small Footprint
- No Changes to existing MAC required.
- Addresses all concerns of 802.15.3 limitations
- Mesh functionality implemented and OEM ready.

OEM Ready Software Control Layer Features		WLAN	WMAN	WPAN
	Small 60Kb low power footprint: can run on wireless chip *			
	Distributed Control for scalable and stable solutions *			
	No Site Survey requirements- out-of-box connectivity			
	Software is Radio Hardware and MAC Protocol agnostic *			
	Bridging between protocols (802.16-802.11-802.15) *			
	Self Healing, Self Configuring, Auto Discovery			
	Adapt/adjust network topology for latency/ throughput *			
	Auto Load Balancing with no special client software *			
	Automatic Channel Allocation at each AP - no central control			
	Automatic Rogue AP Detection and Notification to NMS			
	Multi-BSS Multi-Hop Infrastructure Mesh [Meshed ESS] *			
	Enhanced Ad-Hoc Wireless Mesh for Multi-PNC coordination *			
	Power-level aware routing for WPAN UWB Chips *			
	Beacon Alignment for Simultaneous Operating Pico-nets *			
	Seamless roaming: includes voice traffic management			
	Location Sensing capability integrated into heart beat			
	 = Optional			

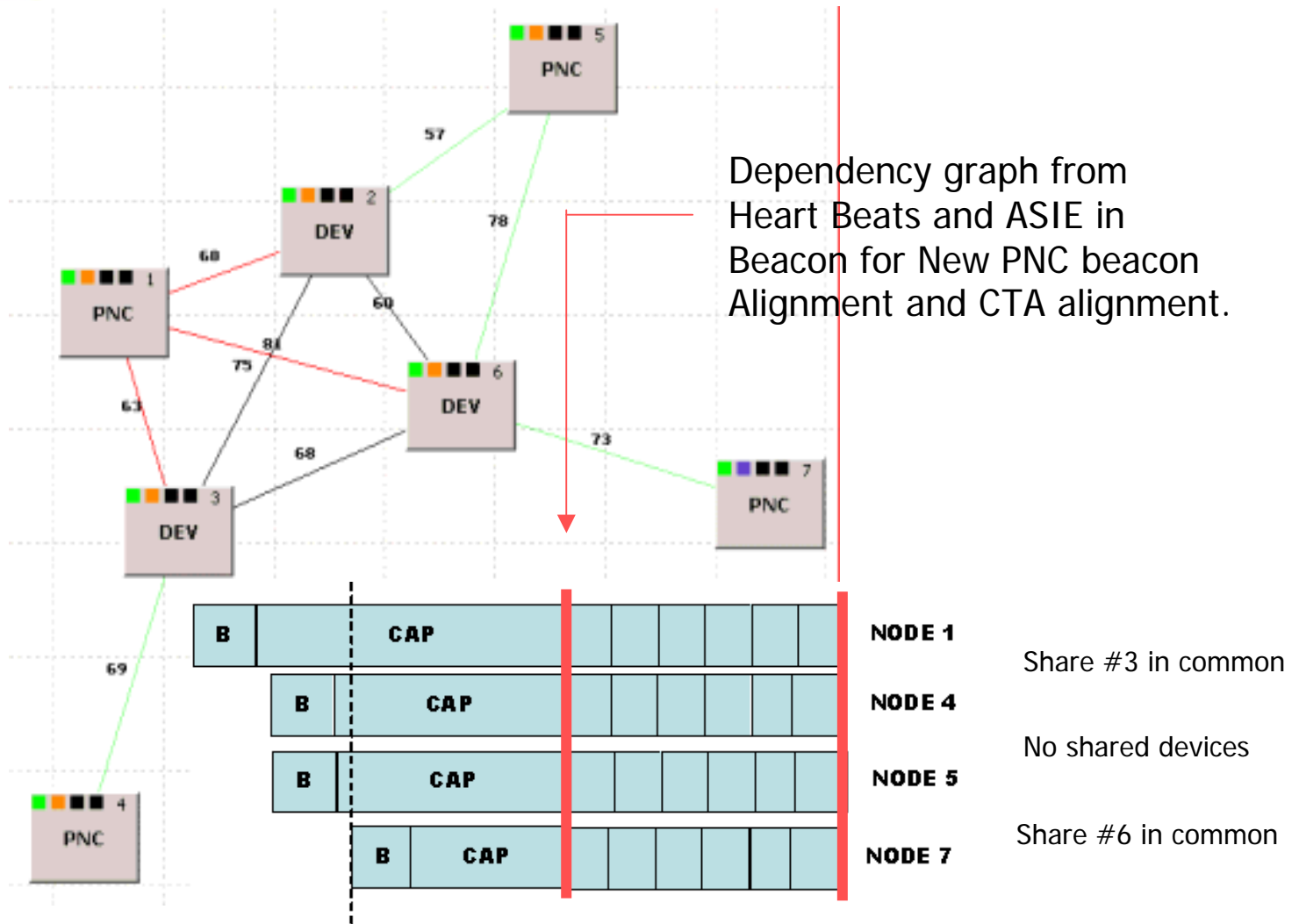
* no adequate alternatives exist today for these specific features, patents pending

