The Three ‘A’s of Communications – Radar Spectrum Sharing

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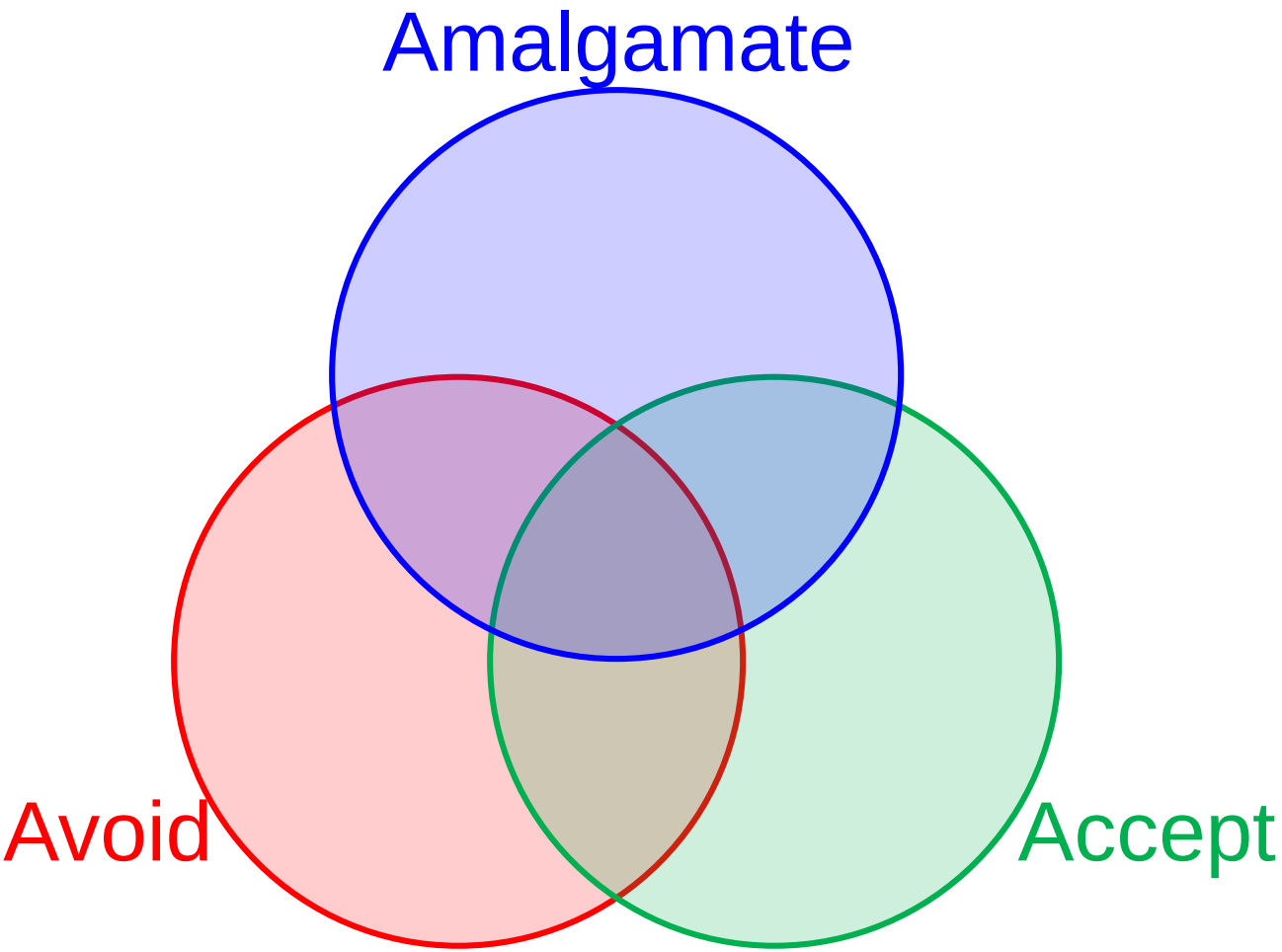
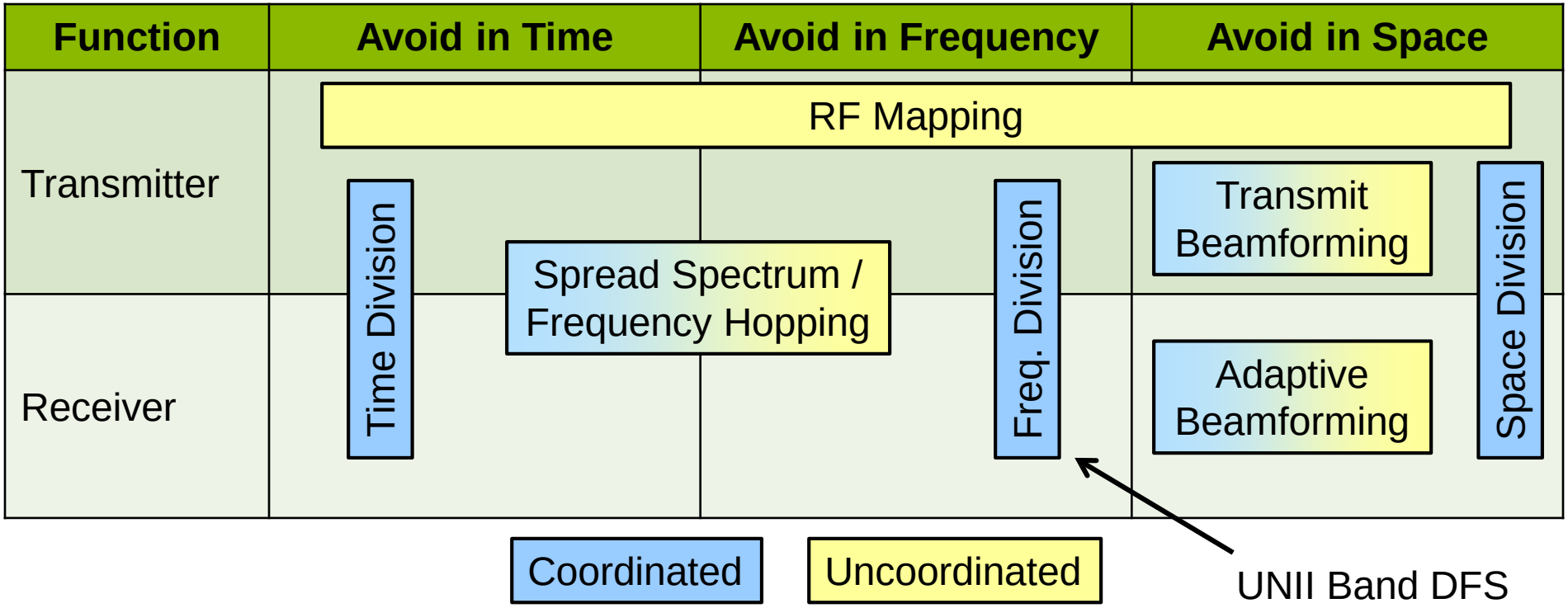
Taxonomy of Spectrum Sharing



