

Title: Improvements in System Performance due to simultaneous transmission of E-MBS and Unicast

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Purpose: To discuss and adopt the superposition coding scheme for broadcast and unicast symbols into 802.16m SDD .

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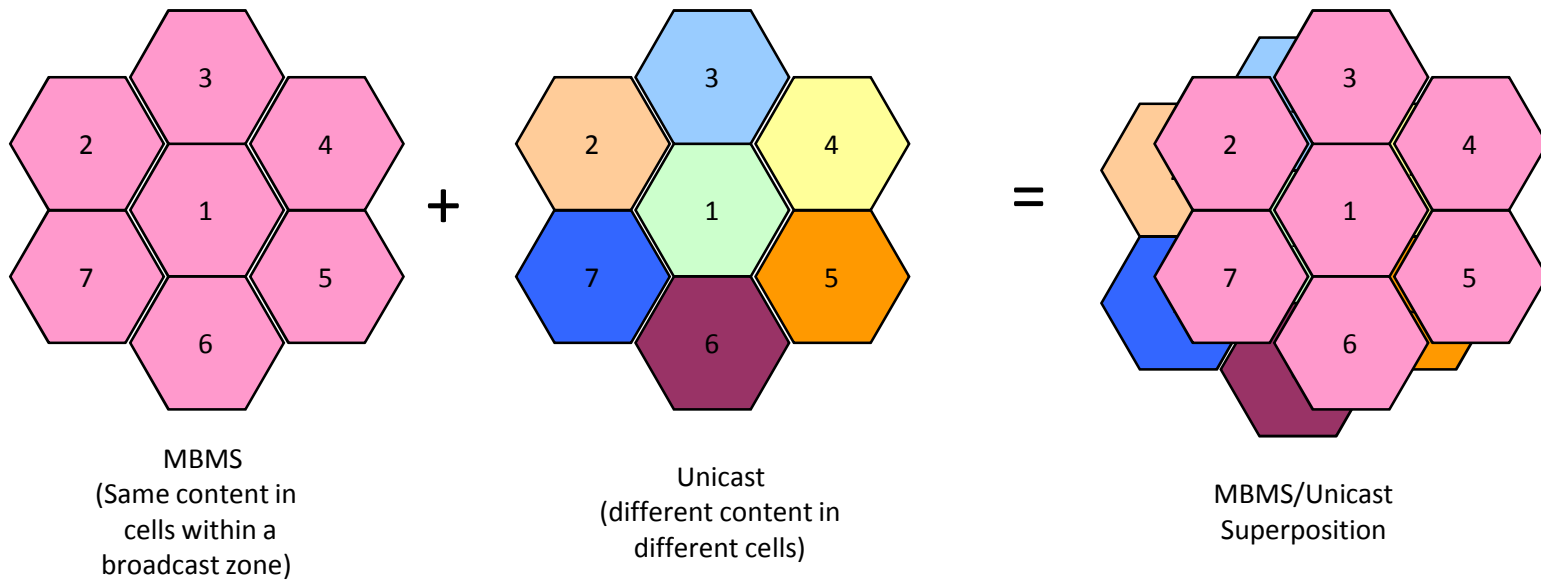
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Improvements in System Performance due to **simultaneous transmission** of E-MBS and Unicast

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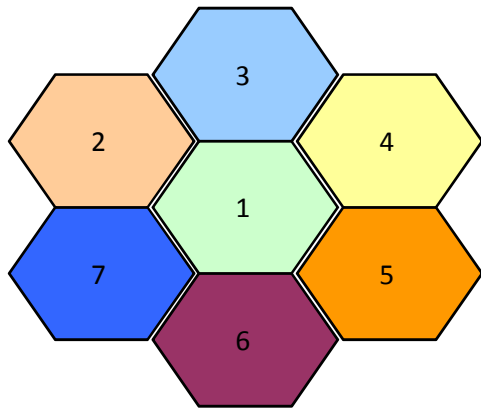
Superposition Coding

Of broadcast and unicast signals



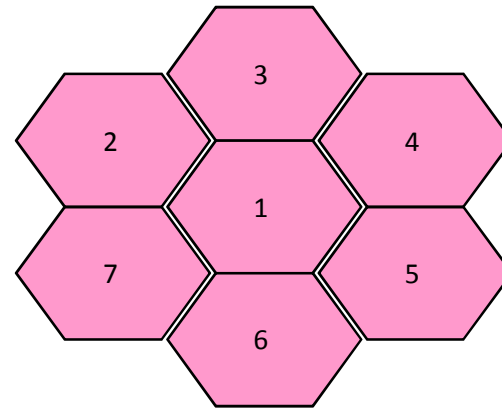
Spectrum Efficiency target for MBMS in LTE: 1 bps/Hz