Heart Beat Based Beacon Alignment



- Intermediary Device “introduces” PNCs to each other
 - PNCs transmit info in the Beacon using ASIE
 - Devices re-transmit PNC Info in heart beats
- One PNC aligns with another to make a logical Pico-Net
- Senior PNC selection based on minimizing change in system.

Heart Beat Based Beacon Alignment



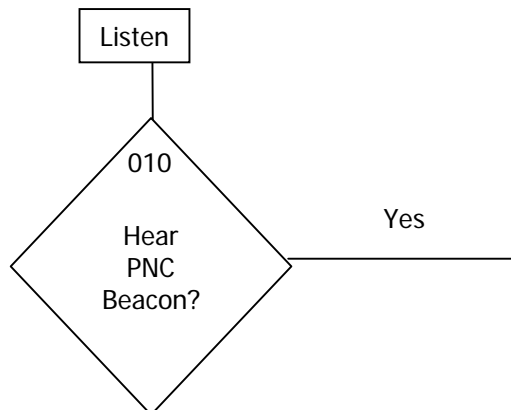
Dependencies identified and drive alignment algorithms

Three Cases cover all situations.

0. PNC Listens

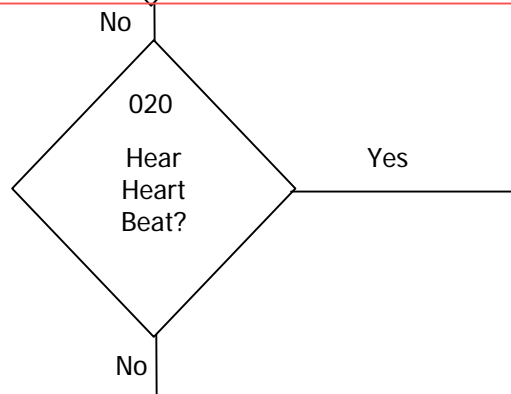
Listen

1. Hears Beacon



Becomes a Device or Child PNC
Beacon Alignment

2. Hears Heart Beat



Align PNC Beacon to avoid interference
| 030 Select Senior PNC
| 040 Align Beacons based on SIA process
| 050 Start sending beacons, listen
| 060 Periodic Collective Perturbation

