

052004

13281 U.S. PTO

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Attorney Docket Number: 56162.000301

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PROVISIONAL APPLICATION FOR PATENT COVER SHEET

MAIL STOP PROVISIONAL PATENT APPLICATION

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THIS IS A REQUEST FOR FILING A PROVISIONAL APPLICATION FOR PATENT UNDER 37 C.F.R. § 1.53(c).

22264 U.S. PTO
60/572481

052004

INVENTOR(S)/APPLICANT(S)

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Additional inventors are being named on page 2 attached hereto.

TITLE OF THE INVENTION (280 characters max)

LEGACY LTS Tx DIVERSITY

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ENCLOSED APPLICATION PARTS (check all that apply)

☒ Specification	Number of Pages	14	☐ Small Entity Status Claimed As:
			☐ Independent Inventor
			☐ Small Business Concern
			☐ Nonprofit Organization
			☐ Non-Inventor Supporting Claim By Another
☐ Drawing(s)	Number of Sheets		☐ Other (specify) _____

METHOD OF PAYMENT OF FILING FEE FOR THIS PROVISIONAL APPLICATION

A check in the amount of ☐ \$ 160.00 ☐ \$ 80.00 is enclosed to cover the filing fee. The Commissioner is hereby authorized to charge any variance between the amount enclosed and the Patent Office charges to Deposit Account No. 50-0206

☒ The Commissioner is hereby authorized to charge the \$ 160.00 filing fee or credit any overpayment to Deposit Account No. 50-0206.

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

☒ No.
☐ Yes, the name of the U.S. Government agency and the Government contract number are: _____

Respectfully submitted,

By

Yisun Song

Date

May 20, 2004

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202-955-1500

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44,487



C O N E X A N T

CNXT-009

Legacy LTS Tx Diversity:

CDD vs. CAD

May 20, 2004

13281 U.S. PTO



052004

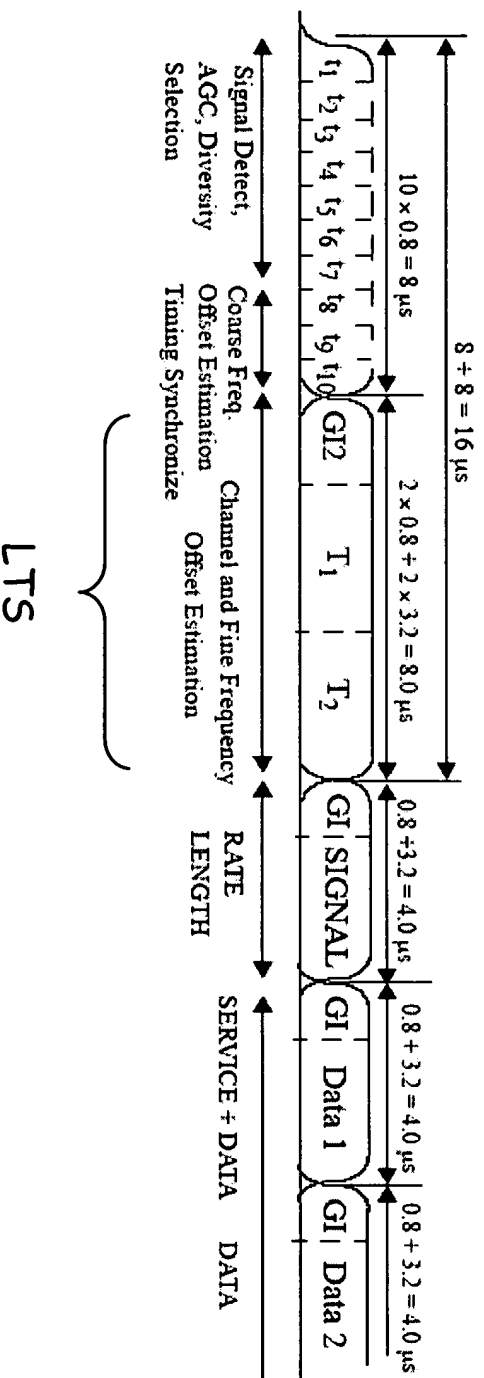
Overview



- To use multiple antennas for packet transmissions to legacy radios, cyclic shifted Tx diversity has been recommended
- This presentation considers the impact of smaller LTS cyclic shifts
 - The reaction of some legacy radios is postulated
- Two types of cyclic shifts are proposed
 - CDD: Cyclic delay diversity
 - CAD: Cyclic advance diversity
- For smaller cyclic shifts, it is surmised that CAD is preferable to CDD for FFT (fast fourier transform) misplacement tolerance
 - Assumes channel impulse response (CIR) estimate made using cyclic-shifted LTS