Geometry: Unicast vs. Broadcast



Unicast
(different content in
different cells)

$$SINR_{unicast} = \frac{P}{fP + N_0}$$

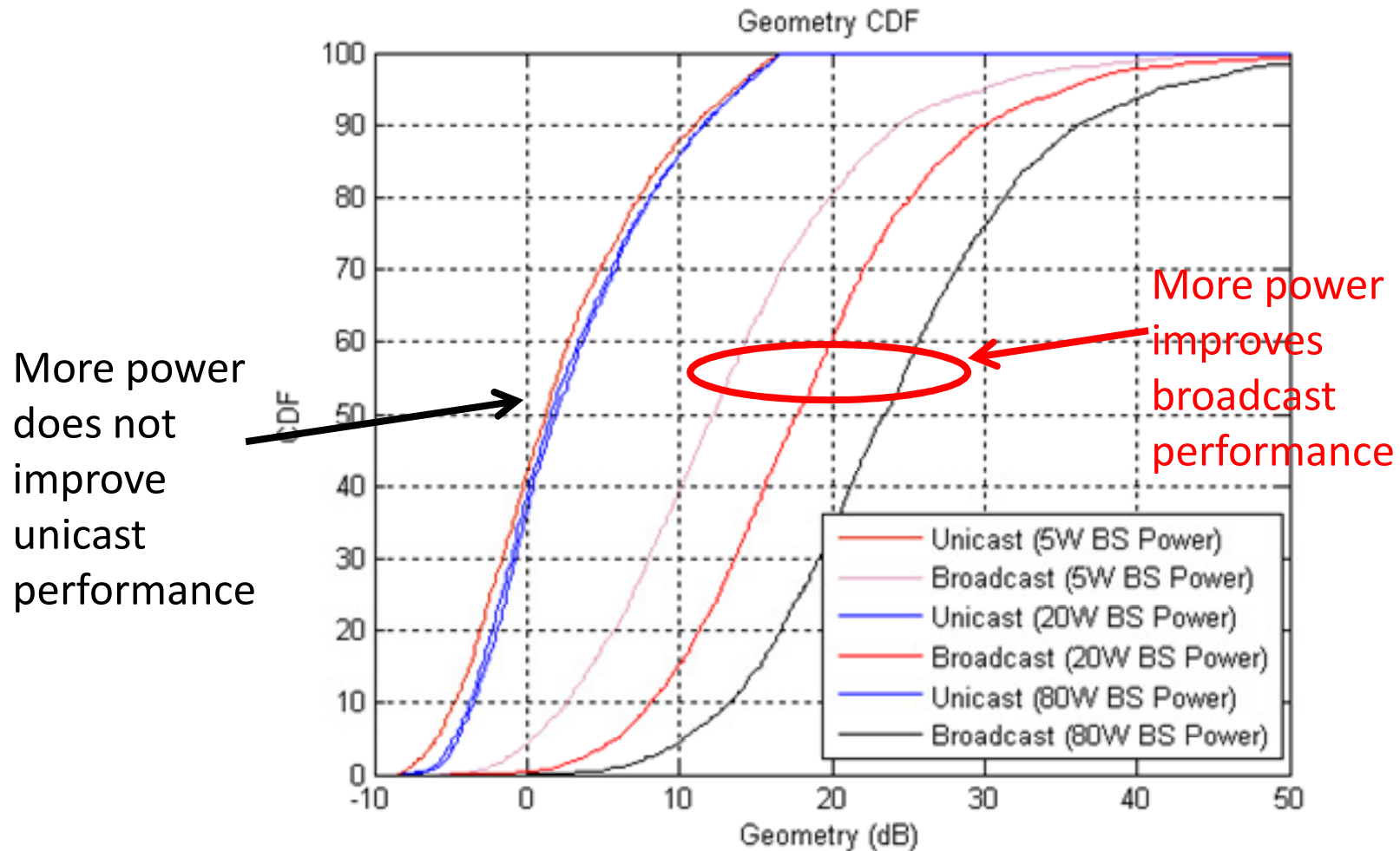


MBMS
(Same content in
cells within a
broadcast zone)

