



The background image is a composite of an aerial photograph of a desert landscape and a network diagram. The network diagram consists of various nodes connected by lines. Nodes include a CAOC (Command and Control Operations Center) on the left, a Gateway/Relay aircraft at the top, a RAIDER aircraft in the center, and a group of fighter jets in the bottom right. Ground units, including tanks and a building, are also shown. The lines connecting the nodes are colored blue, green, orange, and red, representing different communication links or data flows. The text 'Analysis of OFDM in VHF/UHF tactical MANETs with SDRs' is overlaid in the center in a large, white, serif font.

Analysis of OFDM in VHF/UHF tactical MANETs with SDRs

Iván Corral Viñas Gateway/Relay

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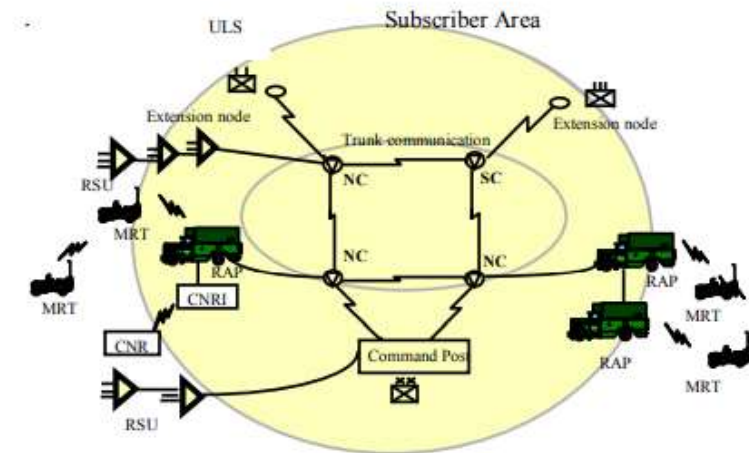
1. Introduction
2. Tactical MANETs
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4. OFDM in MANETs
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6. References



Introduction

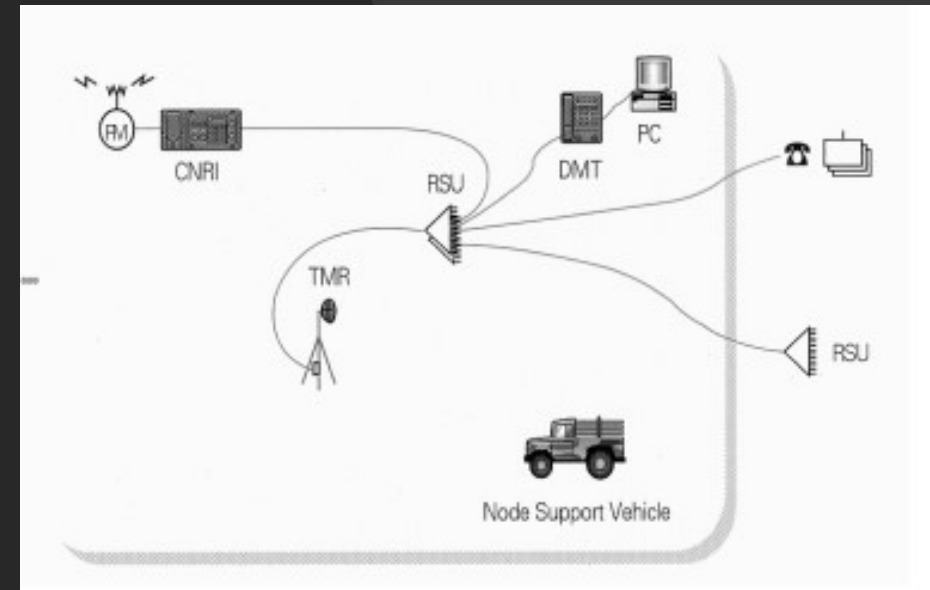
Tactical communications are military communications between two or more military units, including communications between different military ranks. This information is usually orders and military intelligence, which can be classified in voice, video or data.

