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Filter Bank Ultra-Wideband Communications

September 2024

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Changing the World's Energy Future

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Filter Bank Ultra-Wideband Communications

Battelle Energy Alliance manages INL for the U.S. Department of Energy's Office of Nuclear Energy

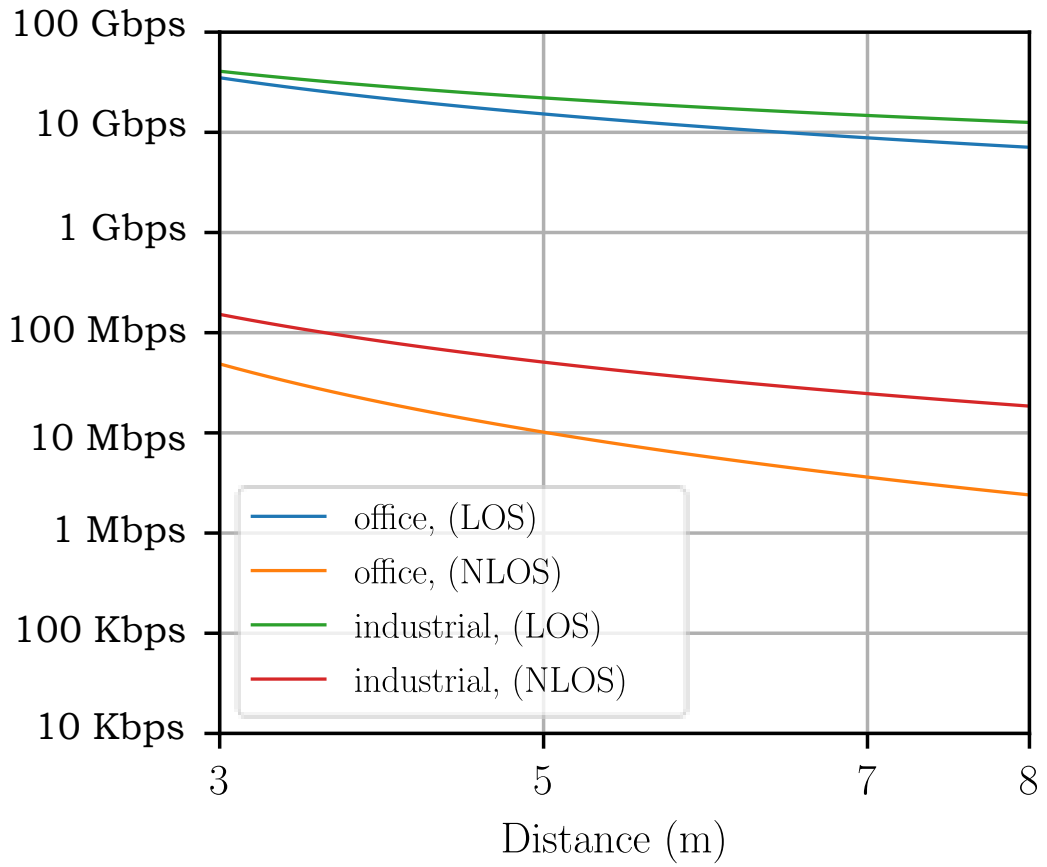
Idaho National Laboratory

What is missing here?