$$SINR_{broadcast} = \frac{KP}{N_0}$$

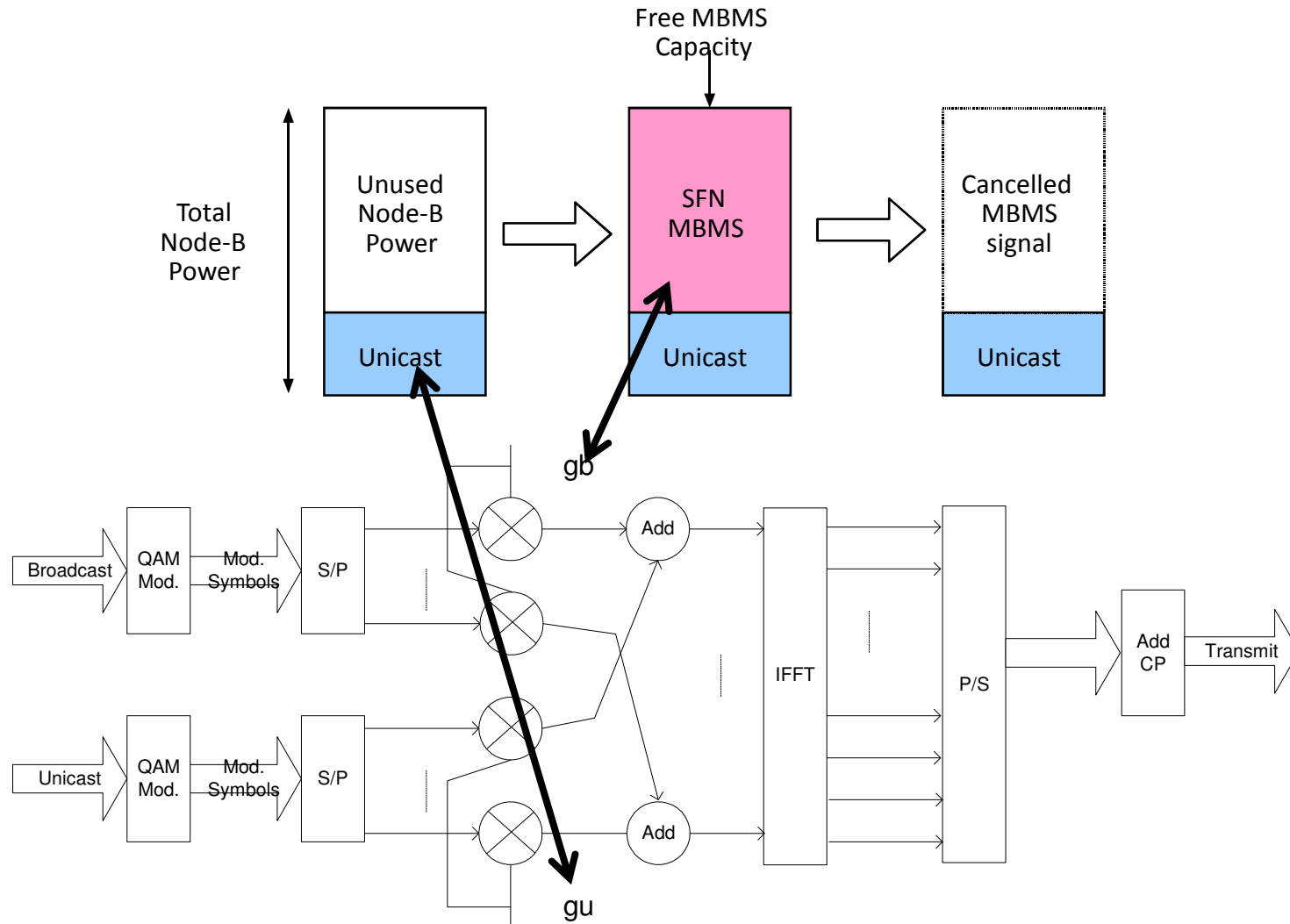
Unicast traffic is **interference limited**; broadcast is not.