Avoid

- Most common approach to radar-communications spectrum sharing
- Basis for most ‘Cognitive Radio’ spectrum sharing systems



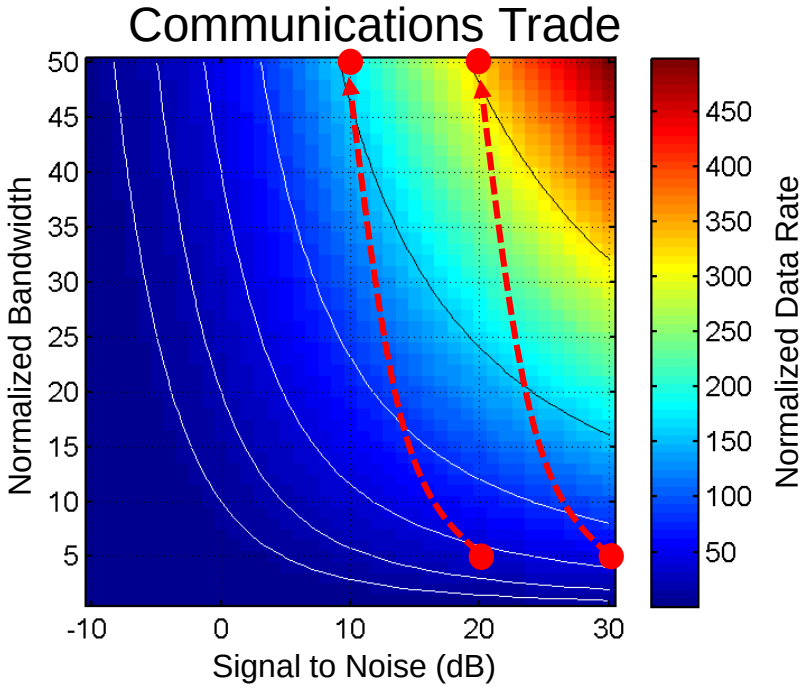
- Layering techniques increases spectral reuse and/or robustness…
- … but increases complexity