Superset of other cases

3. Hears Neither. Either:

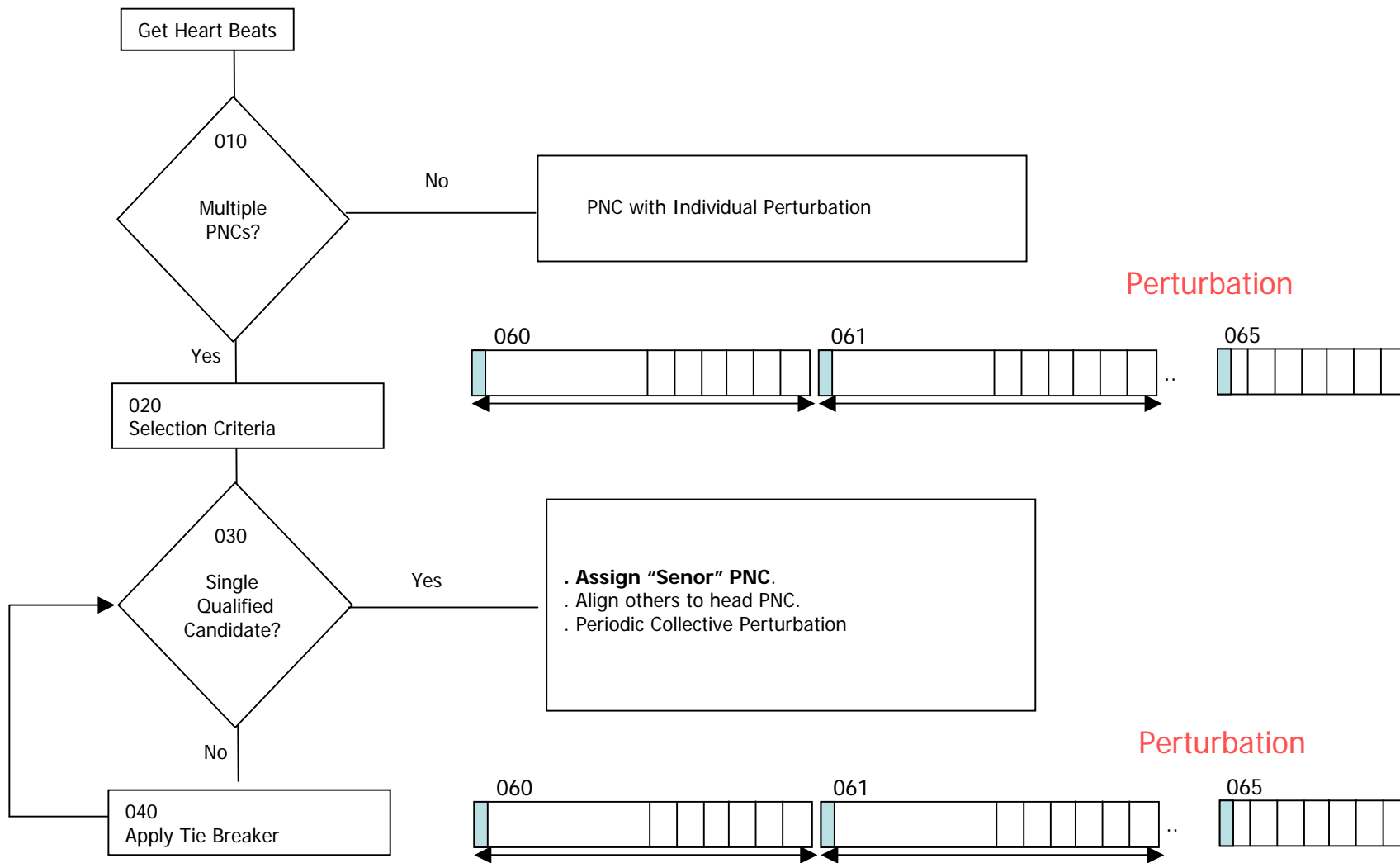


Becomes a Lone PNC, listens for Beacon.
| 080 Starts sending beacons, listen
| 090 Repeated Individual Perturbation

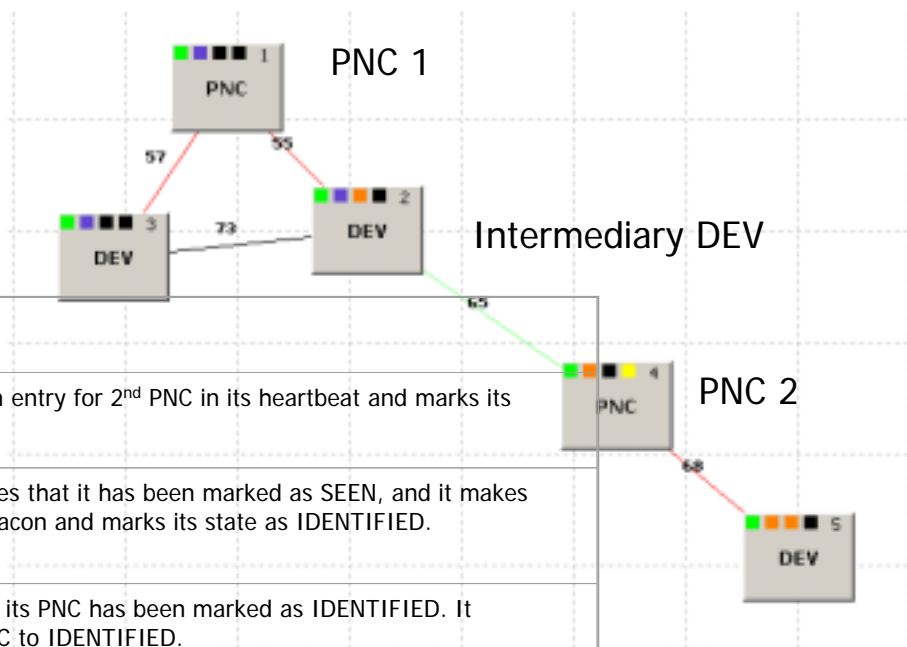
- Lone PNC?
- Beacon Interference?