Interference limited Unicast

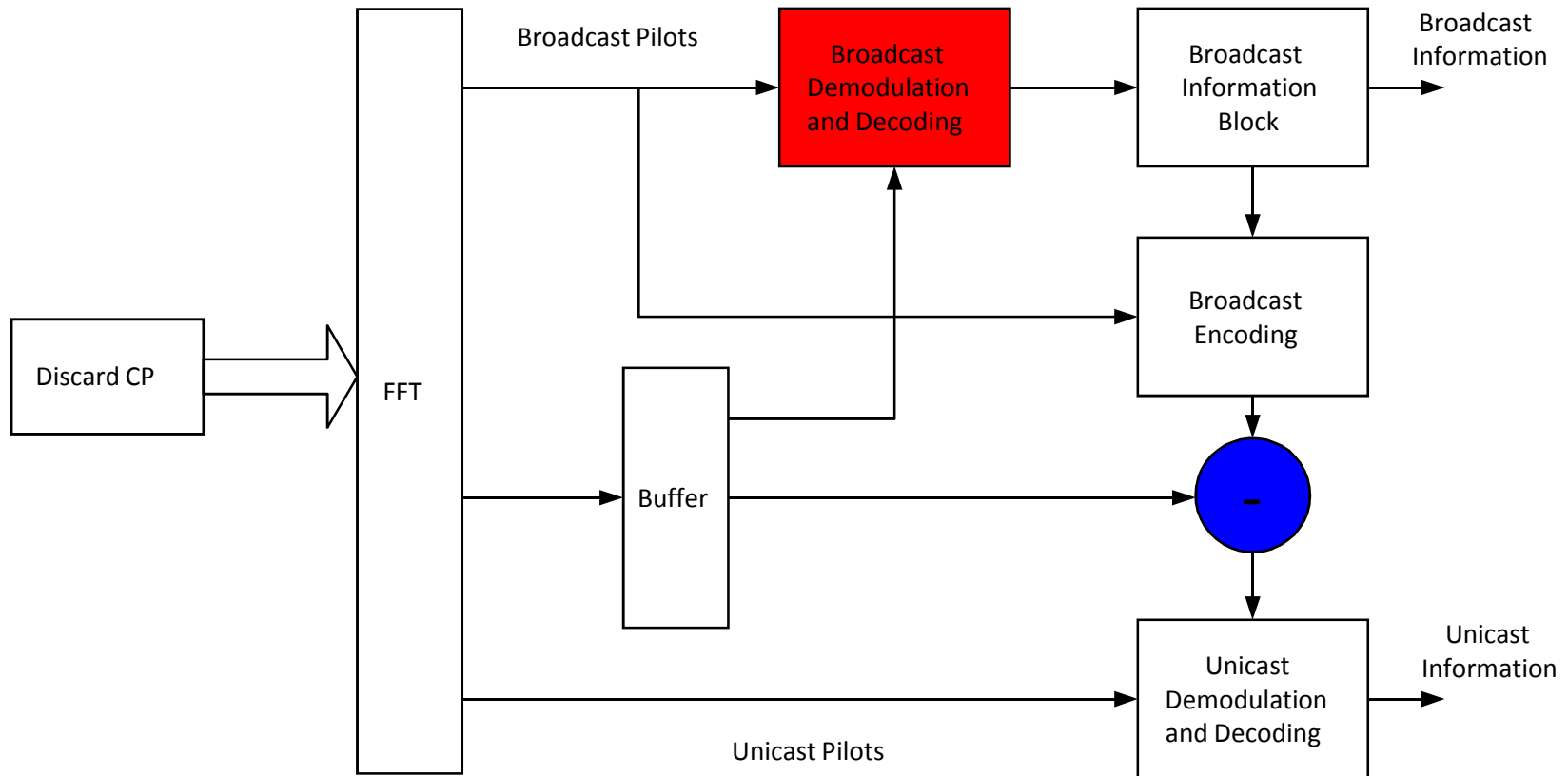


Superposition MIMO

Split power budget between unicast and MBMS signals



Interference cancellation



Decode broadcast MBMS signal first & cancel it from received signal to decode unicast symbols

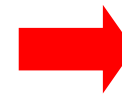
Spectral Efficiency with superposition

$$C_{broadcast} = \log_2 \left(1 + \frac{\sum_i P_{Bi}}{\sum_i P_{Ui}} \right) \approx \log_2 \left(1 + \frac{P_B}{P_U} \right) \quad [b/s/Hz]$$

For broadcast, the SINR is proportional to the power ratio P_B/P_U

$$C_{unicast} = \log_2 \left(1 + \frac{P_U}{I_{BSIC} + fP_U + N_0} \right) \quad [b/s/Hz]$$

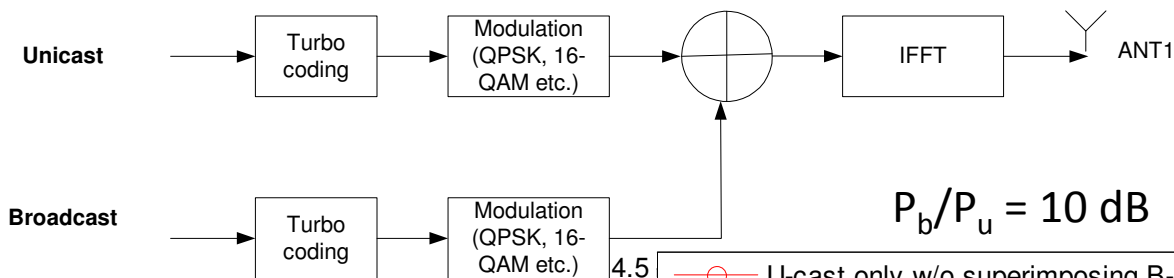
Residual interference due to imperfect interference cancellation



Noisy channel estimates

Spectral Efficiency curve - I

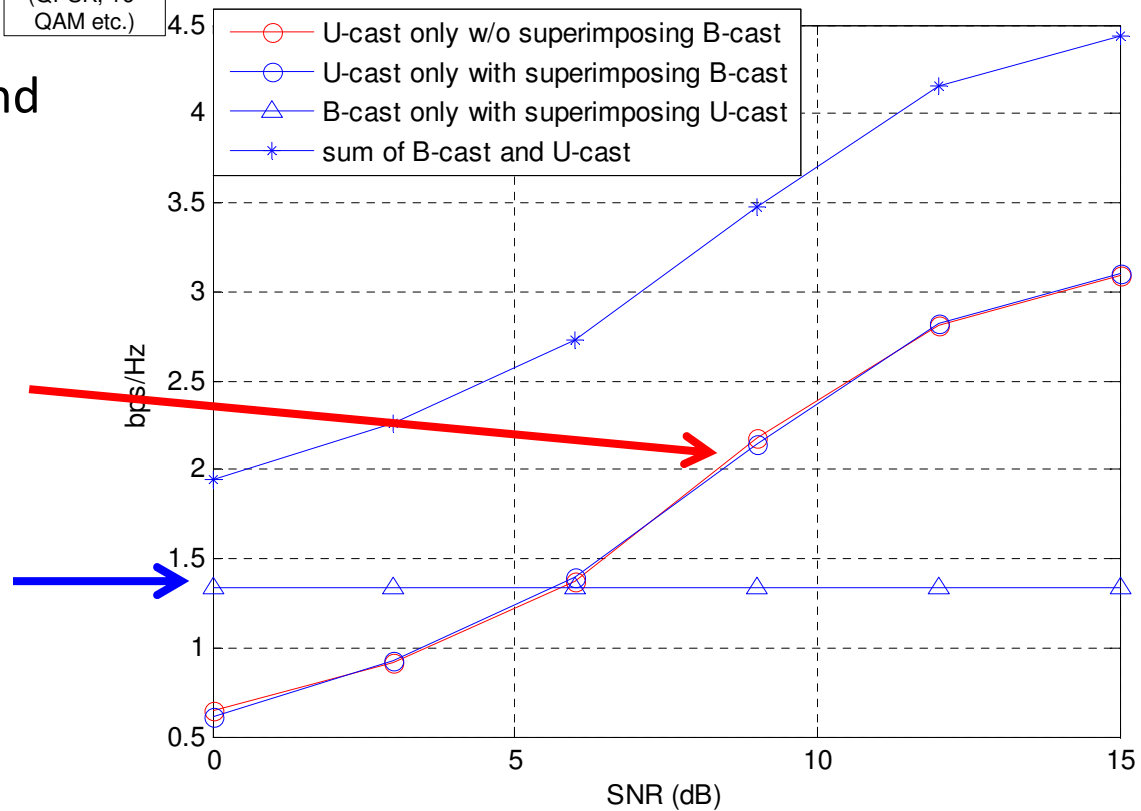
Perfect channel estimates for both broadcast & unicast signals



