System Capacity with Channelization

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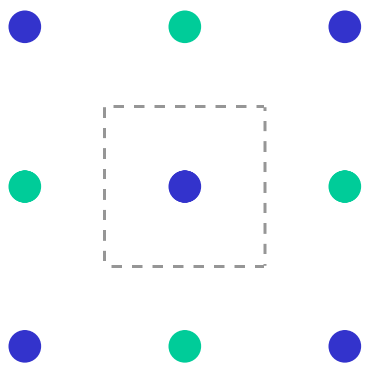
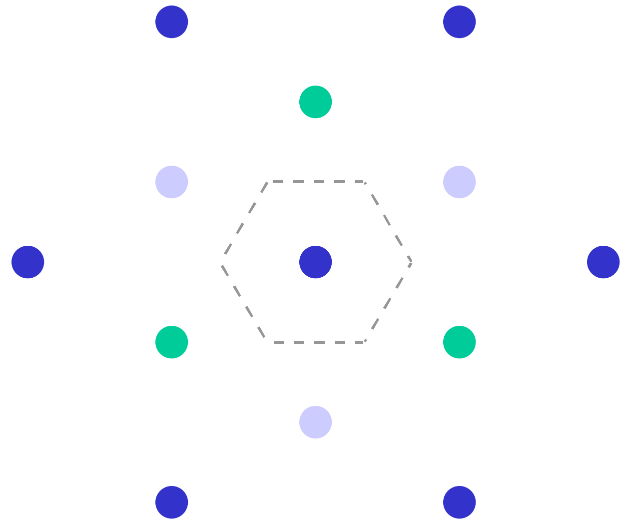
Access-Point-Location Geometries