*Possibility: Beacons Interfering
Addressed by Perturbation*

Selection of "Senior" PNC.

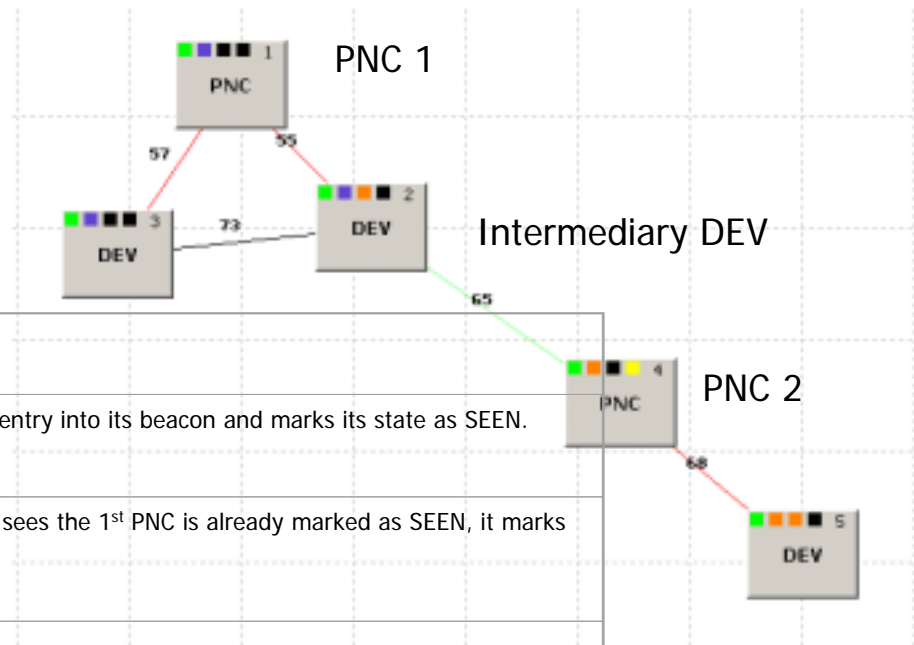


Case I: PNC Hears Heart Beat First.



No	Super Frame Number	Action
1	1	DEV hears beacon and makes an entry for 2 nd PNC in its heartbeat and marks its state as SEEN.
2	2	2 nd PNC hears heartbeat and, sees that it has been marked as SEEN, and it makes an entry for the 1 st PNC in its beacon and marks its state as IDENTIFIED.
3	2	DEV hears beacon and sees that its PNC has been marked as IDENTIFIED. It changes the state for the 2 nd PNC to IDENTIFIED.
4	3	DEV sends heartbeat
5	4	1 st PNC and 2 nd PNC hear the heartbeat, and decide who is senior amongst them. The junior PNC immediately aligns its beacon appropriately, and marks its entire CTAP as reserved, and also sends out a CTA request to the senior PNC. The DEV picks up the beacon and copies the CTA request into its heartbeat.
6	5	The senior PNC picks the HB, allocates CTA, changes super-frame length appropriately and sends beacon.
7	5	The DEV picks beacon, copies CTA information into heartbeat and sends heartbeat.
8	6	The junior PNC hears the HB and is now fully aligned.