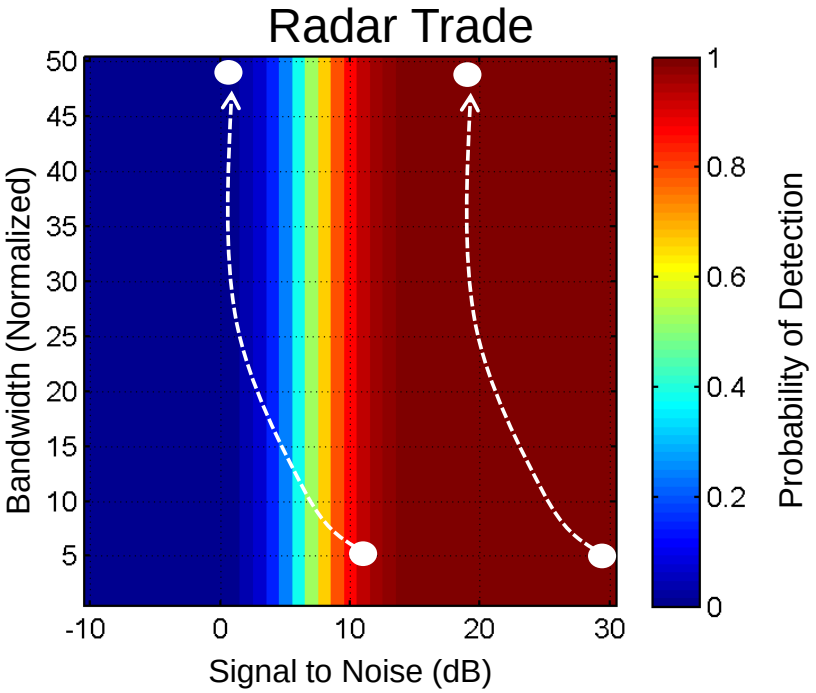
Accept

- The basis of many communications systems

$$\text{Spectral Efficiency} = \log_2(1 + SINR) \text{ b / s / Hz}$$

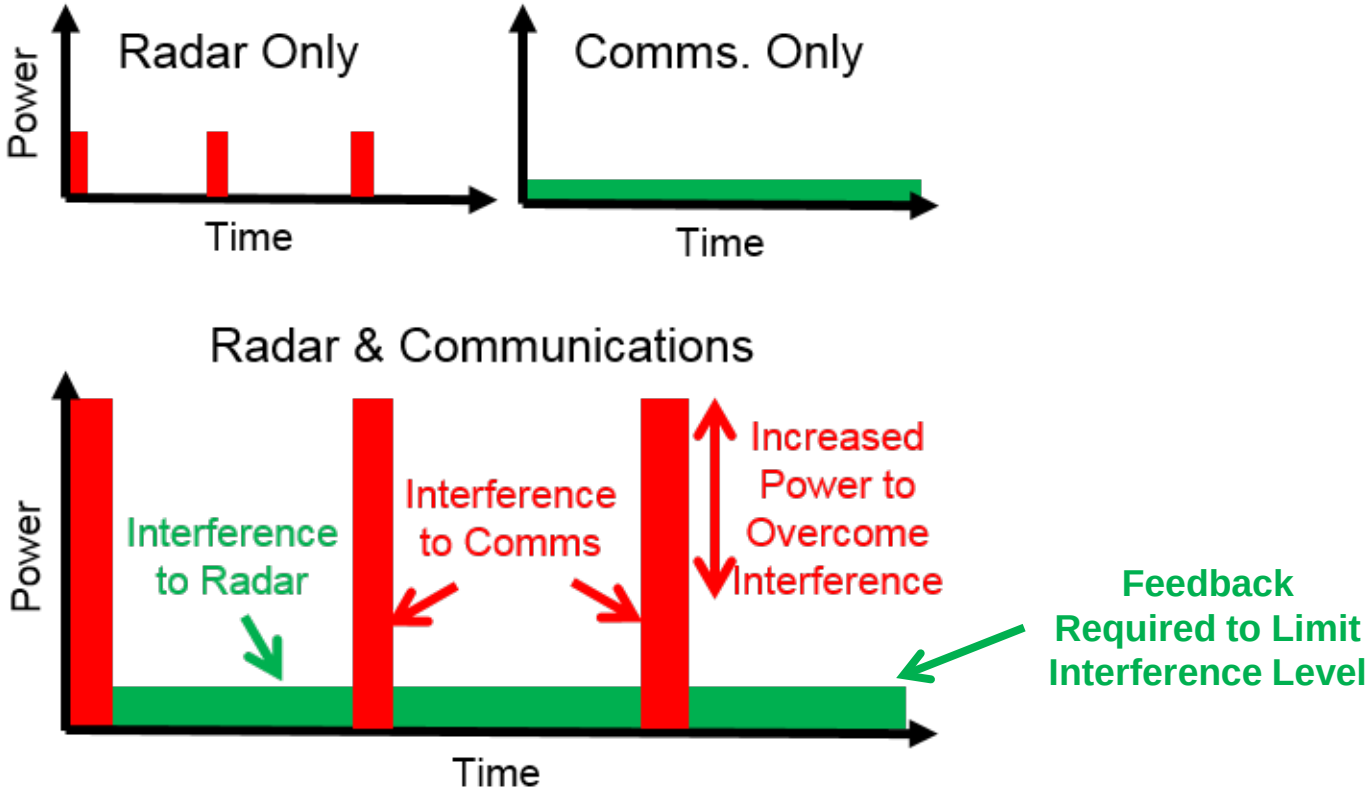
- Giving up SINR in return for either bandwidth and/or time is usually beneficial for a communications system (e.g. spatial reuse in cellular & WiFi)





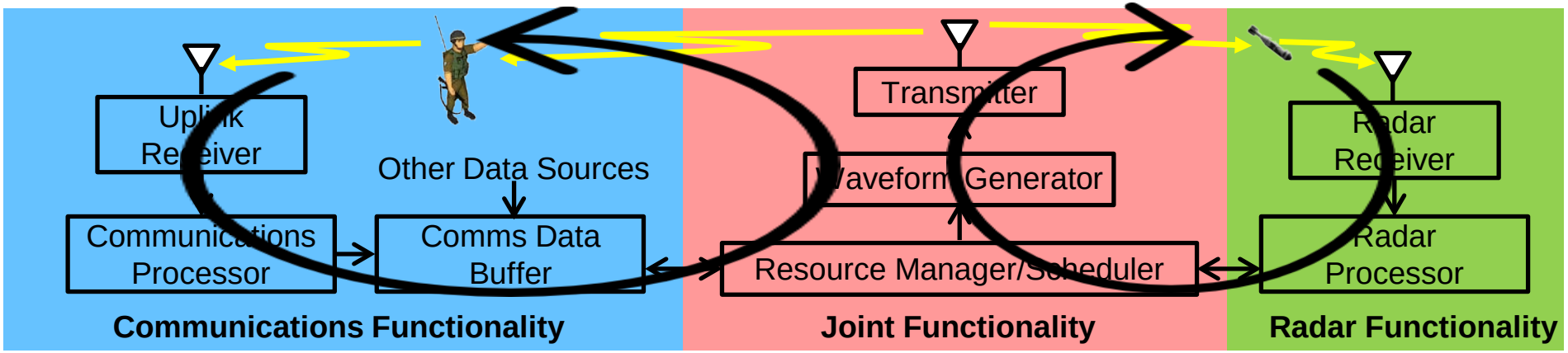
- Giving up SINR is never beneficial for a radar system, though in some regimes (when the PD is very high) the degradation may be negligible
- Communications often bandwidth limited, radar usually energy to noise limited

Example Accept Scenario



- Accepting radar interference may be mutually beneficial
  - Accept 10 dB more interference if comms pays for more than 10 dB more radar power aperture
  - Communications only sees high interference during the ~10% transmit duty factor
  - Overcome with forward error correction coding
- A spectrum sharing solution is building bigger more powerful radars!