Two Frequency Channels

Many Data-Code Channels

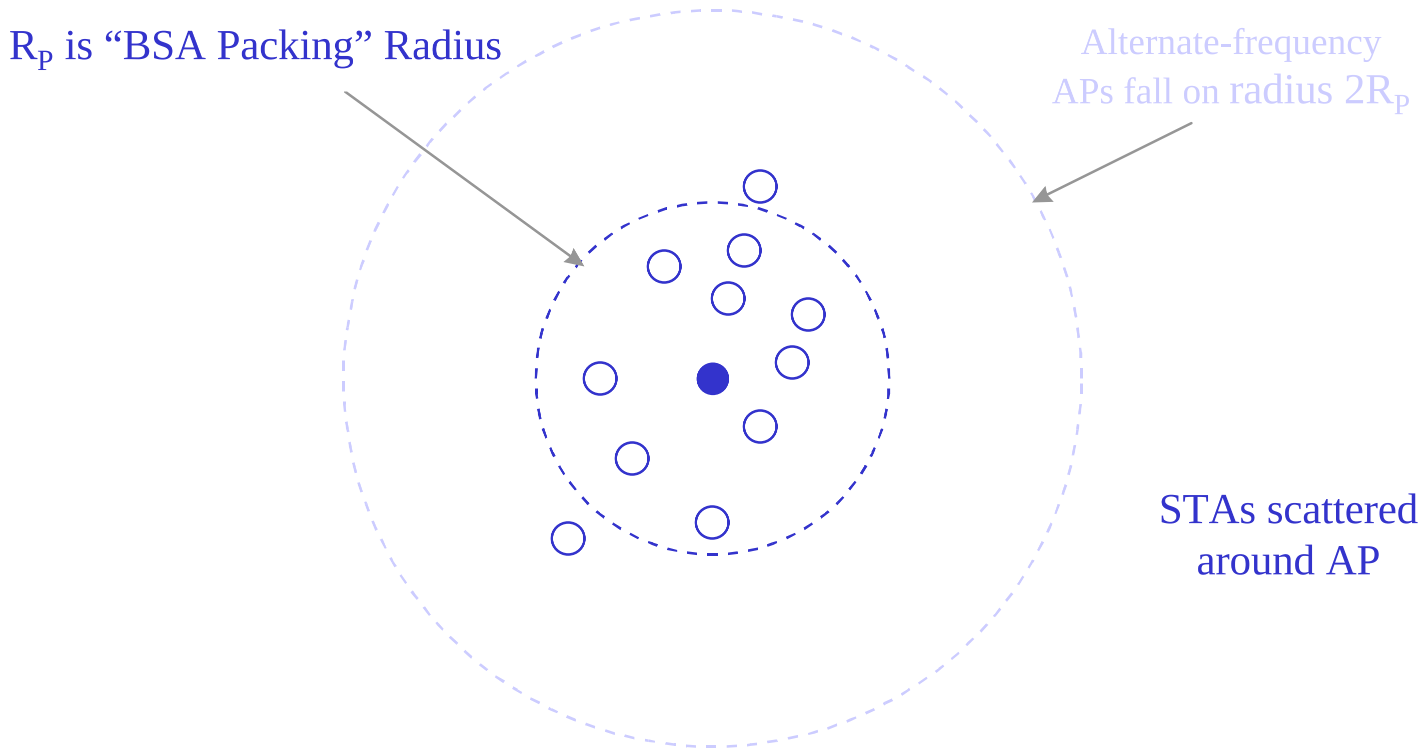


Three Frequency Channels

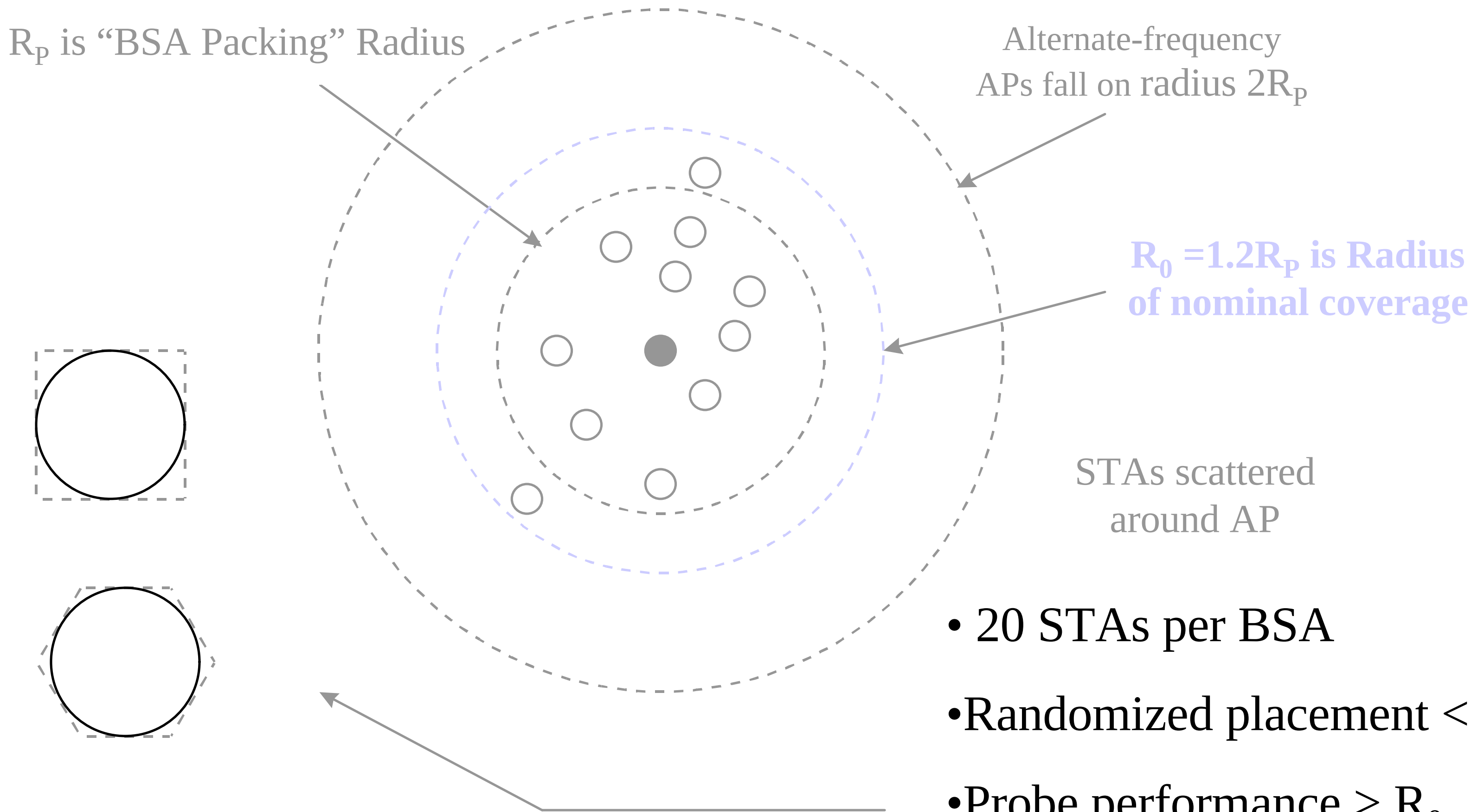
One Code

Same nearest-neighbor separation gives ≈ same areas per AP

Basic BSA Geometry

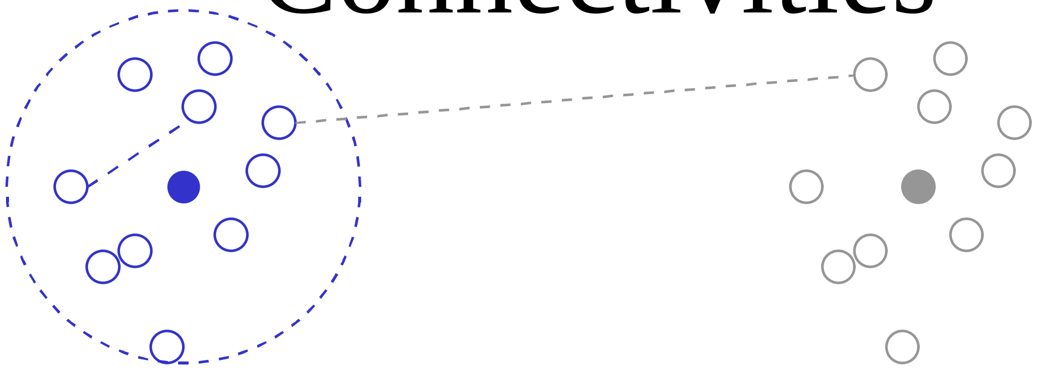


Basic BSA Geometry



- 20 STAs per BSA
- Randomized placement < R_0
- Probe performance > R_0

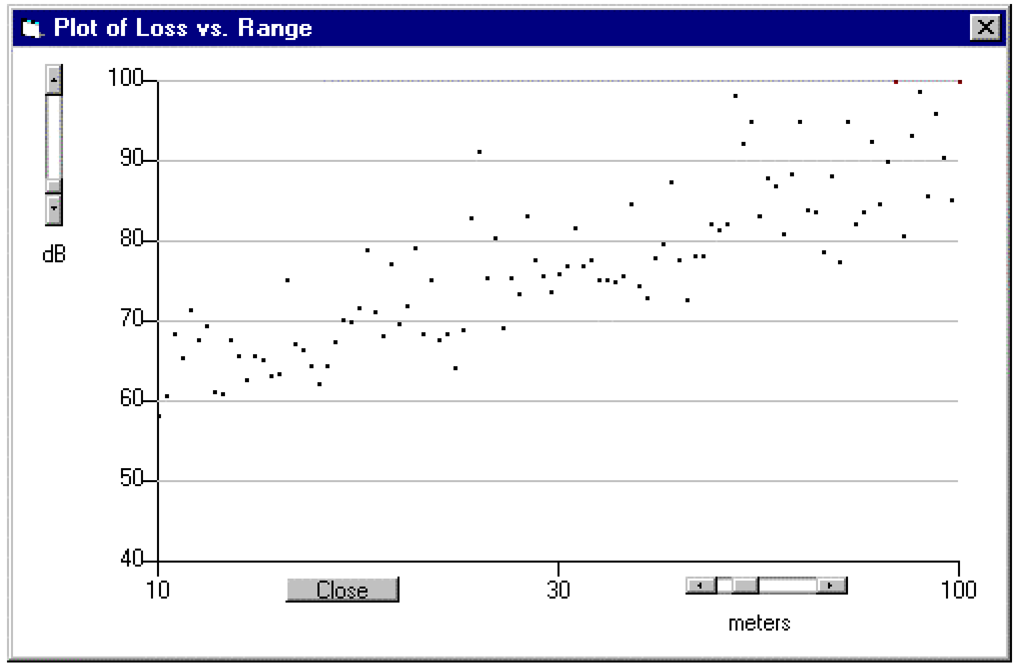
Generation of Sample Connectivities



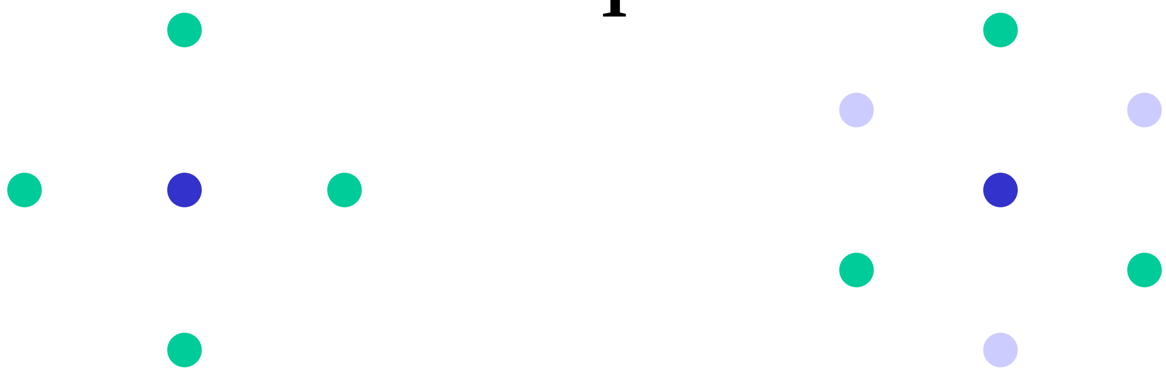
- Generate Random Link Connectivities within BSA_0
- If AP Signal < Threshold+3 dB at STA
  - Re-generate that link connectivity (3 tries max.)
  - Emmulates fine-scale repositioning STA if poor contact
- Also Compute Links Between other BSAs and BSA_0
- Same Local Random STA Positions Re-Used in All BSAs
  - Allows use of BSA_0 STA & AP parameters for All BSAs

Propagation Models

- Large Scale Variation
  - Free-Space to 1m
  - R^n beyond 1m
  - n=1.5 to 4
- Local Signal Fading
  - None
  - Rayleigh
  - Three-Ray
- <u>Used: n=2.5 & Rayleigh</u>