Single stream unicast and broadcast traffic

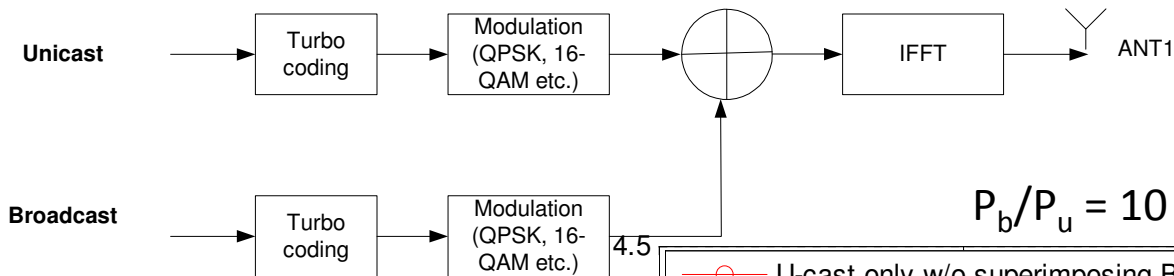
No deterioration in unicast rates due to superposition

QPSK + 2/3 coding rate: 4/3 bps/Hz



Spectral Efficiency curve - II

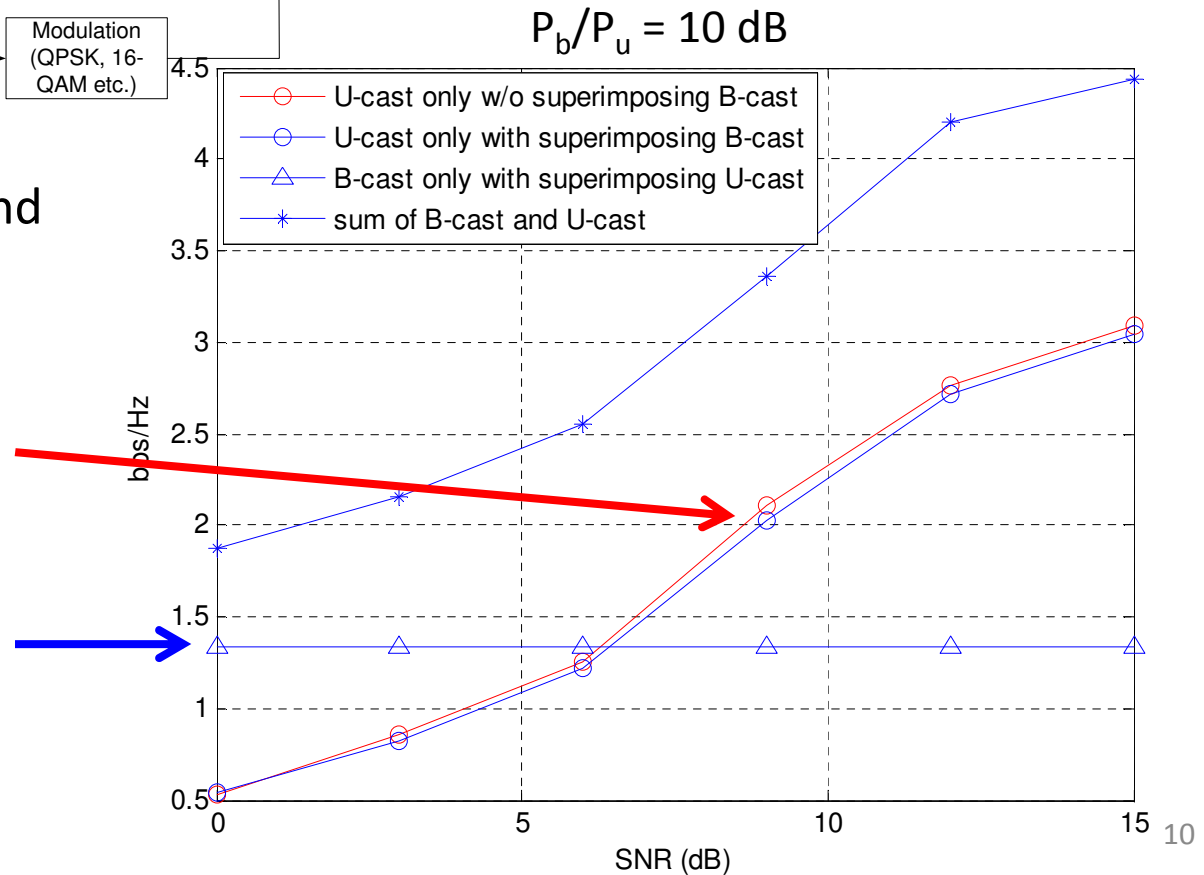
Imperfect channel estimates for broadcast