- Mobility
- Security
- Availability
- Flexibility and interoperability



Introduction

- Data is sent from the Personal Computer (SDR)
- Remote Switching Unit routes the packets processed in the Digital Multirole Terminal
- Tactical Microwave Radio is the antenna



Everything over IP is one of the main requirements of the next generation of tactical MANETs.

For medium access, as nodes must share the radioelectric spectrum, techniques like OFDM and TDMA are used.

Tactical MANETs

A MANET is a dynamic and self-configuring network consisting of a collection of mobile nodes connected by wireless links.

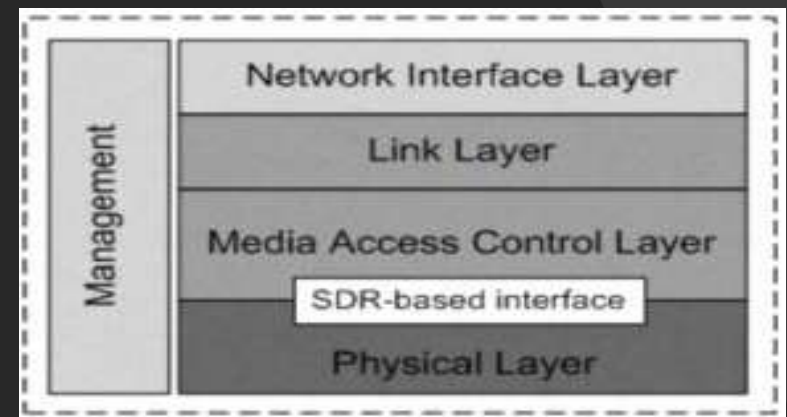
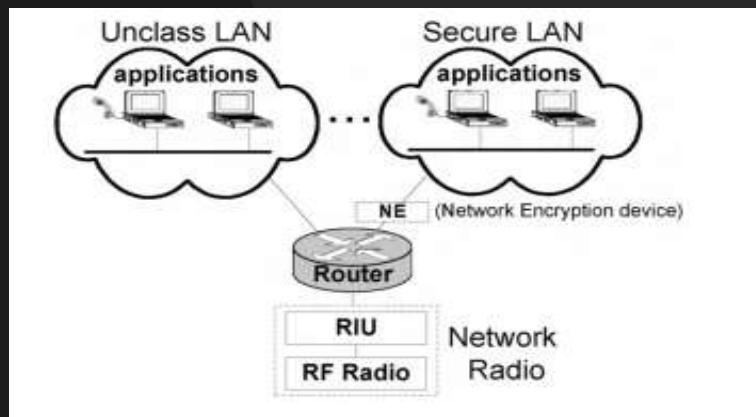


shared spectrum



information of the network and its neighbor's nodes

Each node is mobile and can move in and out of the transmission range of another node → relays



Tactical MANETs



Situational Awareness
(BFT)

```
-Length: (160) depends on Data-Coding-Scheme  
Header  
Data Header Length: 5  
Concatenated short messages, 8-bit reference number  
Information Element Identifier: 0x00  
Length: 3  
Page identifier: 238  
Page parts: 2  
Page part number: 1  
F0 = Fill bits: 0x0  
2 msg: The quick brown fox jumps over the la
```

Short Payload Messaging



Voice/Data Simultaneously



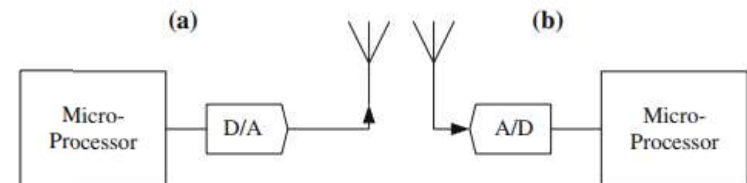
Multicasting/Broadcasting

Software Defined Radios (SDRs)

- Necessity of communicating different type radio systems or different waveforms.

Wireless communication in which the transmitter modulation is generated or defined by a computer. The receiver then also uses a computer to recover the signal intelligence.