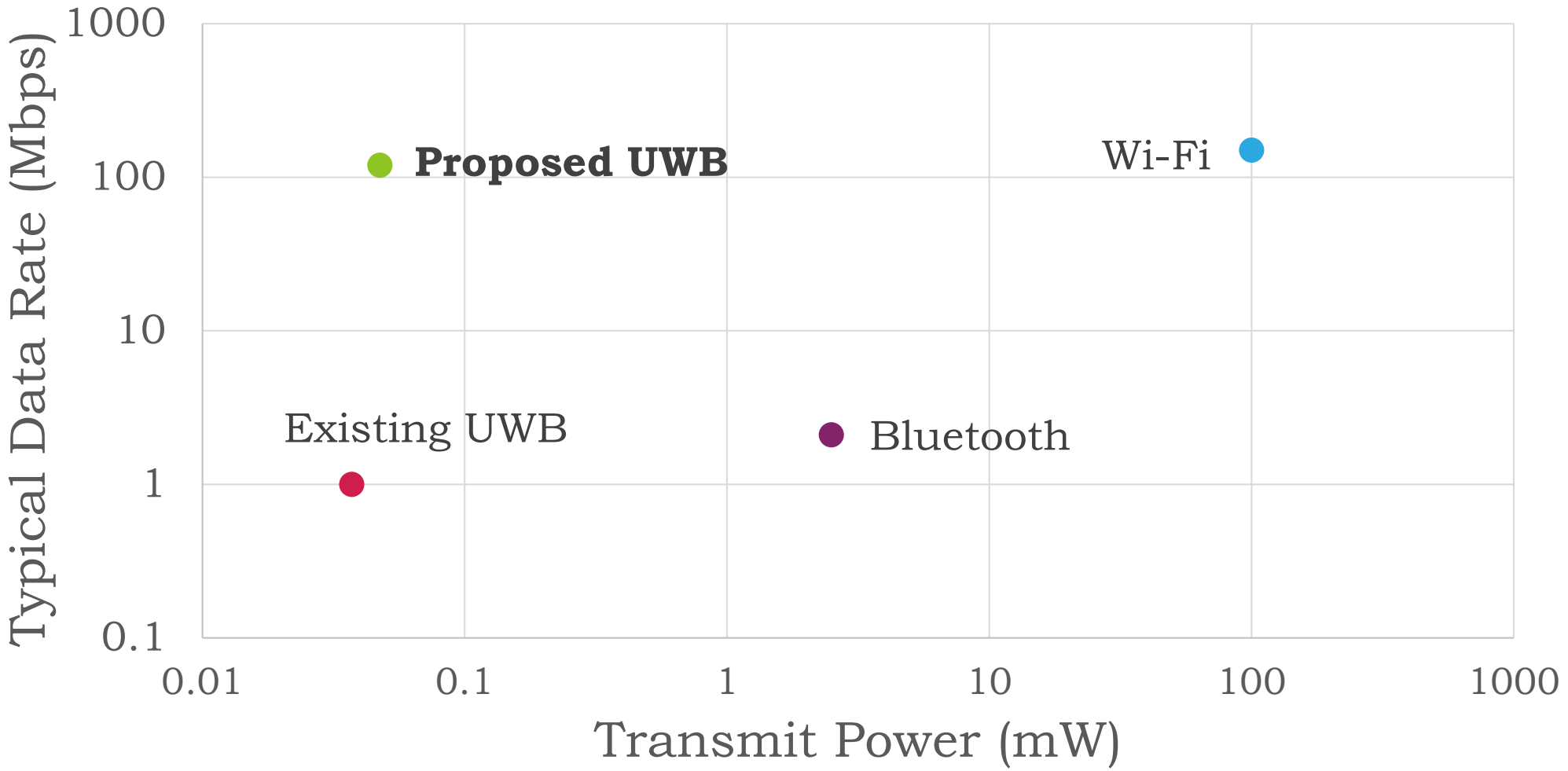
- Wires!
- Imagine wireless systems supporting 4K video streams in
  - Offices
  - Home theaters
  - High-rate sensor networks
- Ultra-wideband (UWB) technology has this potential

UWB technology can have large impacts on consumer and government communications.

- Over short ranges, UWB offers:
  - High data rates (≥ 1Gbps)
  - Low transmission power (≤1mW)
  - Spectrum reuse
  - Less observable transmissions