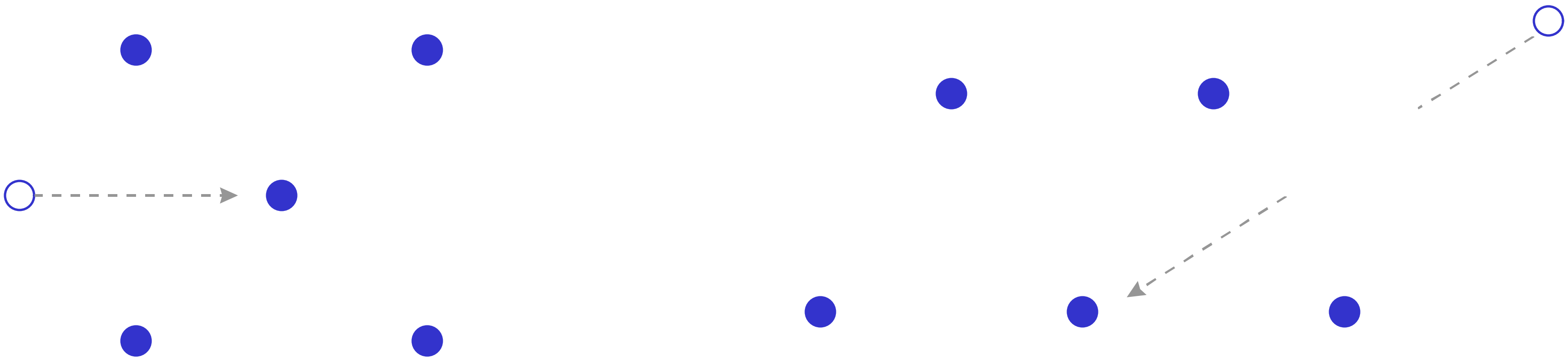


Interaction for Different Frequencies



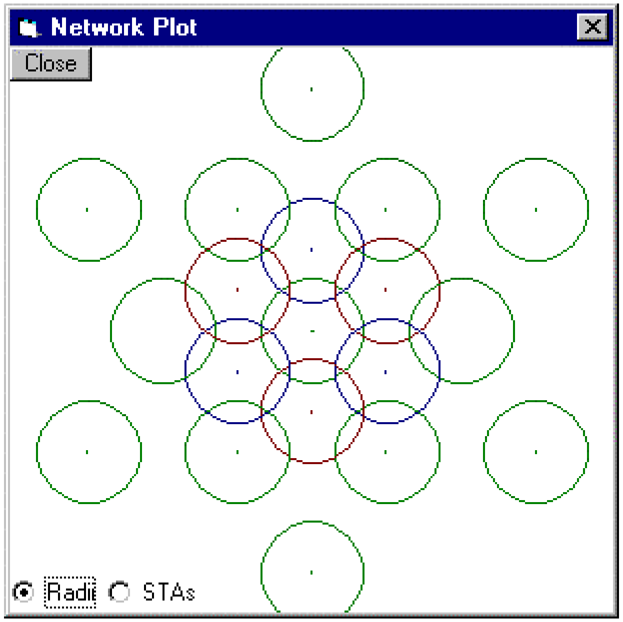
- Interference at Short Range
- Suppressed by ACI Rejection Ratio (~35 dB)
- Consider Only Nearest Off-Frequency BSAs

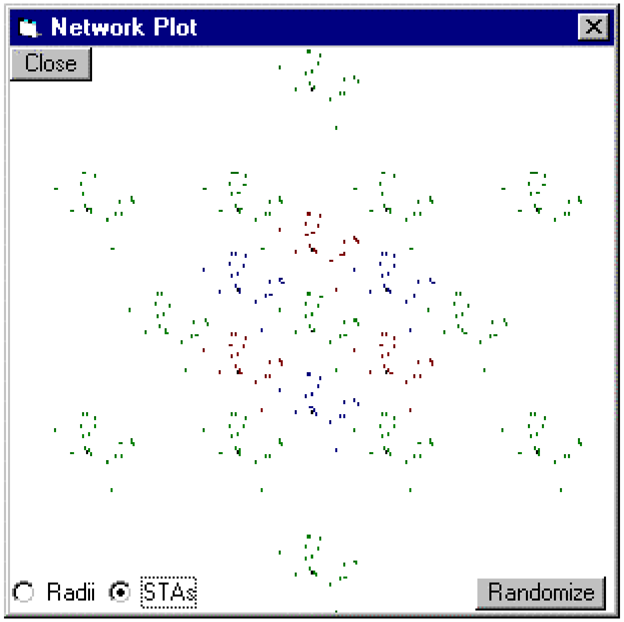
Interaction for Same Frequencies

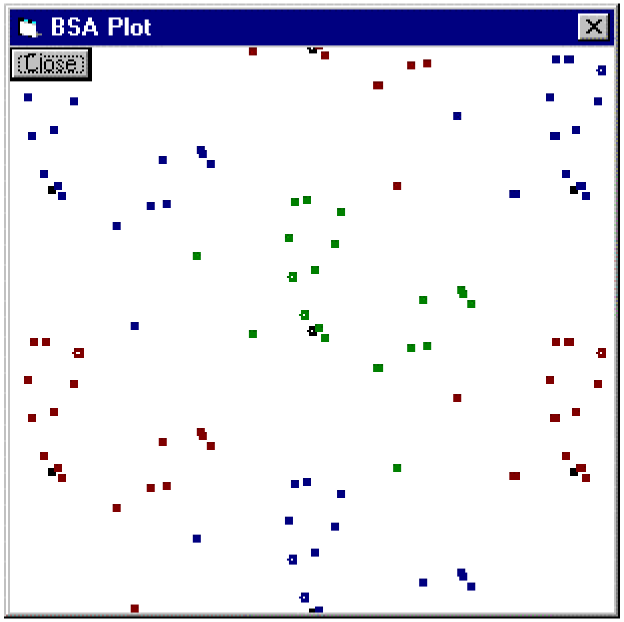


- Multiplicity of Effects
  - Interference (Near/Far)
  - Signal Correlations (Leakage)
- Must Consider Near and Some Far BSAs