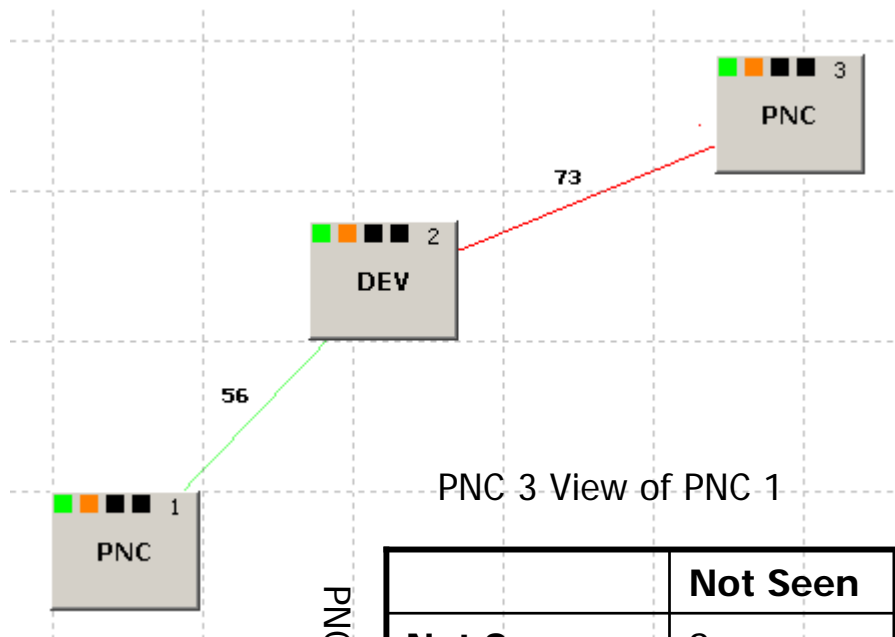
Case II: DEV hears PNC Beacon First.



No	Super Frame Number	Action
1	1	2 nd PNC hears HB and makes an entry into its beacon and marks its state as SEEN.
2	2	DEV hears 2 nd PNC's beacon and sees the 1 st PNC is already marked as SEEN, it marks the 2 nd PNC as IDENTIFIED.
3	3	DEV sends heartbeat
5	4	1 st PNC and 2 nd PNC hear the heartbeat, and decide who is senior amongst them. The junior PNC immediately aligns its beacon appropriately, and marks its entire CTAP as reserved, and also sends out a CTA request to the senior PNC. The DEV picks up the beacon and copies the CTA request into its heartbeat.
5	5	The senior PNC picks the HB, allocates CTA, changes super-frame length appropriately and sends beacon.
6	5	The DEV picks beacon, copies CTA information into heartbeat and sends heartbeat.
7	6	The junior PNC hears the HB and is now fully aligned.

Alignment Handshaking (with Heart Beat)

Before Alignment



PNC 1 and PNC 3 are made aware of Each other through intermediary DEV2 H.B.

- DEV2 Heart beat information recd
- Views expressed by PNC1 heard by DEV2
- Views expressed by PNC3 heard by DEV2
- Handshaking "state" is based on truth table
- Intermediary DEV2 moves process forward

