



The Case for Receiver Standards and Regulations

Dennis A. Roberson

Vice Provost and Research Professor

Illinois Institute of Technology

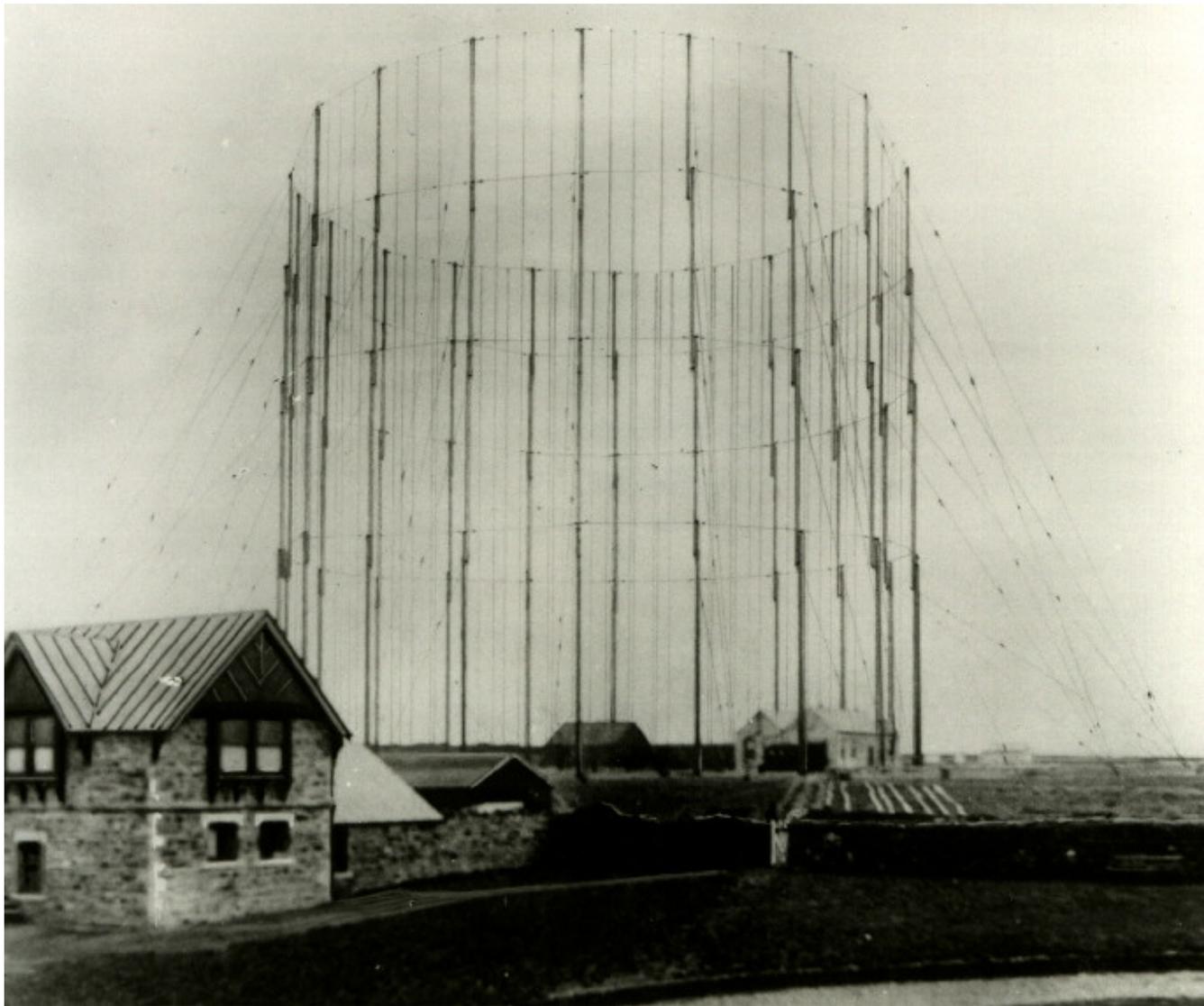
Disclaimer

- The thoughts expressed in this presentation are purposefully presented in a provocation manner to stimulate discussion and to fully acknowledge the “Elephant in the Room”.

Wireless Systems

- Wireless communications only exists when transmitters are properly and harmoniously connected to receivers. Both elements of the system contribute significantly to the success of the communications.
- Initially there was no competition for the spectral resource so wireless systems used a “spark gap” approach showering the spectrum with energy impulses and looking for these perturbations with equally blunt receiver instruments.

1901 Guglielmo Marconi:
transatlantic radio transmission → “S”



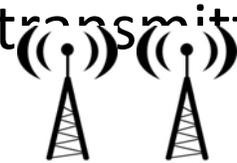
Wireless Systems (cont)

- As Discrete wireless systems (AM/FM radio, TV, public safety radio, cellular, Wi-Fi, Bluetooth...) emerged, an ever more complex environment of STANDARDS based SHARING was required initially focusing on frequency, power and geographic allocations and more recently on time and ultimately on a dependency on various orthogonal codes and diversity approaches.
- To date we have been able to manage this sharing by placing restrictions (standards and regulations) on the transmitter since it is the visibly active side of the system.

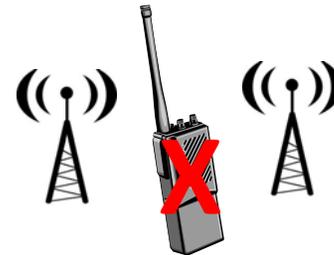
Unfortunately: Fundamental Radio Coexistence

Concept 5

- The transmitter for a desired signal is completely unaffected by the existence of an interfering transmitter.