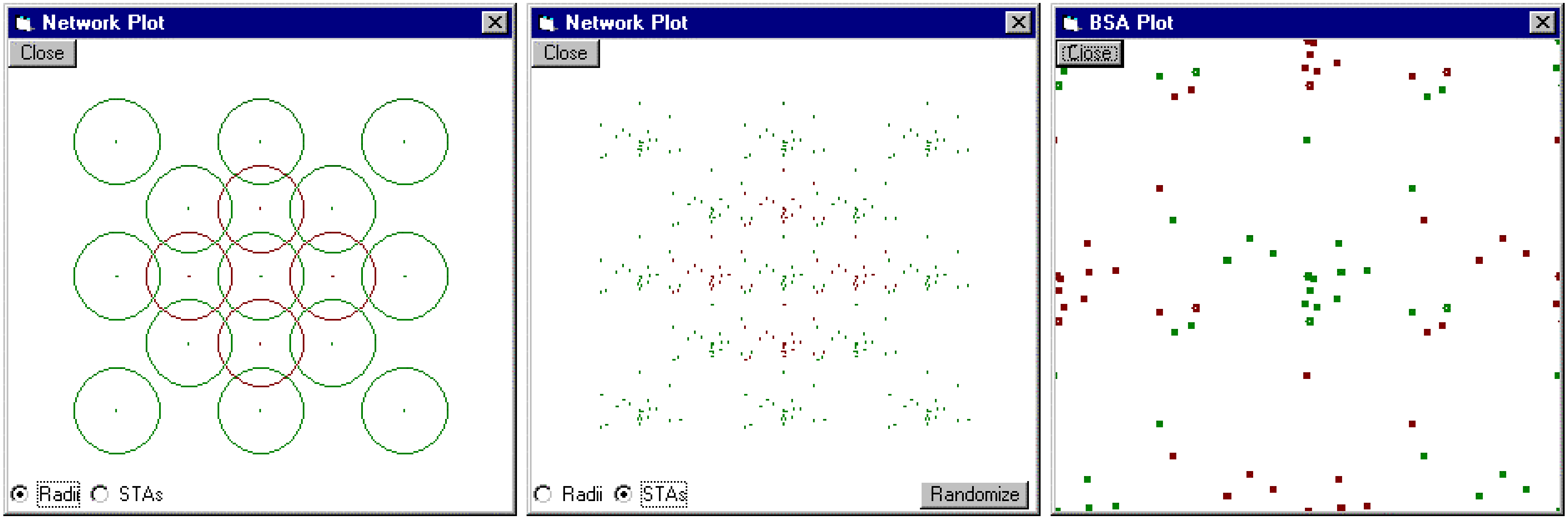
Typical 3-Frequency Deployment







Typical 2-Frequency Deployment



Typical Link Statistics

20 STAs/BSA 100-dB Path Loss Tol. 35-dB ACI Rej. 2450 MHz

Links in first 10-dB above Rx Threshold

Links in first 10-dB below Rx Threshold

Links more than 10-dB below Rx Threshold

Links within BSA_0

Links between Off-Frequency BSAs and BSA_0

Links between Off-Frequency BSAs and BSA_0

Current Link Statistics

Link Type Path Loss Bracket >	> 110	< 110	< 100	< 90	< 80	< 60
STAs to AP within BSA0				7	3	10
STAs to STAs within BSA0		2	12	64	89	23
Off-freq APs to AP in BSA0	4					
Off-freq STAs to AP in BSA0	80					
Off-freq APs to STAs in BSA0	80					
Off-freq STAs to STAs in BSA0	1556	38	5	1		
Same-freq APs to AP in BSA0	1	2	6	3		
Same-freq STAs to AP in BSA0	5	42	143	50		
Same-freq APs to STAs in BSA0	1	40	152	46	1	
Same-freq STAs to STAs in BSA0	113	943	2715	995	31	3

Re-Randomize Links Re-Randomize Positions & Links

2 frequency channels

BSA Traffic Model

- STA-to-AP and AP-to-STA Only (no peer-to-peer)
- 20 STAs Each Offer Poisson Traffic λ Frames/s
- AP Offers 20 λ Frames/s
- 1024-Bytes Frames
- AP Contends with STAs (no CFI)
- All BSAs Carry Same Traffic Load (by symmetry)

Generalized Throughput Equations

- Detailed Balance

$$(1-p_m) l_m \left(\overline{T} \quad + \overline{T \quad} \right) = p_m \frac{P \quad {}_{\_Collision} P_{Xm}}{\{k,1\}_{\max}}$$

- Aggregate Queued Traffic

$$k = \sum_m p_m \quad \rightarrow \quad \overline{P} \quad {}_{\_Collision}, \overline{T}_{BO}, \overline{CW}$$

- Average Contention Parameters
- Compute Throughput

$$S = \sum_m (1-p_m) l \; {}_m$$

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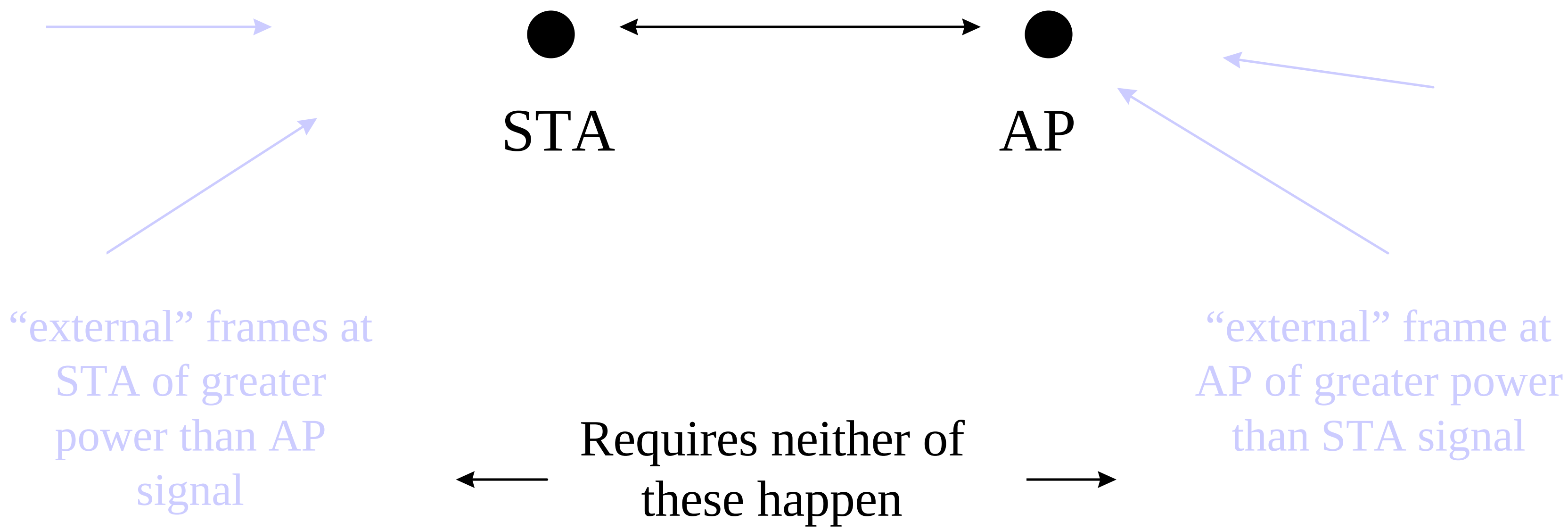
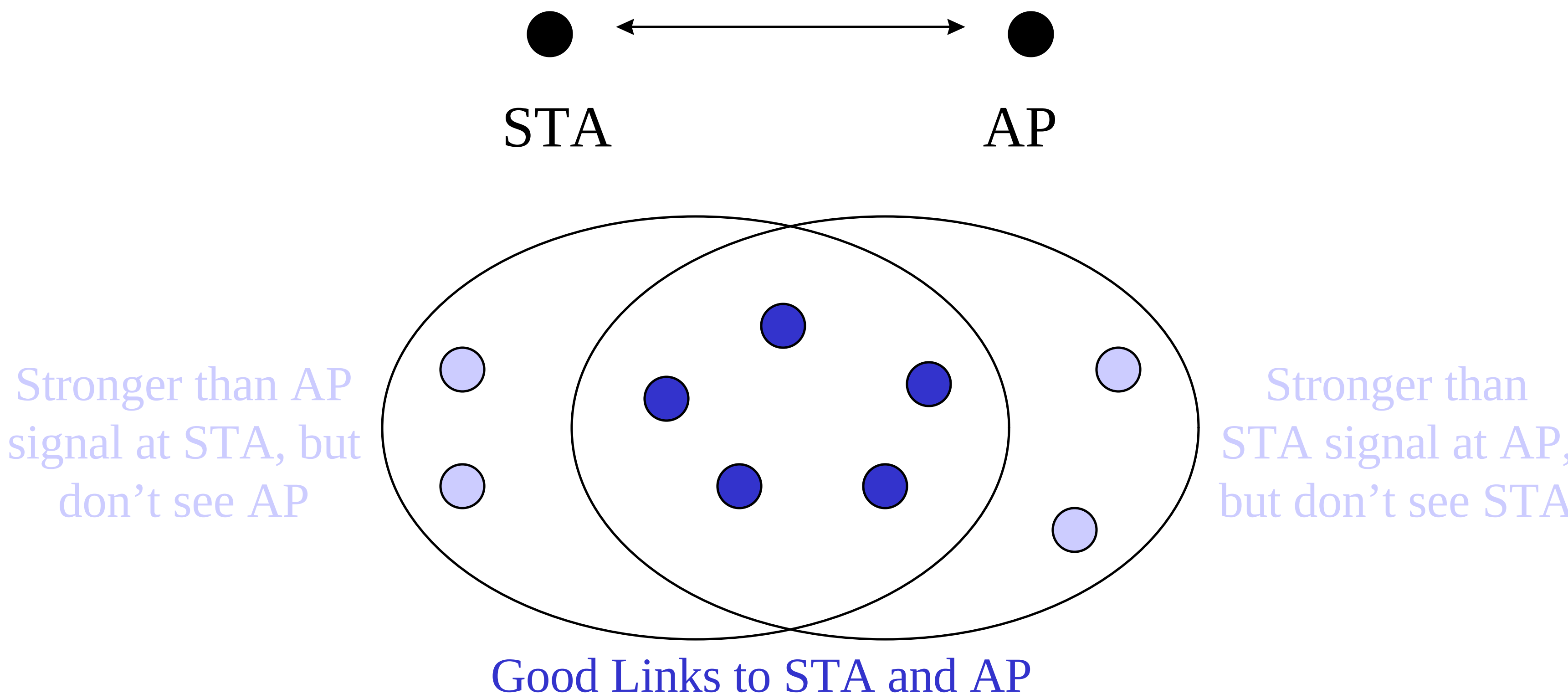
- What is $\frac{P_{Xm}}{\{k,1\}_{\max}}$?

