A Comprehensive Evaluation on Multicast and Unicast in Public Safety Communications

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Outline







Motivations



Evaluation and Decision Options: Unicast or Multicast

Summary

Motivations





Motivations





Motivations





MBSFN Introduction





MBSFN: Multimedia Broadcast multicast service over Single Frequency Network.



Constructive signal combining. Interference reduction especially at cell edge. One copy to multiple users. Full access to entire resource from each user.

MBSFN Introduction







No MIMO support. No HARQ. Transmission rate limited by the worst SINR is experienced by all users.

Evaluation Methodology



1500



C. Liu, C. Shen, J. Chuang, R. A. Rouil and H. -A. Choi, "Evaluating Unicast and MBSFN in Public Safety Networks," *2020 IEEE 31st Annual International Symposium on Personal, Indoor and Mobile Radio Communications*, 2020, pp. 1-7, doi: 10.1109/PIMRC48278.2020.9217346. Regular hexagonal LTE network. 700 MHz public safety spectrum. Inter-Site-Distance 500 m.

LTE: Long-Term Evolution.

Evaluation Methodology





Public Safety Networks," 2020 IEEE 31st Annual International Symposium on Personal, Indoor and Mobile Radio Communications, 2020, pp. 1-7, doi: 10.1109/PIMRC48278.2020.9217346.

Inter-Site-Distance 500 m.

LTE: Long-Term Evolution.

Switch Points



- The balance among several factors leads to a switch point in the number of users, across which unicast or multicast outperforms.
- The switch point changes upon system configurations and the performance metric selected.

Switching point could serve as one metric in selecting unicast or multicast deployment upon public safety incidents.



Shen, C., Liu, C. and Rouil, R. (2021), A Comprehensive Analysis on Multicast and Unicast Performance and Selection, IEEE Global Communications Conference 2021 (Globecom), Madrid, ES.¹¹

Outage Probability

- Multicast has much lower outage probability.
- With the same planned outage probability, multicast has a significantly higher achievable bits/symbol.
- A larger MBSFN area will correspond with a greater improvement.

Multicast can be a potential candidate for meeting the stringent coverage requirement for first responders.



C. Liu, C. Shen, J. Chuang, R. A. Rouil and H. -A. Choi, "Evaluating Unicast and MBSFN in Public Safety Networks," *2020 IEEE 31st Annual International Symposium on Personal, Indoor and Mobile Radio* 12 *Communications*, 2020, pp. 1-7, doi: 10.1109/PIMRC48278.2020.9217346.

MBSFN Area Shape



• Performance differs with MBSFN area shapes and relative locations to network.

The analysis

- provides performance prediction for incidents with underlying macro-cell.
- serves as a guideline in mobile base station deployment for incidents without underlying macro-cells.

Post-equalization SINR heatmap



Different MBSFN area shapes, the same three sites / nine cells

C. Shen, C. Liu, R. A. Rouil and H. -A. Choi, "Study of Multicast Broadcast Single Frequency Network Area in Multicast Communications," *2020 14th International Conference on Signal Processing and* 13 *Communication Systems (ICSPCS)*, 2020, pp. 1-8, doi: 10.1109/ICSPCS50536.2020.9310041.



MBSFN Area Shape



- Post-equalization SINR shows distinct distribution among cells.
- Performance differs with MBSFN area shapes and relative locations to network.

The analysis

- provides performance prediction for incidents with underlying macro-cell.
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Post-equalization SINR Cumulative Distribution Function (CDF)



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Summary



- Public safety incidents impose special requirements on network design and deployment.
- Multicast shows great potential to improve first responder's user experience.
- Decision options in multicast or unicast were provided and resulting performance impacts were evaluated.

Thank You!

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