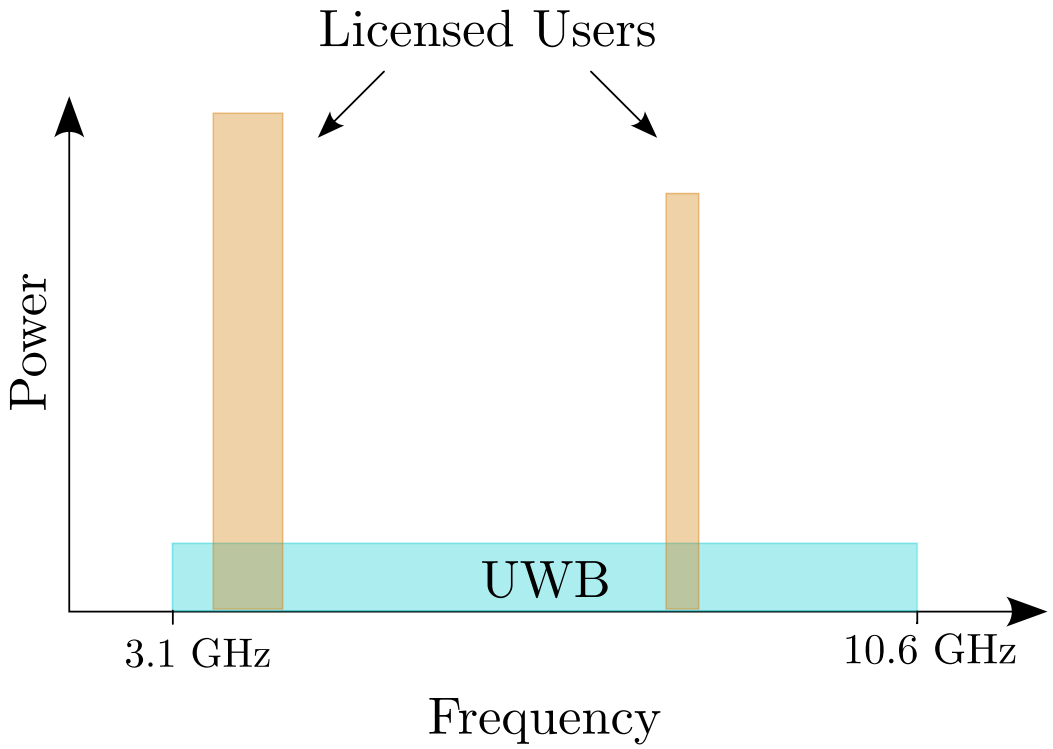


UWB is a low power, wideband class of wireless systems.



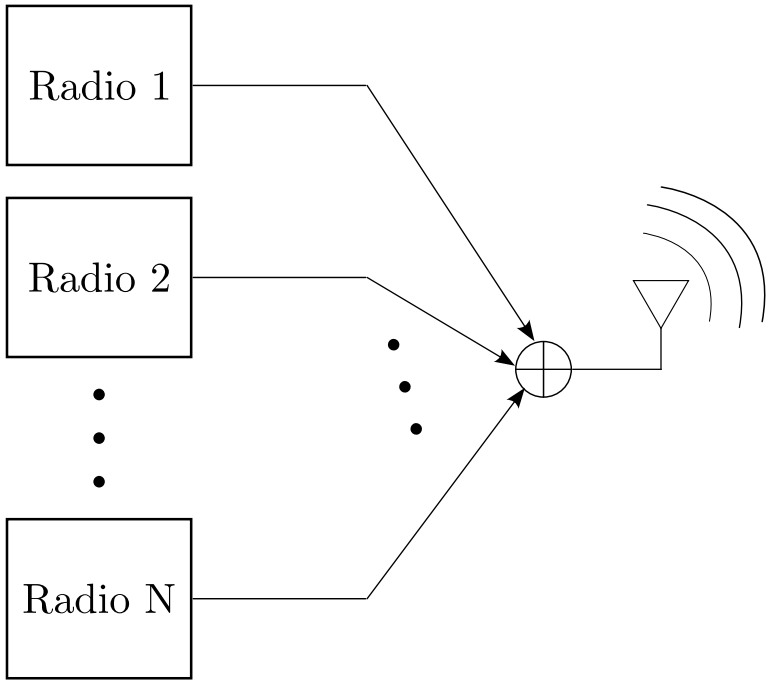
The UWB operating environment has several challenges that have limited the technology's use.

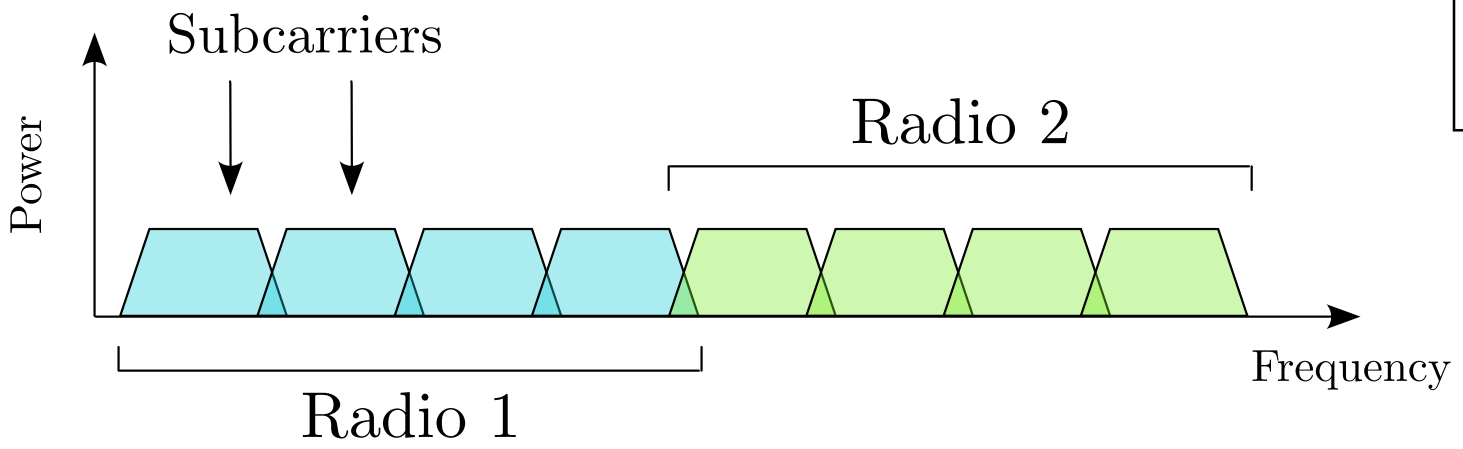
- High samples rates for digital implementations
- High power interference from other technologies such as Wi-Fi, cellular, and radar
- A harsh multi-path channel



An alternative technology based on filter banks can realize UWB's potential.