P_{Xm} for Uncorrelated Codes

For successful Exchange, Data Frame and ACK Must Get Through

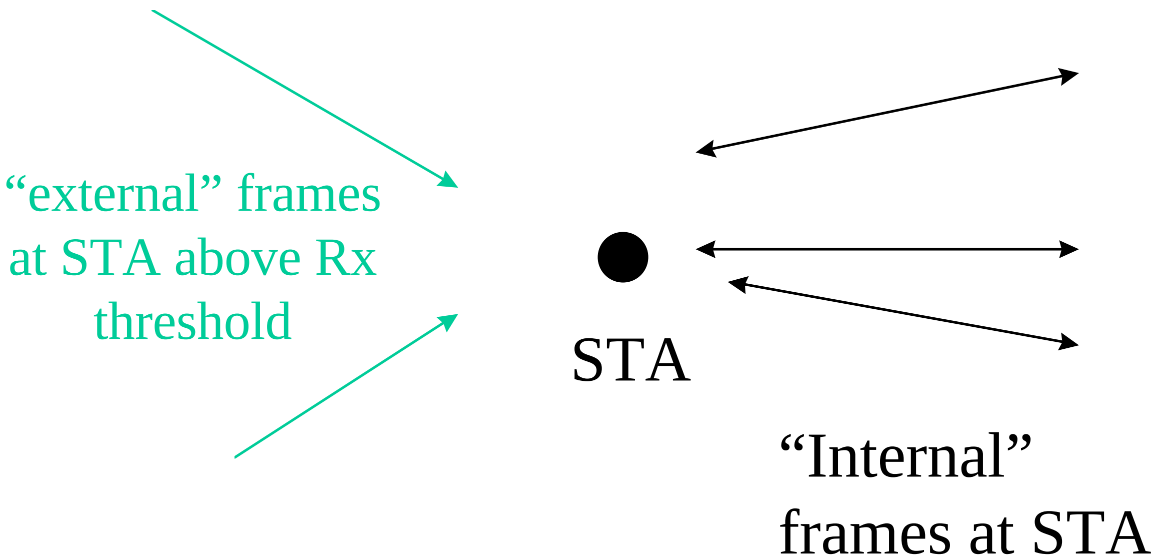


P_{Xm} for Single Code



Hidden external STAs cause interference (handle as in many-code case)

Effect of Leakage for Single Code

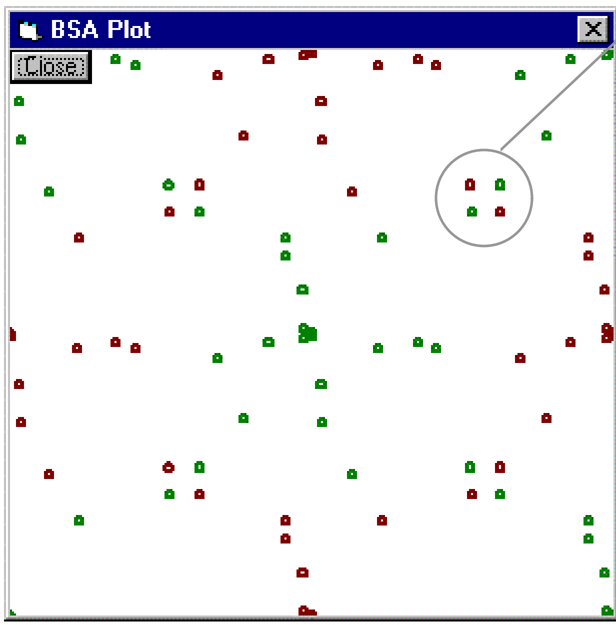


$$\frac{P_{Xm}}{\{k,1\}_{\max} + k_{Xm}}$$

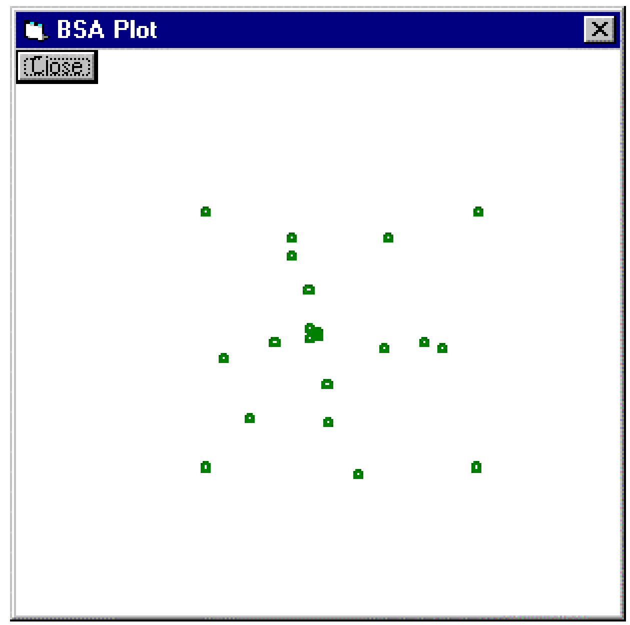
Include effect of queued traffic as seen by each STA individually

Random Deployment made Worse

Cluster in bad corner
(4 by symmetry)