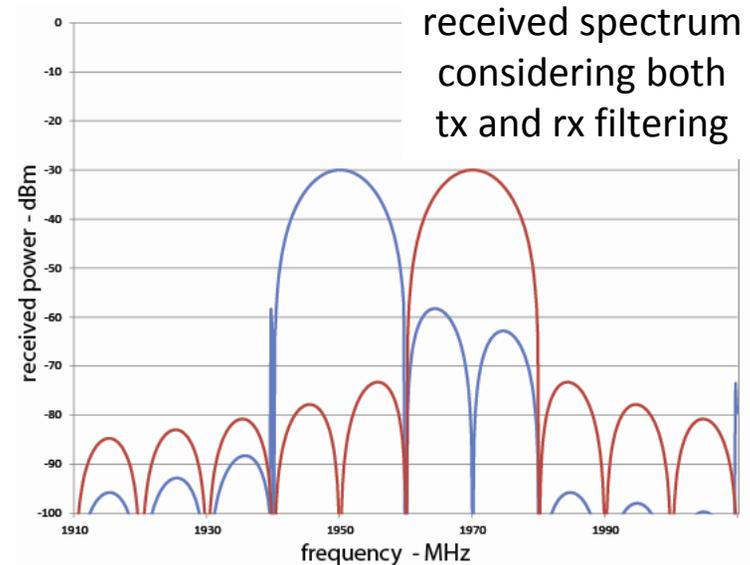
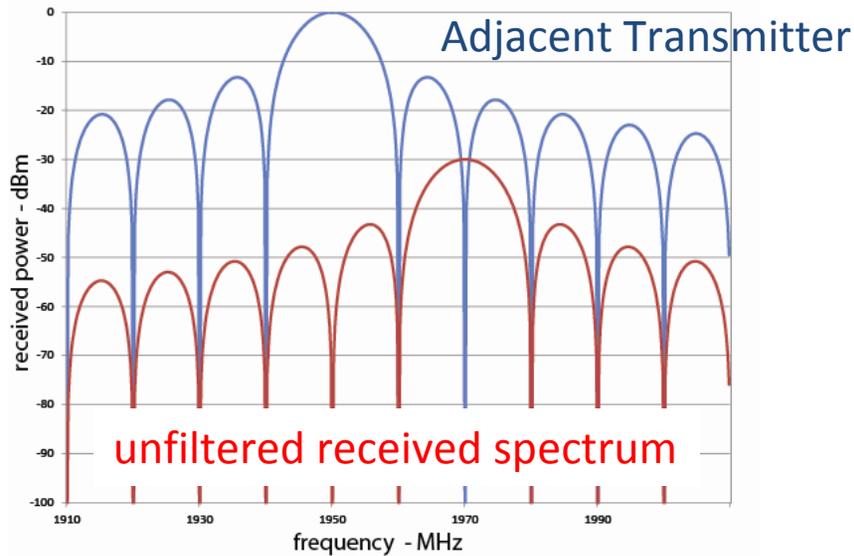
- The receiver for a desired signal is highly affected by the existence of an interfering signal.



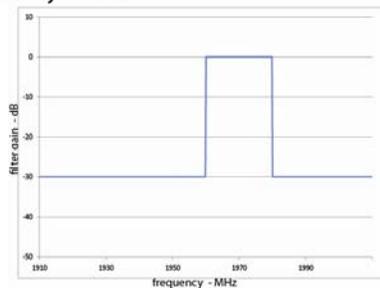
→ **interference exists only at the receiver**

- Interference mitigation and spectrum sharing techniques affect the receiver AND the transmitter and can involve spatial, spectral, temporal, coding and diversity techniques to achieve the desired result .

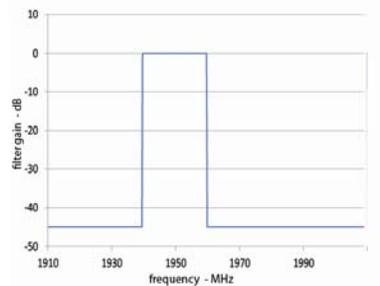
Strong Interferer on Adjacent Channel



receiver filter



transmitter filter



In this example, receiver out-of-band attenuation appears insufficient with respect to the very strong interferer.

Receiver performance degradation due to very strong adjacent channel interference must be mitigated by BOTH transmitter AND receiver design!

Observations

- Radio operation is a systems game with transmitters and receivers cooperating to peacefully coexist while meeting user requirements. Ideally, all transmitters AND receivers across the spectrum, i.e. all systems would similarly cooperate to enable the optimal use of the scarce spectrum resource.
- In Session 4 we observed several of the sever challenges that have been created largely because we haven't had standards for receiver performance. We cannot continue to allow this kind of uncertainty and inefficiency to exist, especially in the emerging world of dynamic spectrum sharing.
- In Session 5 we observed that most major systems already have well established, detailed standards (cellular, public safety, aviation, DTV)

Conclusion

- Given the ever more crowded airways and the need for vastly more efficient use of the spectrum, it is time to take the next major step in spectrum management efficiency improvement by addressing the fundamental receiver issue “head on”.
- We must move to a regime of certifiable receiver standards and associated regulations that protect the rights of compliant receivers, provide a level of certainty to entrant systems and especially the new class of dynamic sharing entrants, and grant no rights to rogue receivers that fail to comply with the basic standards that they will in the future be required to meet.
- This is good for the industry and more importantly good for America’s stewardship of the use of one of its increasingly precious natural resources, its Spectrum.