It includes the air interface, modulation and coding schemes, analog-to-digital converter (ADC), and digital-to-analog converter (DAC).



Software Defined Radios (SDRs)

Interoperability

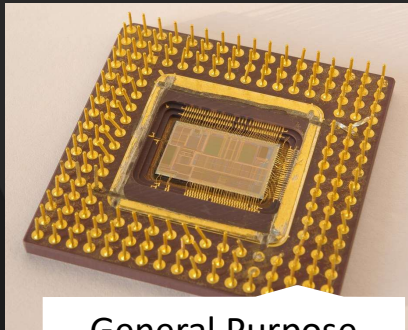
Flexibility

Opportunistic
frequency reuse
(cognitive radio)

Reduced
obsolescence

Lower cost

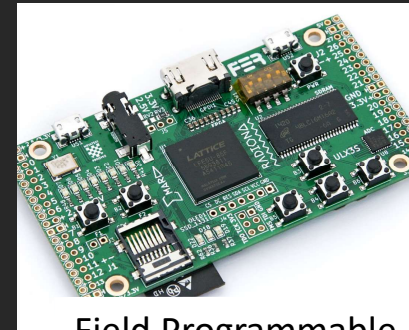
Research and
development



General Purpose
Processor (GPP)



Digital Signal
Processor (DSP)



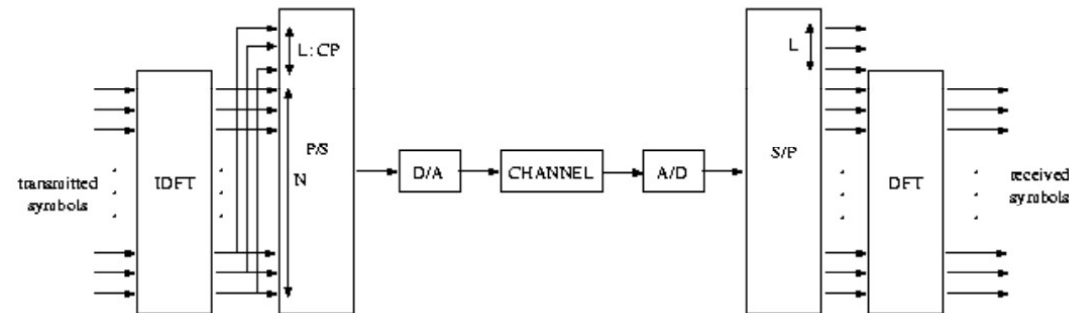
Field Programmable
Gate Array (FPGA)

OFDM in MANETs

OFDM is a modulation technique as well as multiplexing technique

Subcarrier frequencies are orthogonal to each other.

- High spectral efficiency
- It reduces equalization complexity



OFDM in MANETs

SNR  SINR

$$\text{SINR}(x) = \frac{P}{I + N}$$

Inputs:

OFDM symbol size (number of subcarriers)

Number of OFDM symbols and modulation

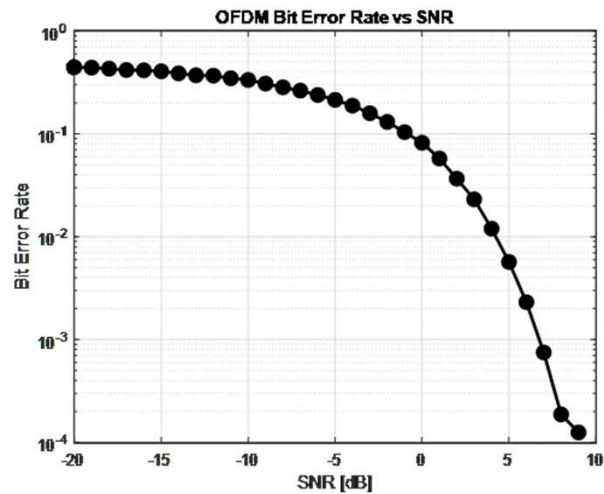
Outputs:

Bit Error Rate (BER) depending on SINR

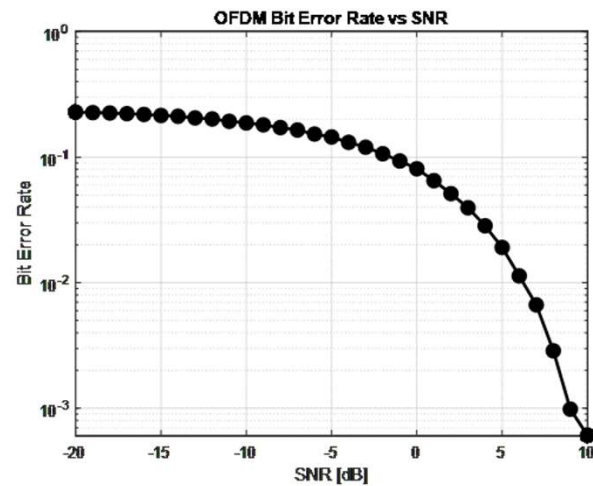
Cyclic Prefix value was set to be fixed as in VHF and UHF communications bandwidth is limited and usually have values from 25 kHz (for narrow-band communications) to 1-4 MHz (for wide-band communications).

OFDM in MANETs

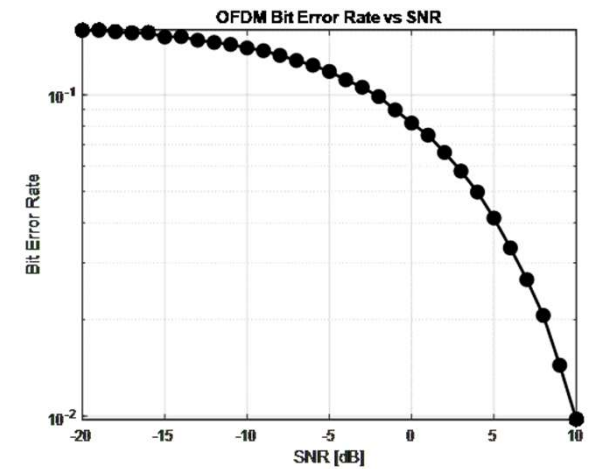
Number of subcarriers	Modulation order
16	2