PNC 3 View of PNC 1

PNC1 View of PNC 3

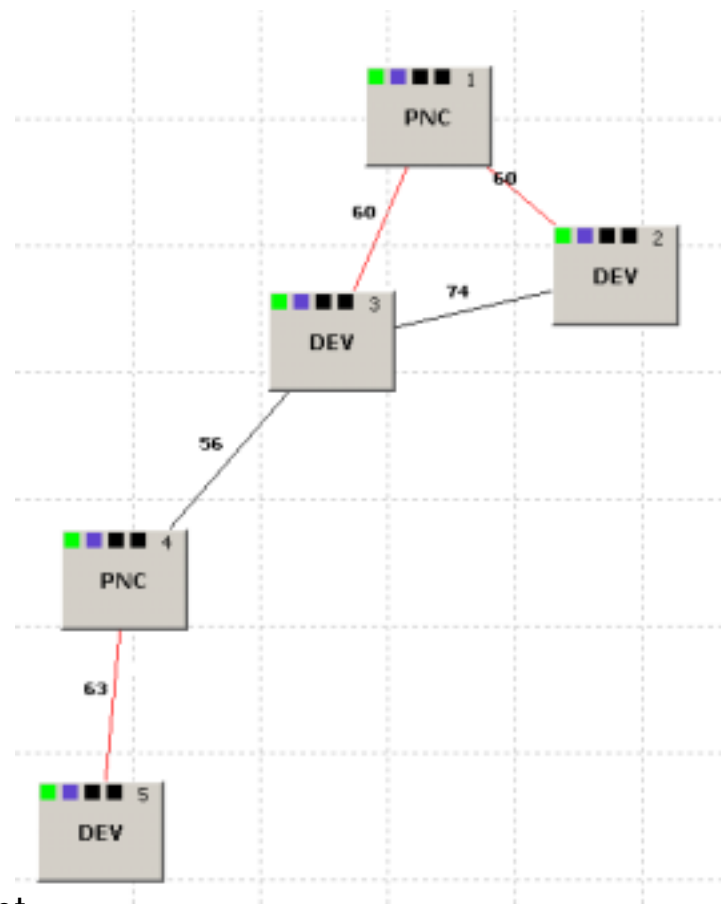
	Not Seen	Seen	Introduced	Aligned
Not Seen	Seen	Introduced	Introduced	Ignored.
Seen	Introduced	Introduced	Introduced	Ignored.
Introduced	Introduced	Introduced	Introduced	Aligned.
Aligned	Ignored.	Ignored.	Aligned.	Aligned.

OUR ALIGNED SYSTEM STAYS ALIGNED

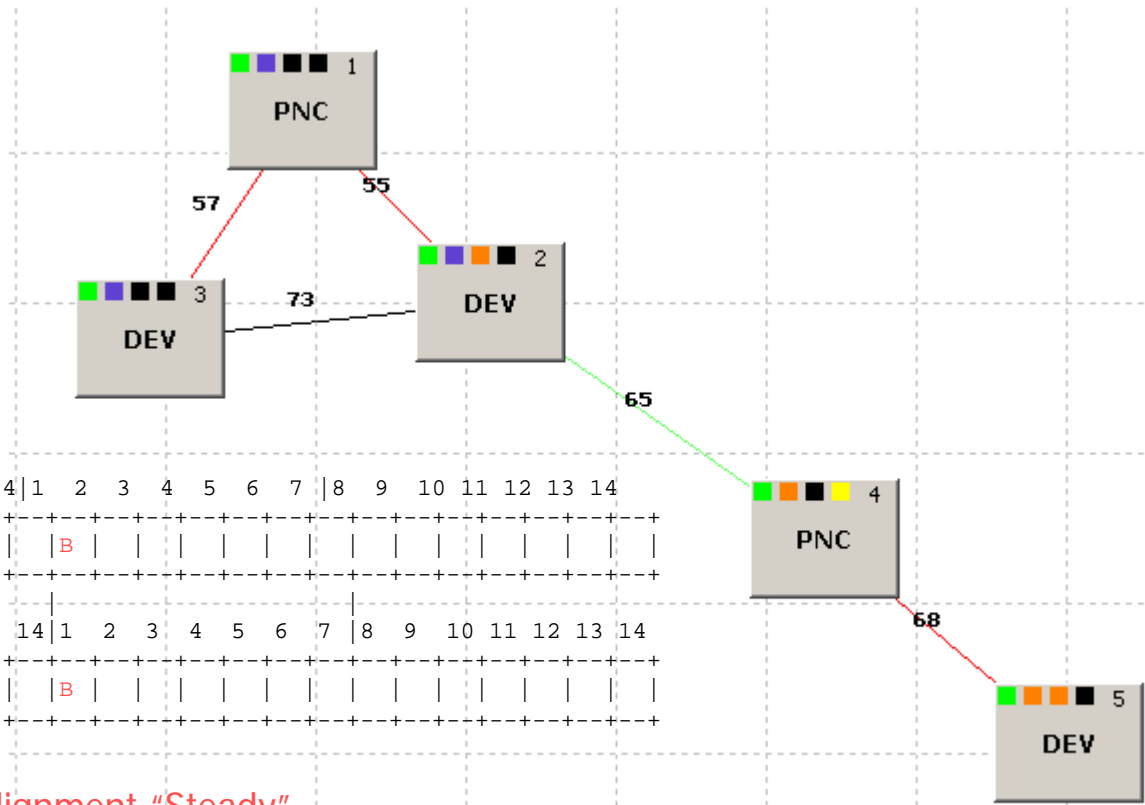
- DEV 5 and PNC 4 have moved.
- DEV 3 now reports seeing PNC 4
- Same truth tables and FSM apply.
- System is impervious to noise:
 - Impervious to open/shut door
 - Impervious to mobility issues