Single stream unicast and broadcast traffic

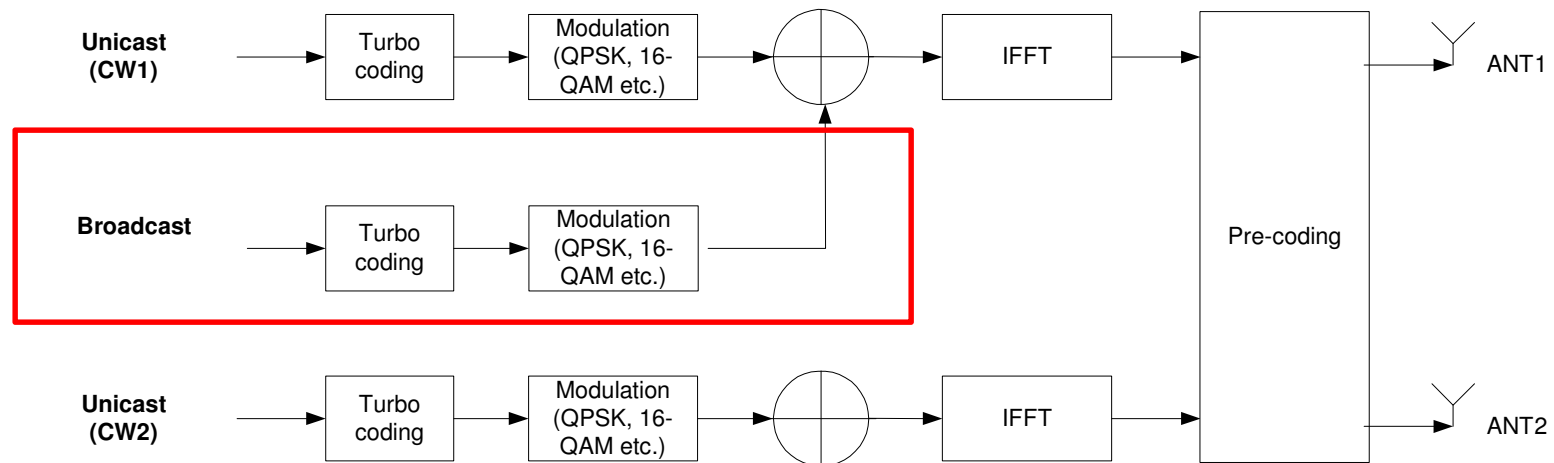
Small deterioration in unicast rates due to superposition