Number of subcarriers	Modulation order
16	4

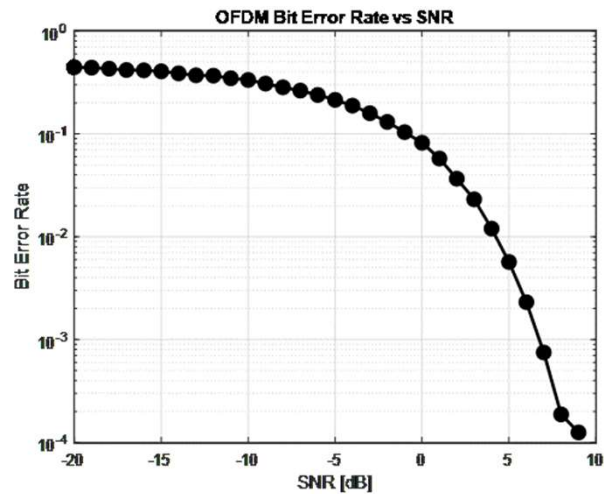


Number of subcarriers	Modulation order
16	8

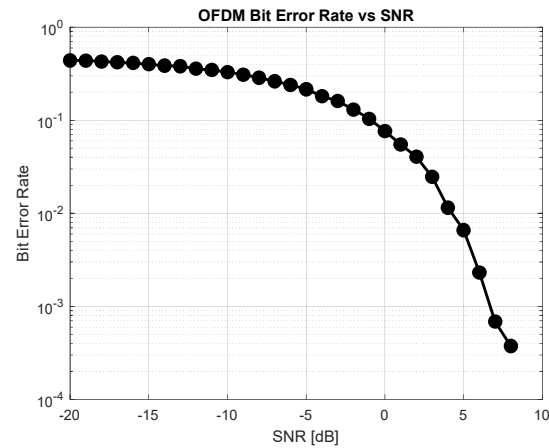


OFDM in MANETs

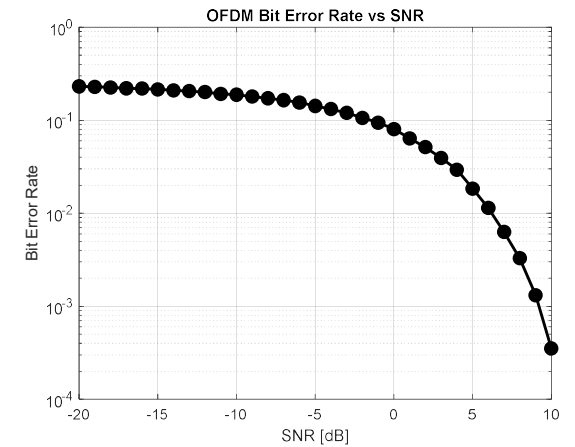
Number of subcarriers	Modulation order
16	2



Number of subcarriers	Modulation order
32	2

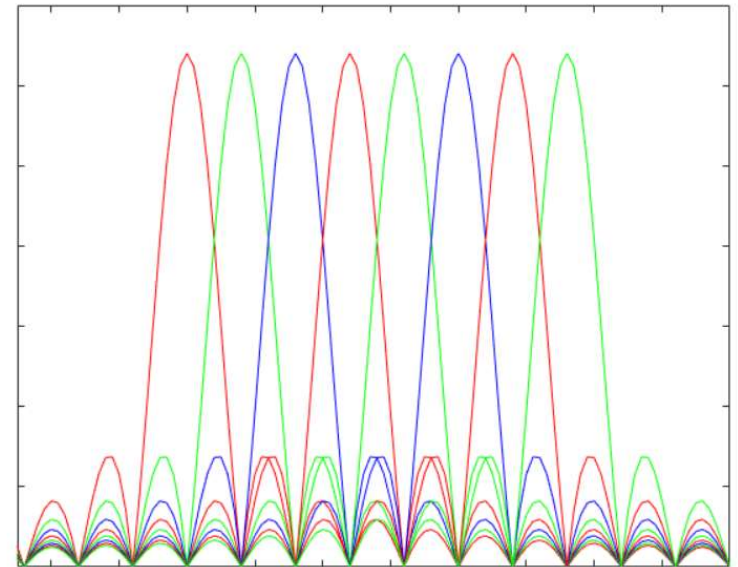


Number of subcarriers	Modulation order
32	4



Conclusion

- Tactical communications have hard requirements in terms of robustness and reliability.
- SDRs usage increment flexibility and interoperability.
- Simulations: despite its advantages for communications with high SNR and bandwidth, their use for military applications in contested scenarios might not be the best option.



References

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- [2] Wang, Haidong; Crilly, Brian; Zhao, Wei; Autry, Chris; Swank, Sean (2007). [IEEE MILCOM 2007 - IEEE Military Communications Conference - Orlando, FL, USA (2007.10.29-2007.10.31)] MILCOM 2007 - IEEE Military Communications Conference - Implementing Mobile Ad Hoc Networking (MANET) over Legacy Tactical Radio Links, 1–7. doi:10.1109/MILCOM.2007.4455103
- [3] I. Labbé, B. Gagnon and J. -F. Roy, "An adaptive VHF/UHF system for the next generation tactical MANETs," MILCOM 2009 - 2009 IEEE Military Communications Conference, 2009, pp. 1-7, doi: 10.1109/MILCOM.2009.5380073.
- [4] Eugene Grayver , "Implementing Software Defined Radio", Springer Science & Business Media, 2012, ISBN: 1441993320, 9781441993328
- [5] Malik Nasereldin Ahmed, Abdul Hanan Abdullah and Satria Mandala, "A Study On OFDM In Mobile Ad Hoc Network" International Journal of Advanced Computer Science and Applications(IJACSA), 3(6), 2012. <http://dx.doi.org/10.14569/IJACSA.2012.030604>