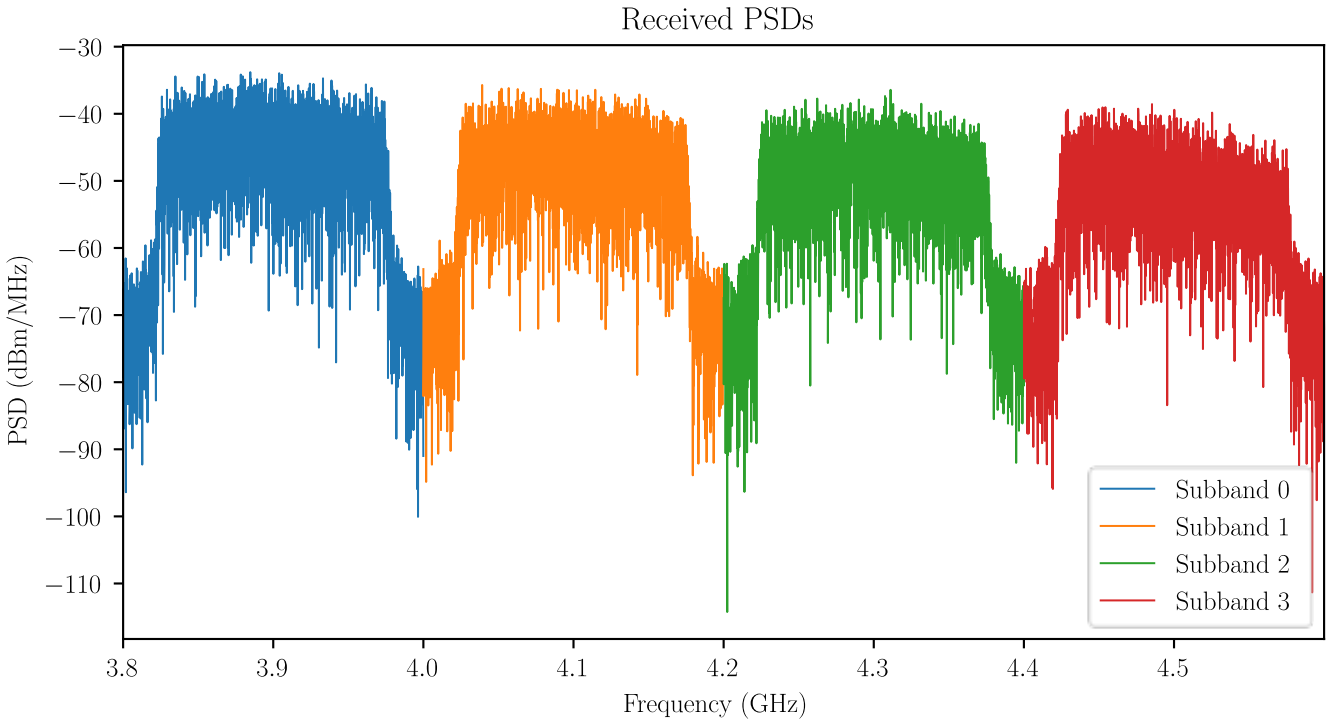
- Our approach is based on filter bank multicarrier (FBMC) communications.
- Sub-bands are synthesized and processed on separate radios.
- Each sub-band consists of many narrow subcarriers.





Filter banks are well-suited to address the harsh UWB operating environment.

- Spectrum partitioning results in
  - Power efficient A/D and D/A converters
  - Efficient, parallel digital signal processing solutions
- Straightforward narrowband interference suppression
- Low complexity channel equalization



Our research will culminate in the design and demonstration of a filter bank UWB system.

- **Current progress:**
  - Thorough study of UWB, filter banks, and multi-coding techniques
  - Initial system design
  - UWB simulation environment
  - Survey of the UWB interference environment
- **Next steps:**
  - Signal Detection
  - Receiver synchronization
  - Over-the-air demonstration

Summary

- UWB designs have the potential for
  - High rate, short range, low power communications
  - Spectrum reuse
  - Less observable transmissions
- Filter bank UWB has several useful properties
  - Spectral partitioning
  - Interference robustness
  - Low complexity channel equalization
- Impacts
  - Licensing opportunities and potential engagement with commercial industry
  - Potential low probability of detection government applications