Amalgamate



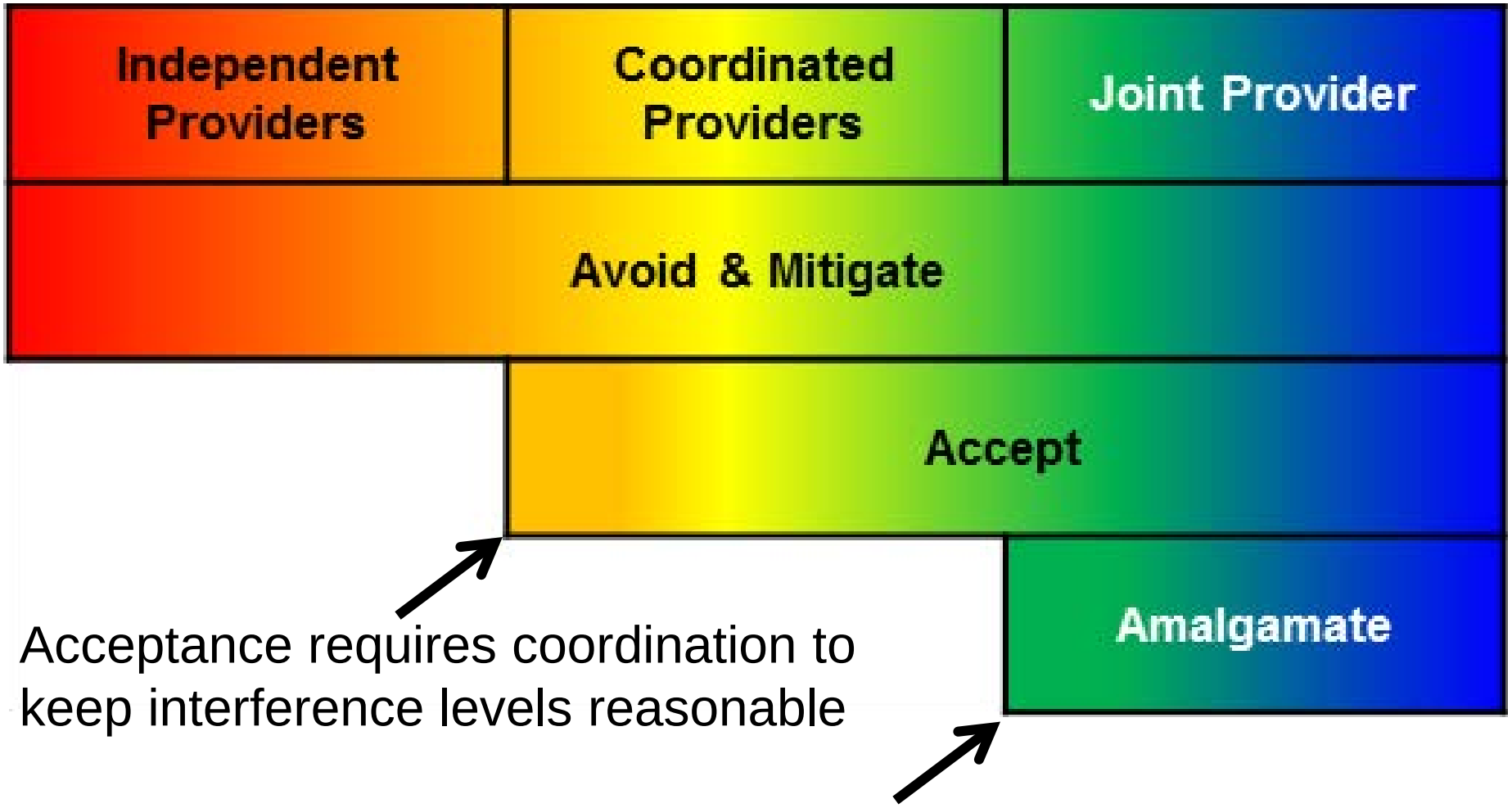
- Synergistic combination of radar and communications
- Radar and communications use the same waveform
- Early 2000's encoded data onto chirps achieving very low spectral efficiencies
- Intentional version of Passive Coherent Location (PCL)
  - Find a better balance between radar and communications in the choice of waveform