REASON:

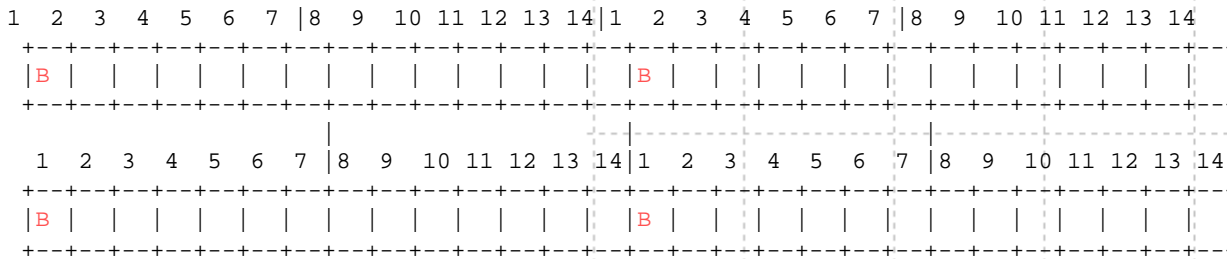
- System is one logical one Pico-Net
- Robust Algorithm for adding another PNC to logical Pico-net
 - If new PNC arrives, added to either top or bottom of list:
 - Bottom: Joined Pico-Net to form larger logical pico-net
 - Top: Existing logical pico-net makes new PNC senior.
- Affect alignment dependencies of other PNCs not affected.
- Alignment completes within 8 Super Frames.



Our Aligned System Stays Aligned

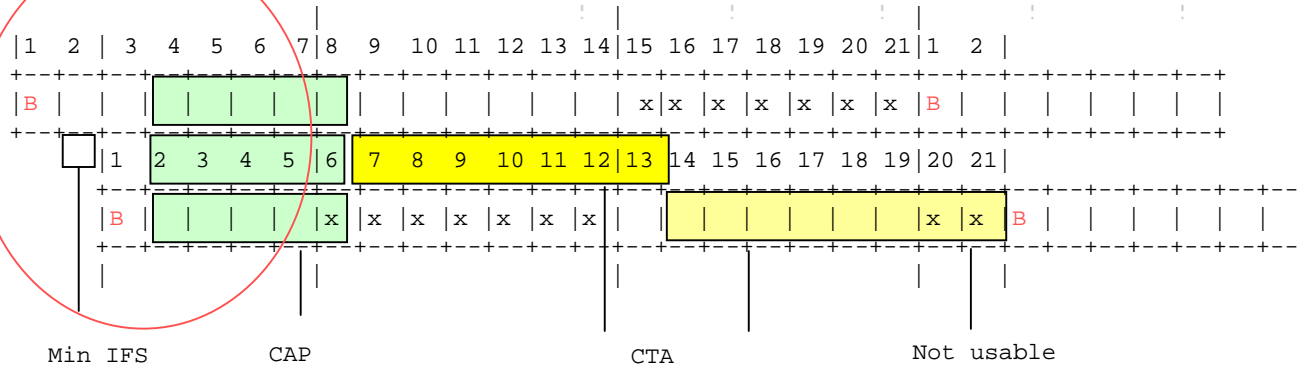


Before Alignment - Beacon interference



After Alignment - Beacons aligned

Alignment "Steady"