QPSK + 2/3 coding rate: 4/3 bps/Hz



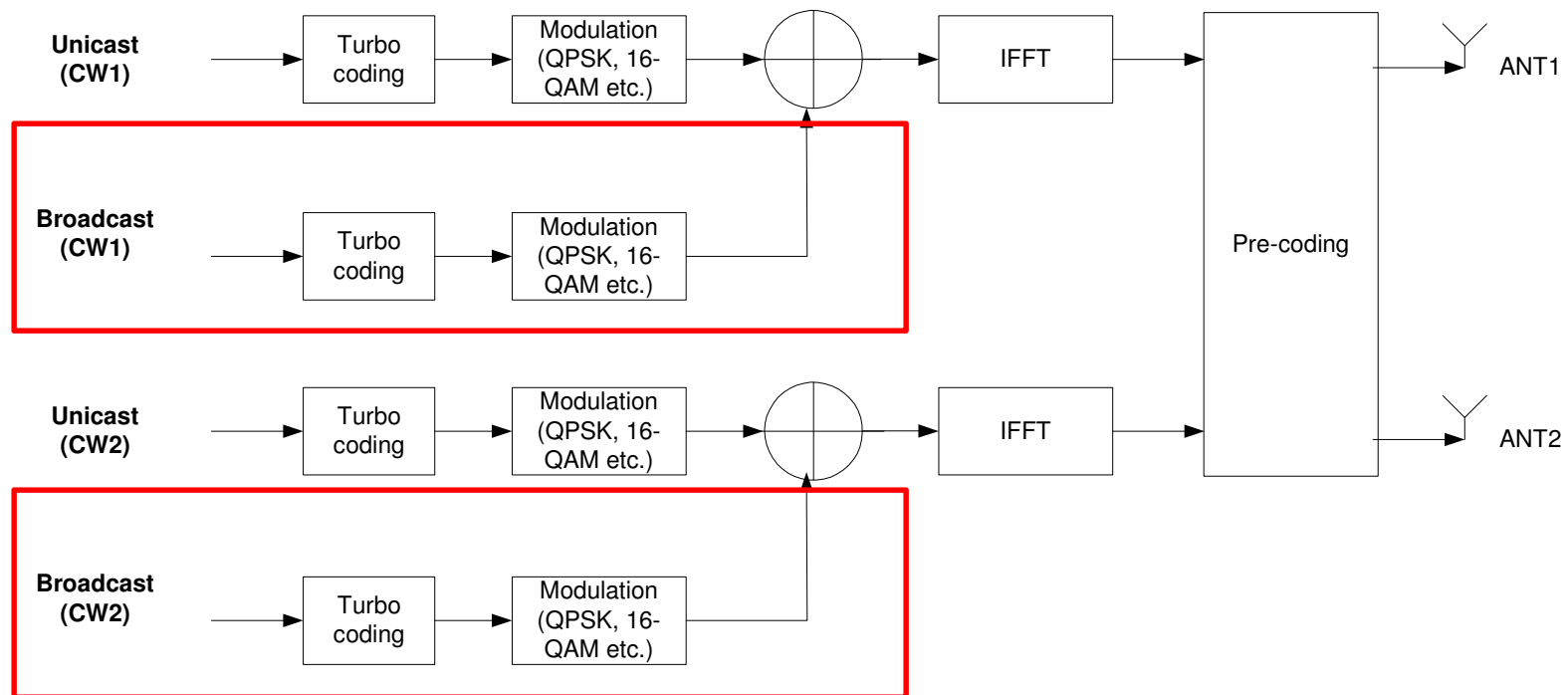
Superposition MIMO

Two streams for unicast and a single stream for MBMS



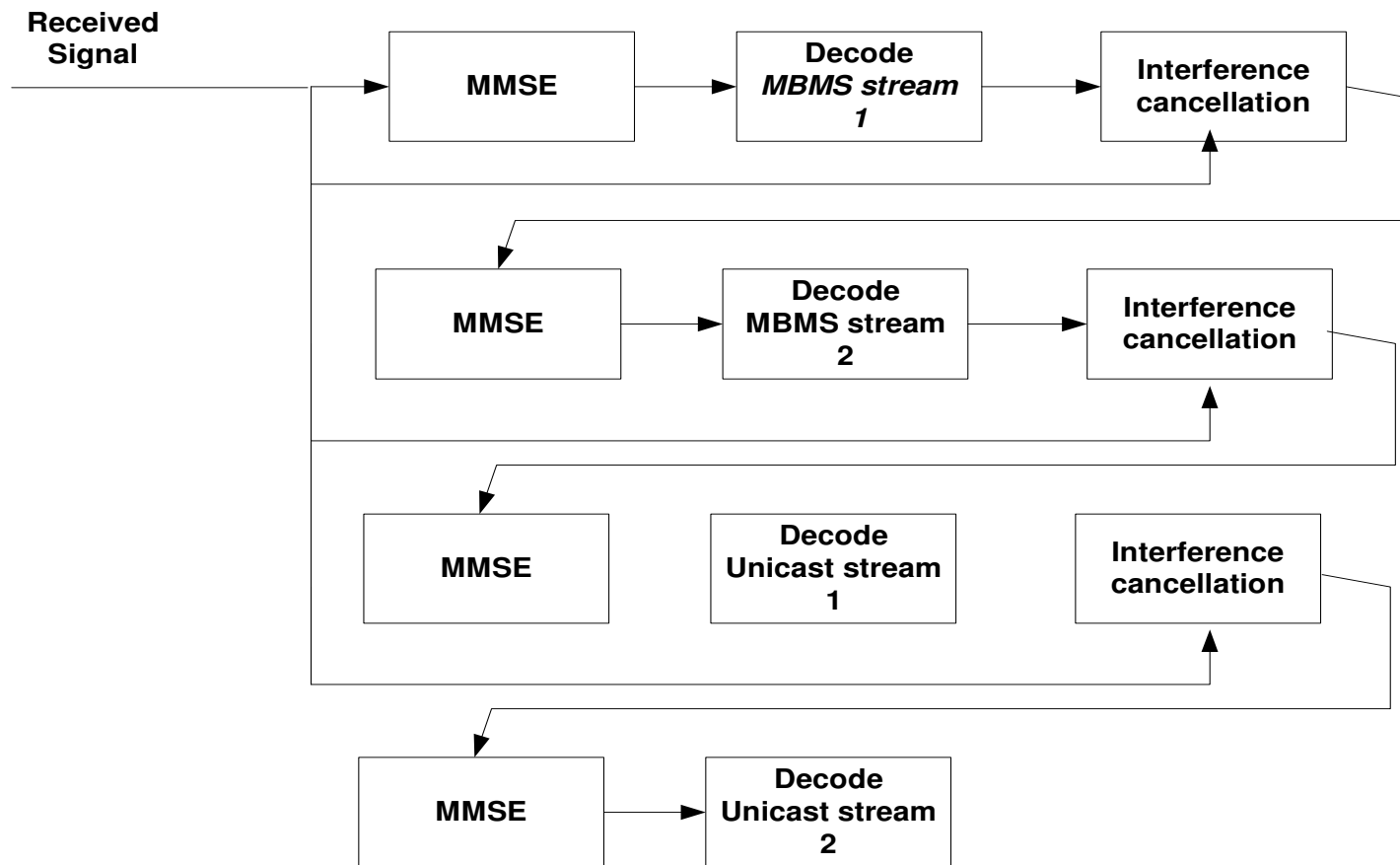
Superposition MIMO

Two streams for both unicast and MBMS



Superposition MIMO

Receiver Operation: **Decode MBMS streams** first and then decode Unicast streams