Combined Waveform Tradespace

Waveform Aspect	Radar	Communications
Amplitude Modulation	Reduced SNR	Higher Data Rate
Multi Carrier	Reduced SNR	Lower Complexity Higher NLOS Data Rate
High Duty Factor	Reduced Coverage (Overcome with STAR)	Higher Data Rate
MIMO	Better Resolution	Higher NLOS Data Rate

- Constant envelope waveforms maximize transmitted power – better SNR
- Radar prefers low duty factor (or needs simultaneous transmit and receive)
  - STAR is a useful technology for both radar and communications
- MIMO techniques are good for both radar and communications

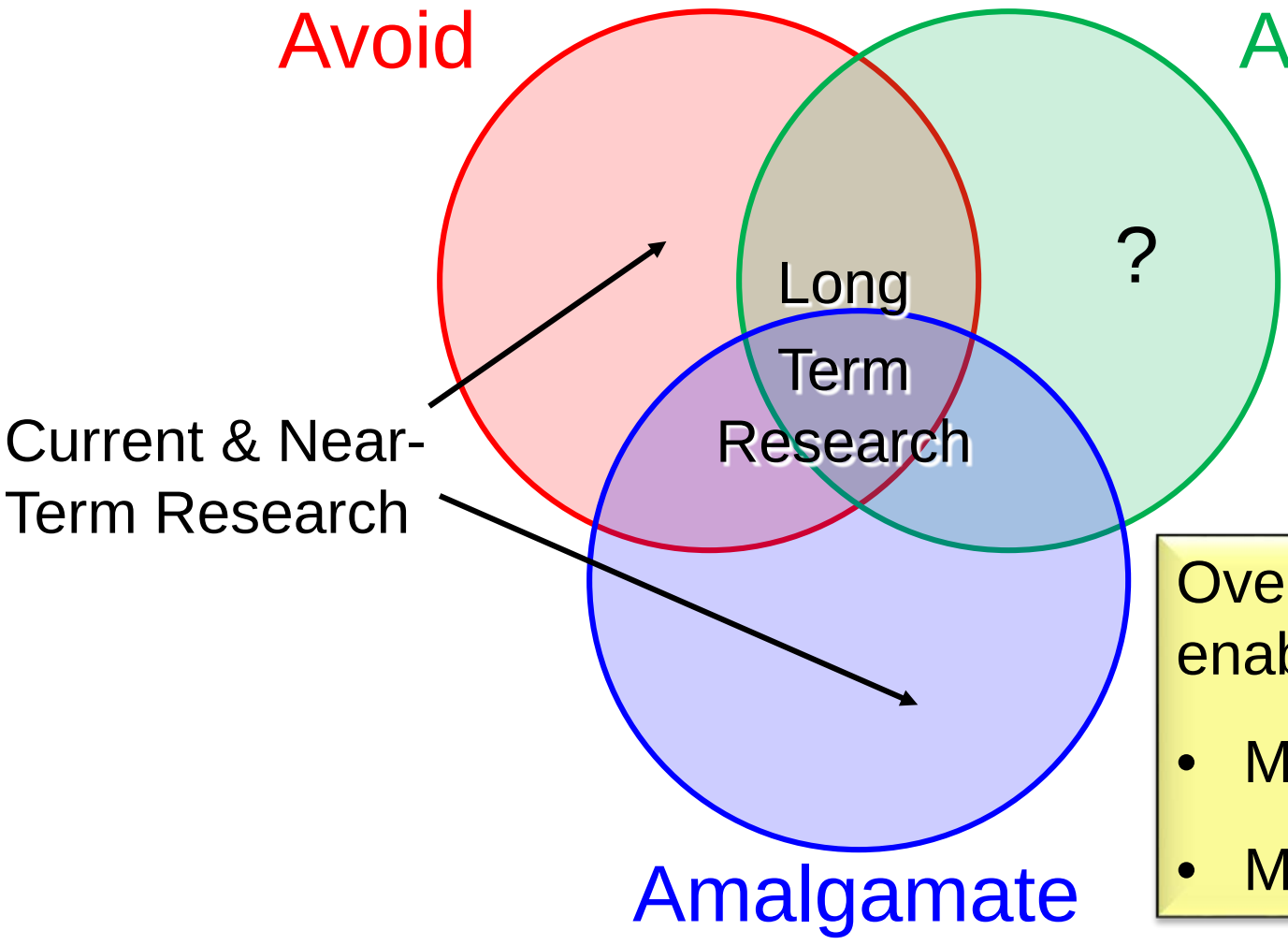
Business Cases



Acceptance requires coordination to keep interference levels reasonable

Amalgamate's common transmitter requires the tight integration that is possible with a joint provider.