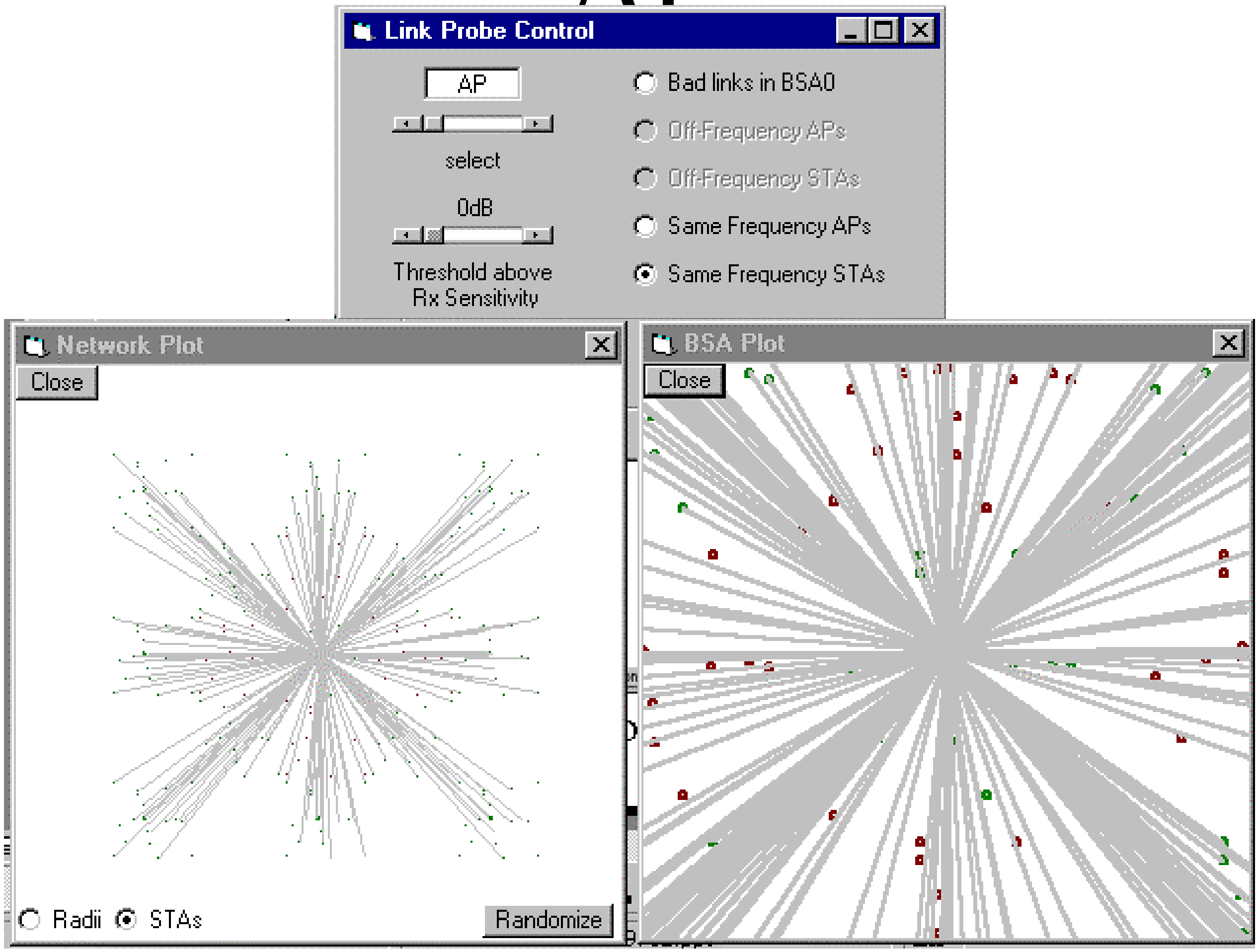


All Units



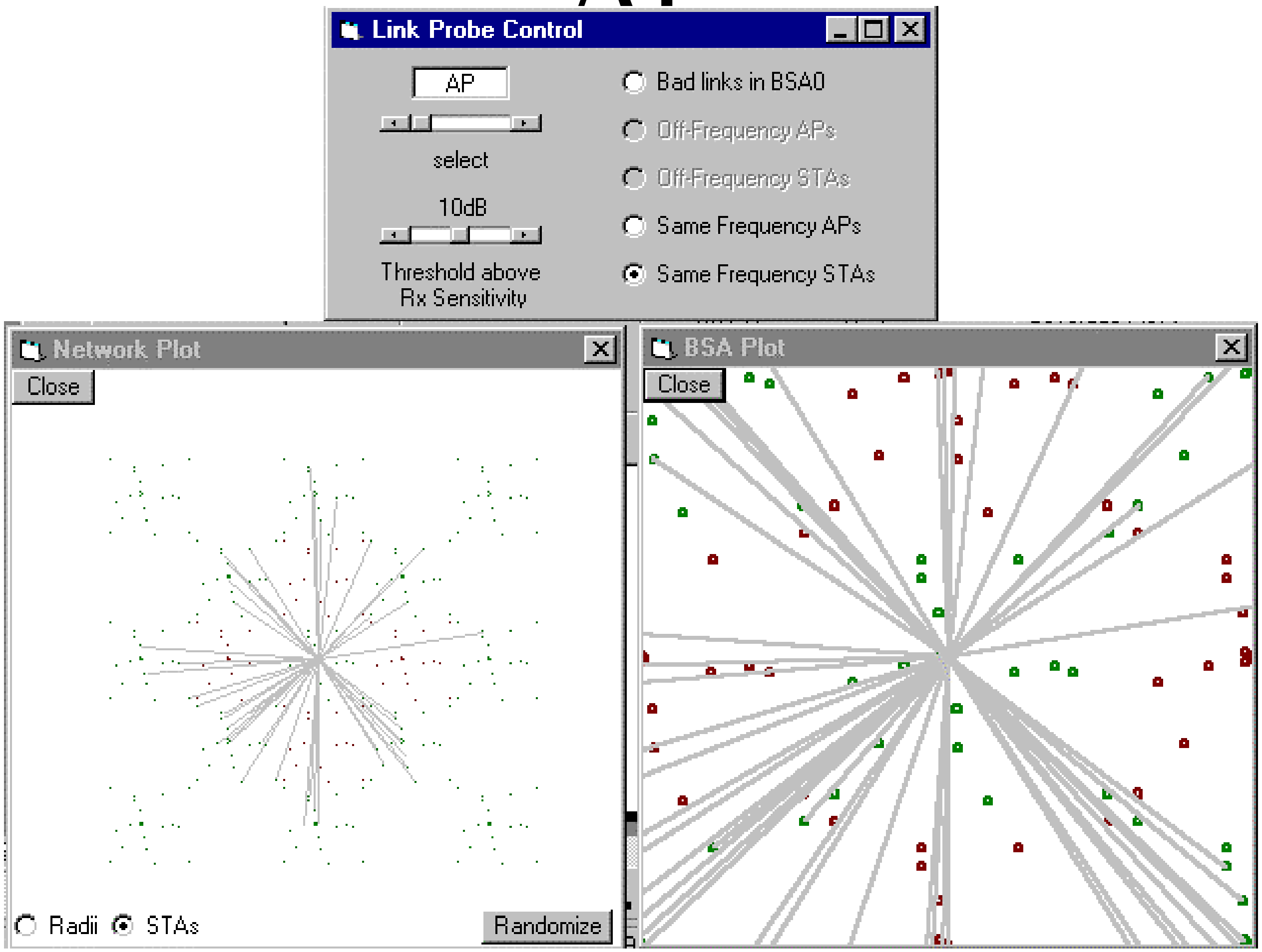
BSA_0 Units Only

Ext. STAs above Rx Threshold at AP



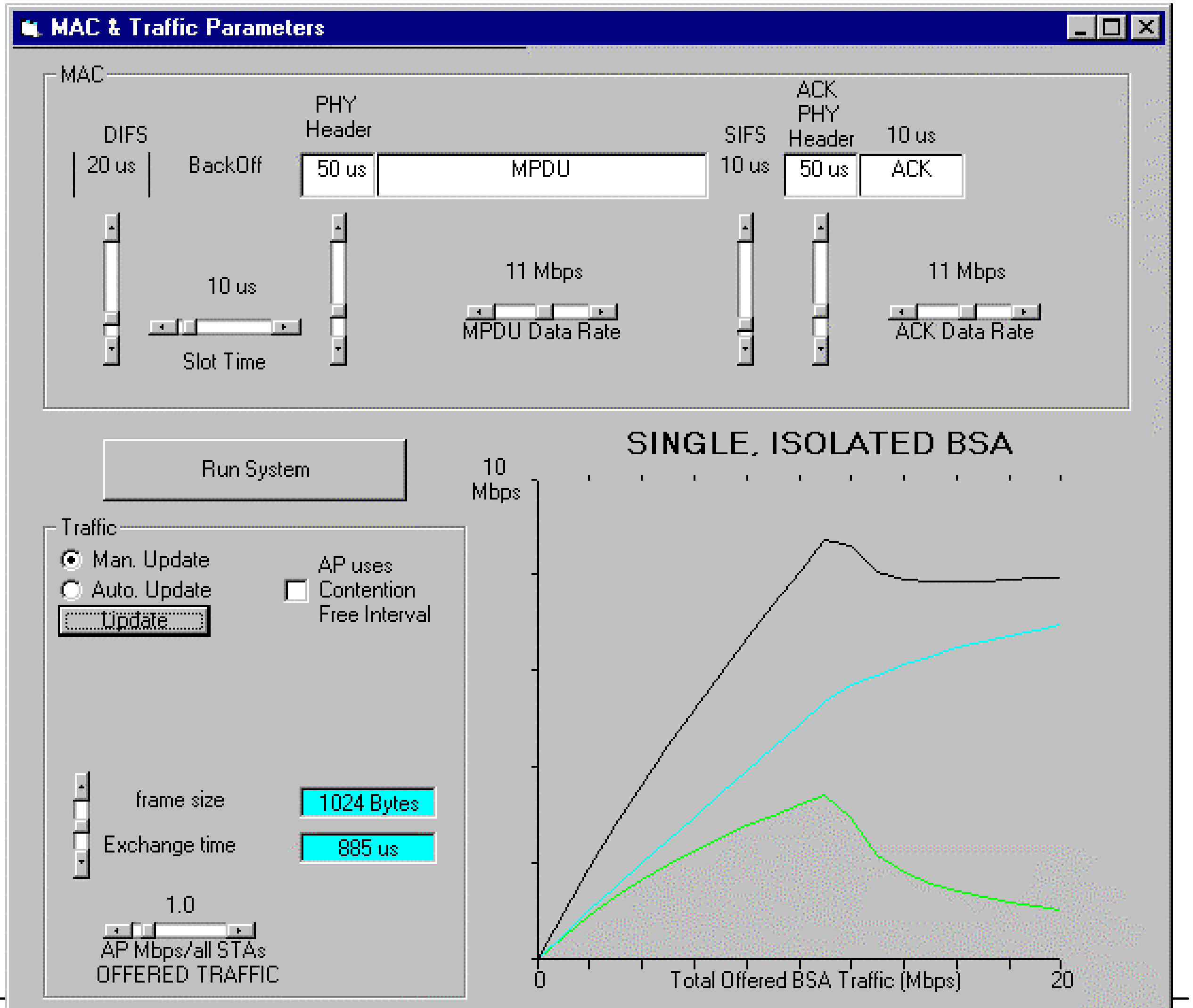
They can be from quite a distance!