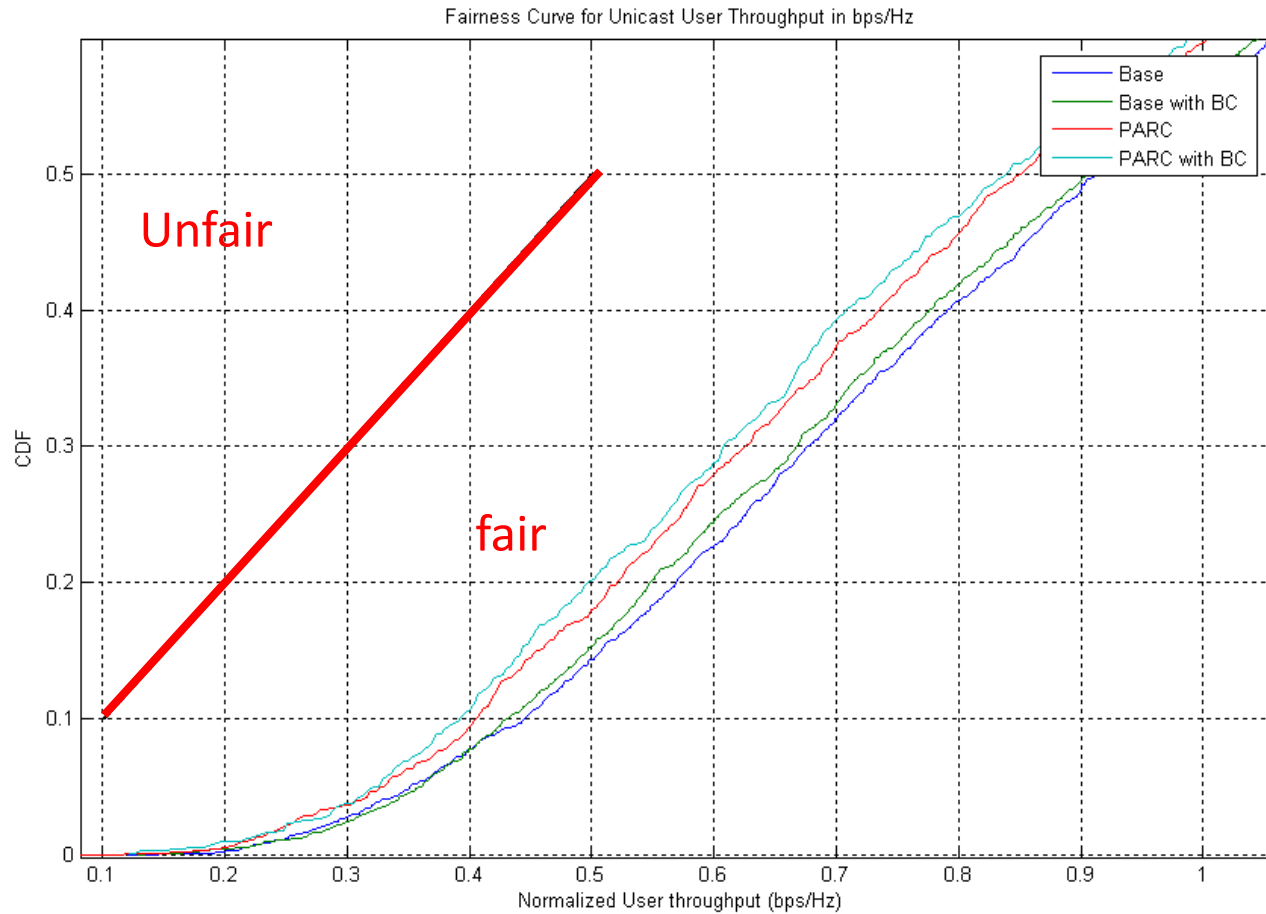


System Simulations: Throughput

> 100% improvement in throughput

	Unicast THP	Broadcast THP	Total	5% User THP
Base Line w/o MBMS Superposition	1.90	0	1.90	0.0667
Base Line with MBMS Superposition	1.89	2	3.89	0.0677
PARC w/o MBMS Superposition	2.17	0	2.17	0.0708
PARC with MBMS Superposition	2.16	2.66	4.82	0.0690

System View: Fairness



Summary

- **More bang for the bucks**
 - For a little extra power, superposition achieves improves overall system throughput and spectral efficiency without adversely affecting unicast rates
 - Simple receiver operation – MMSE with SIC
- **Slight loss in unicast rates due to imperfect interference cancellation**
 - Impact due to imperfect channel estimation
 - Mitigate loss by using a dense packing of power boosted broadcast reference signals.