CTAP Resources are used judiciously

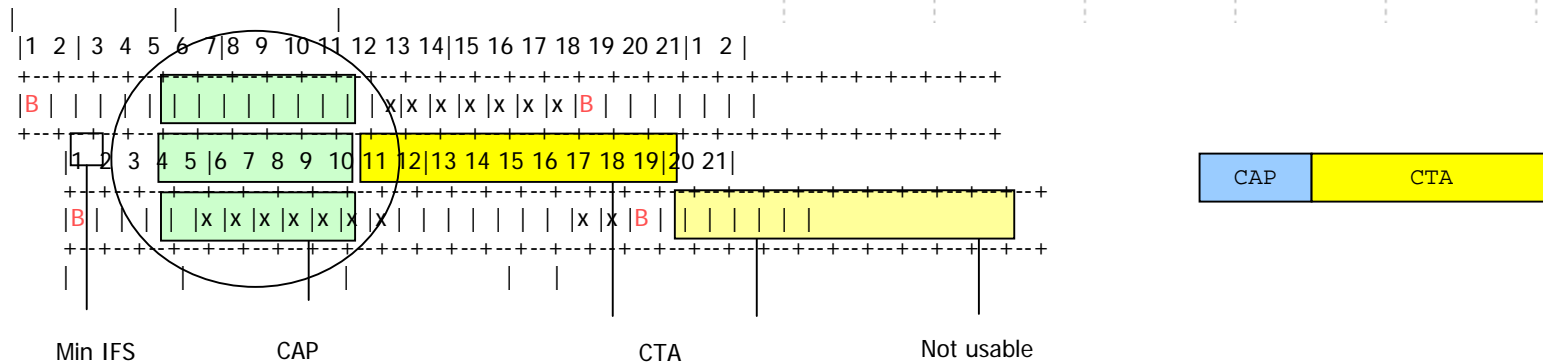
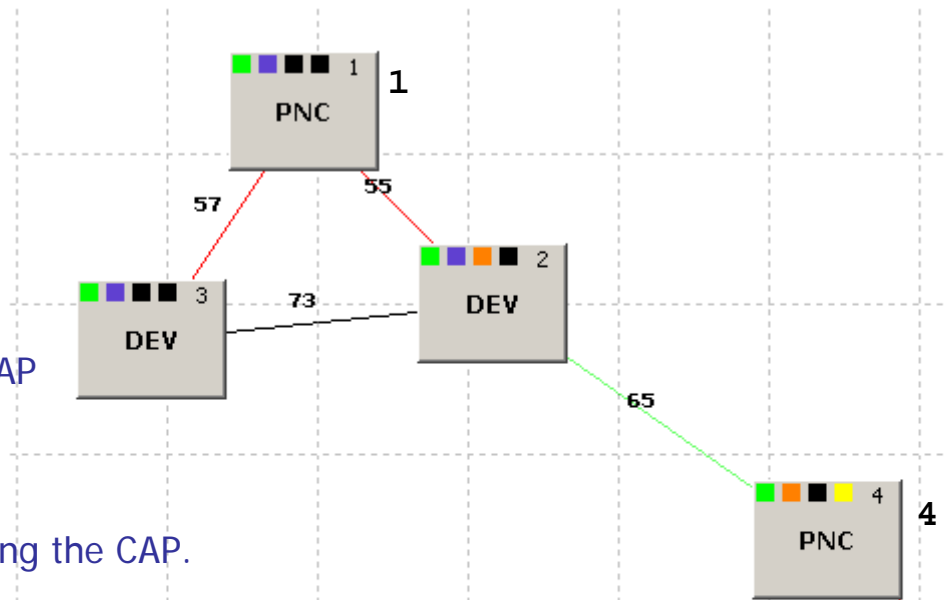
A wasteful CTA based Approach

- PNC Node 4 becomes PNC per 802.15.3
- PNC Node 4 aligns with PNC Node 1.
- Device 2 wants to associate with PNC Node 4
- PNC Node 4 can reserve CTA for DEV 2 in its CTAP

A less CTA resource hungry alternative

PNC Node 4 allowed to communicate via DEV2 using the CAP.

- NO Dynamic CTAP re-allocation is then needed.
- Dynamic CTAP re-allocation not feasible in high mobility situations.
- Allocation of CAP by control algorithms easier, more stable approach.



Demonstrable Implementation