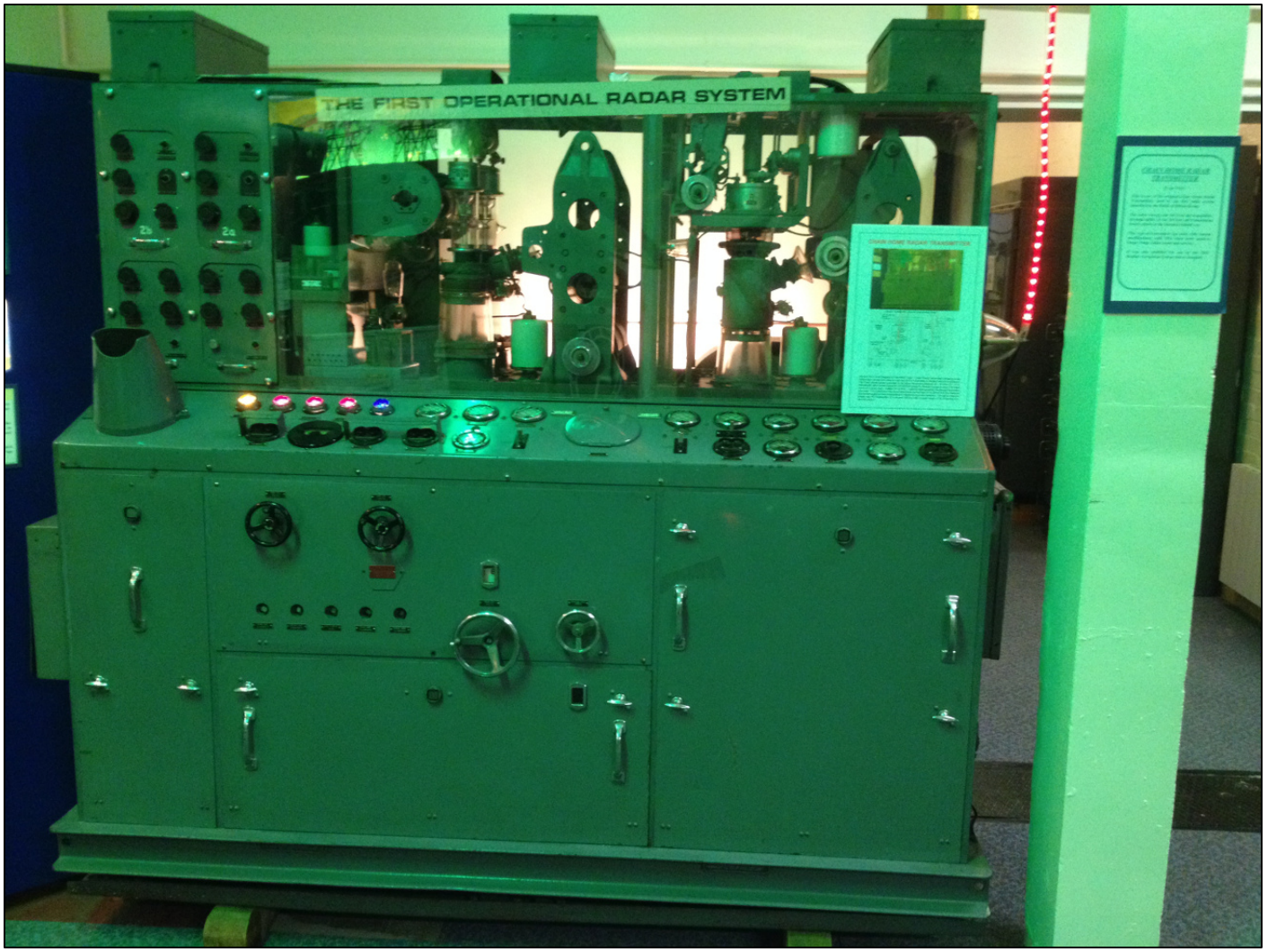
The Future of Radar-Communications Spectrum Sharing



Overlap regions will enable:

- More data and/or
- More robustness

We’ve Come A Long Way….



… But We’ve Also Come Full Circle