STAs 10-dB above Rx Threshold at AP



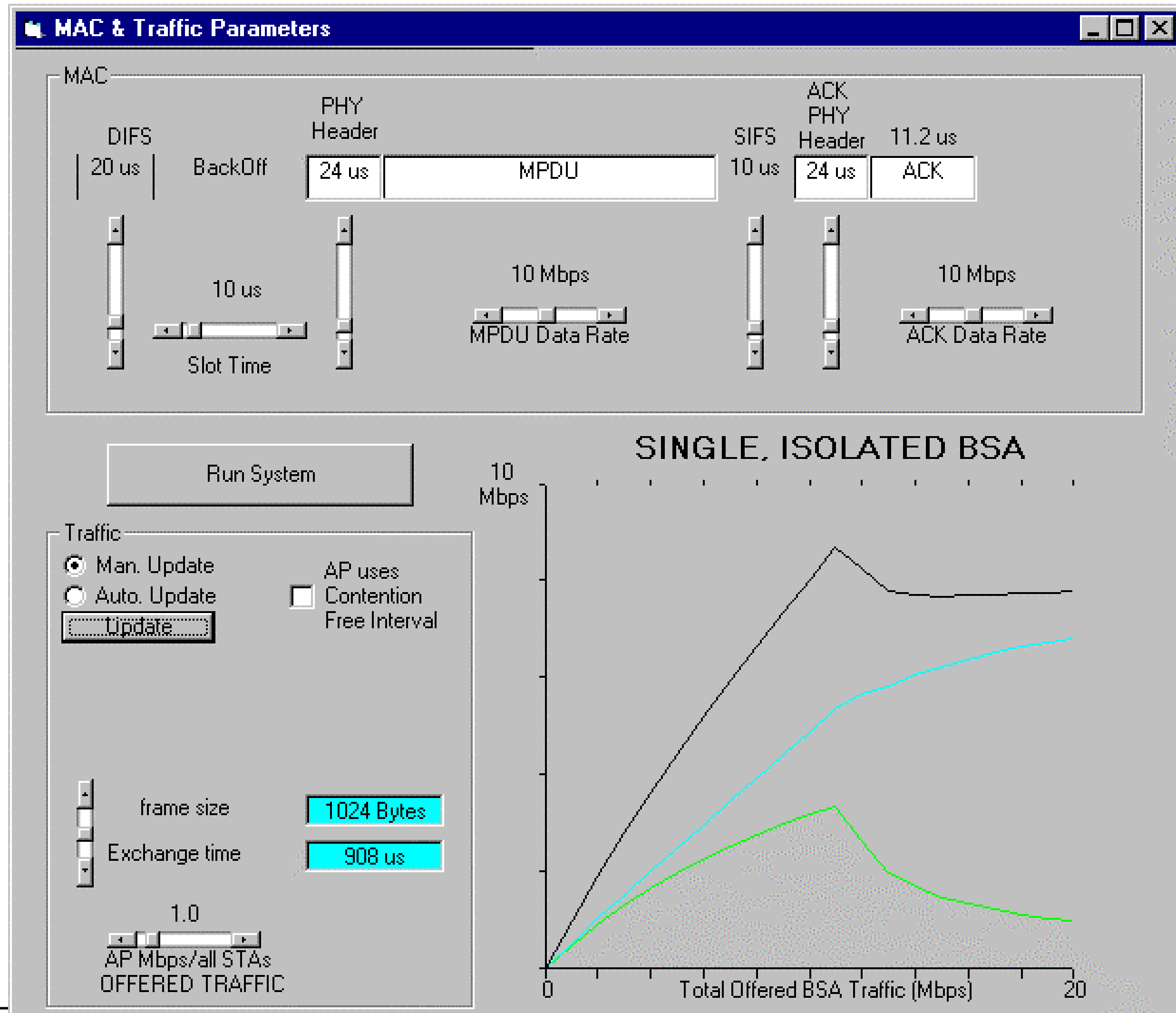
Isolated BSA: Case 1

3 Frequencies
1 Code
SNR_{in}=8dB

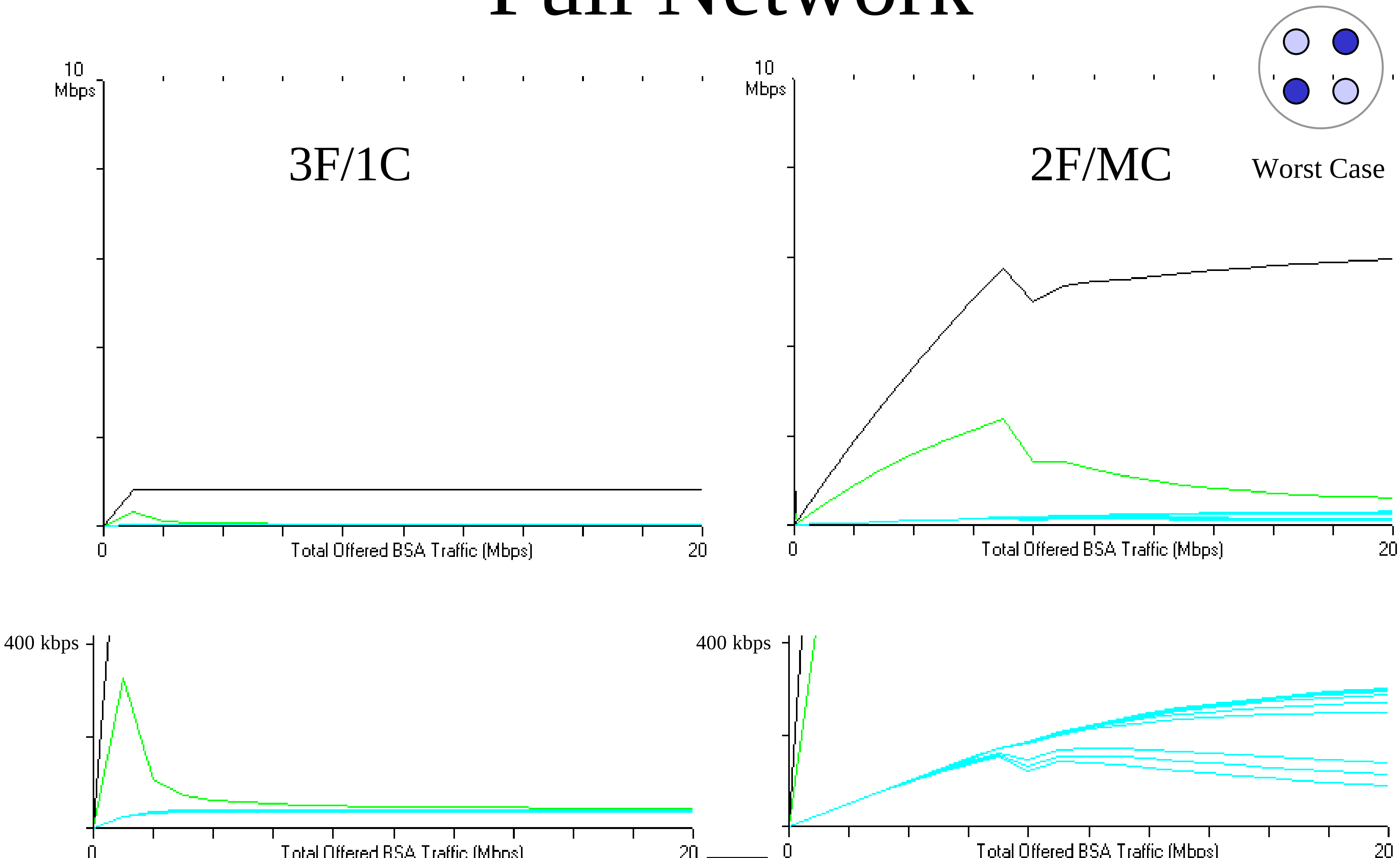


Isolated BSA: Case 2

2 Frequencies
Many Codes
SNR_{in}=2dB

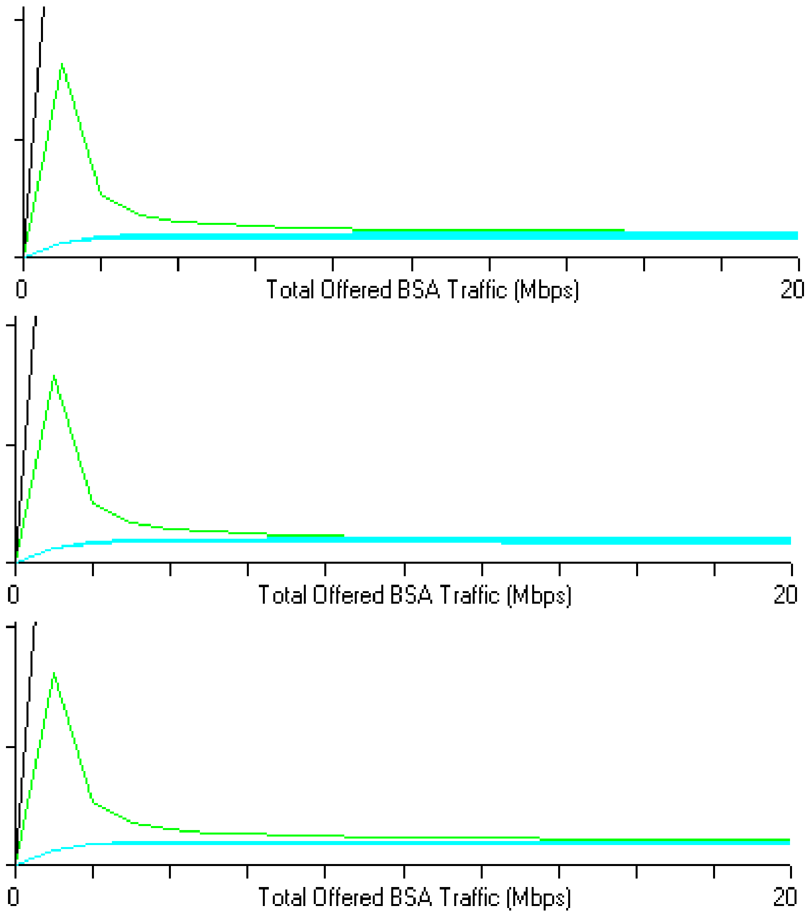


Full Network

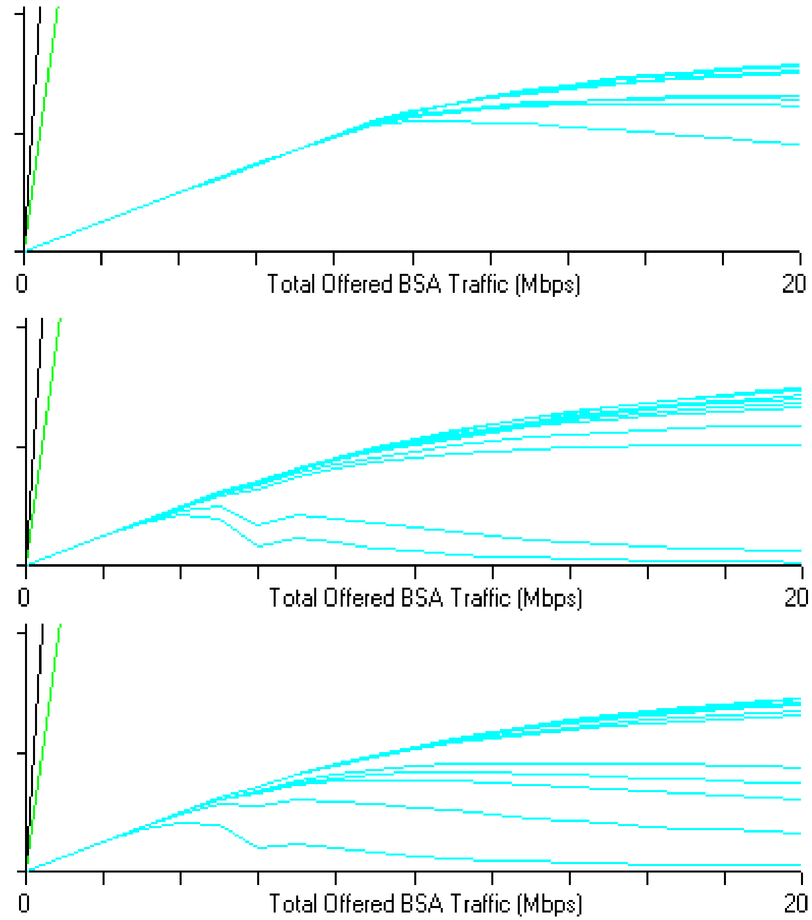


Random Placements

3F/1C



2F/MC



Summary

- Case 1
  - 3 Frequency Channels, Single Code, SNR_{in} = 8 dB
- Case 2
  - 2 Frequency Channels, Many Code Channels, SNR_{in} = 2 dB
- 19 BSAs, 20 STAs + AP per BSA
- Use of Code Channels Offers Greatly Improved System Throughput by Isolating Leakage