802.11a Packet

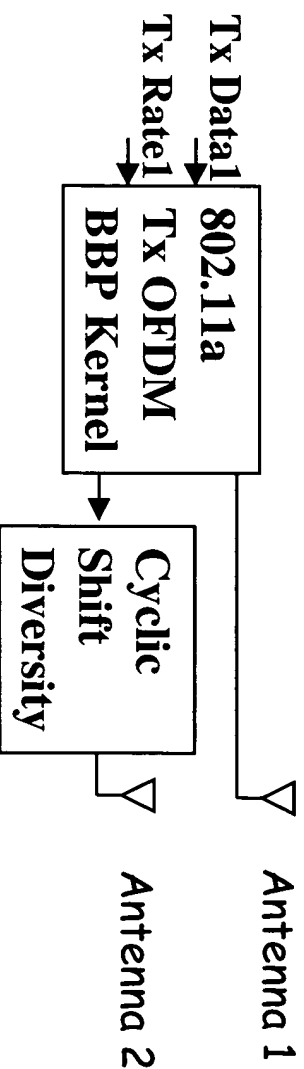
- Packet structure shown
- LTS: Long Training Symbol



Two Antenna ~~Tx Diversity~~



- BBP: Baseband Processor
- The radio would like to transmit the signal using two antennas
- However, the two signals can destructive collide at the receive
- The trick to avoid this is to use cyclic shift diversity on the 2nd antenna
 - Each OFDM symbol is cyclically shifted

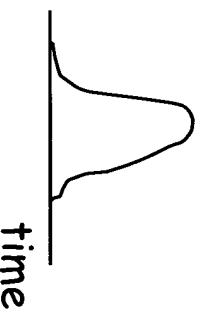


Legacy Radios and Optimal FFT Placement



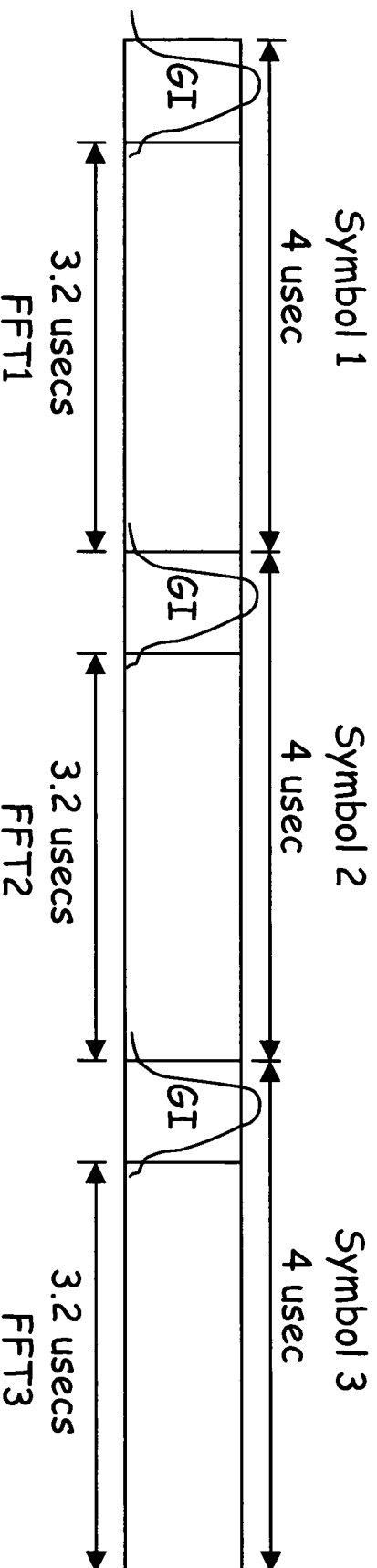
- Optimal FFT placement minimizes intersymbol interference
 - Decay transient from previous symbol
 - Start-up transient due to next symbol

End-to-End Linear Distortion
Impulse Response

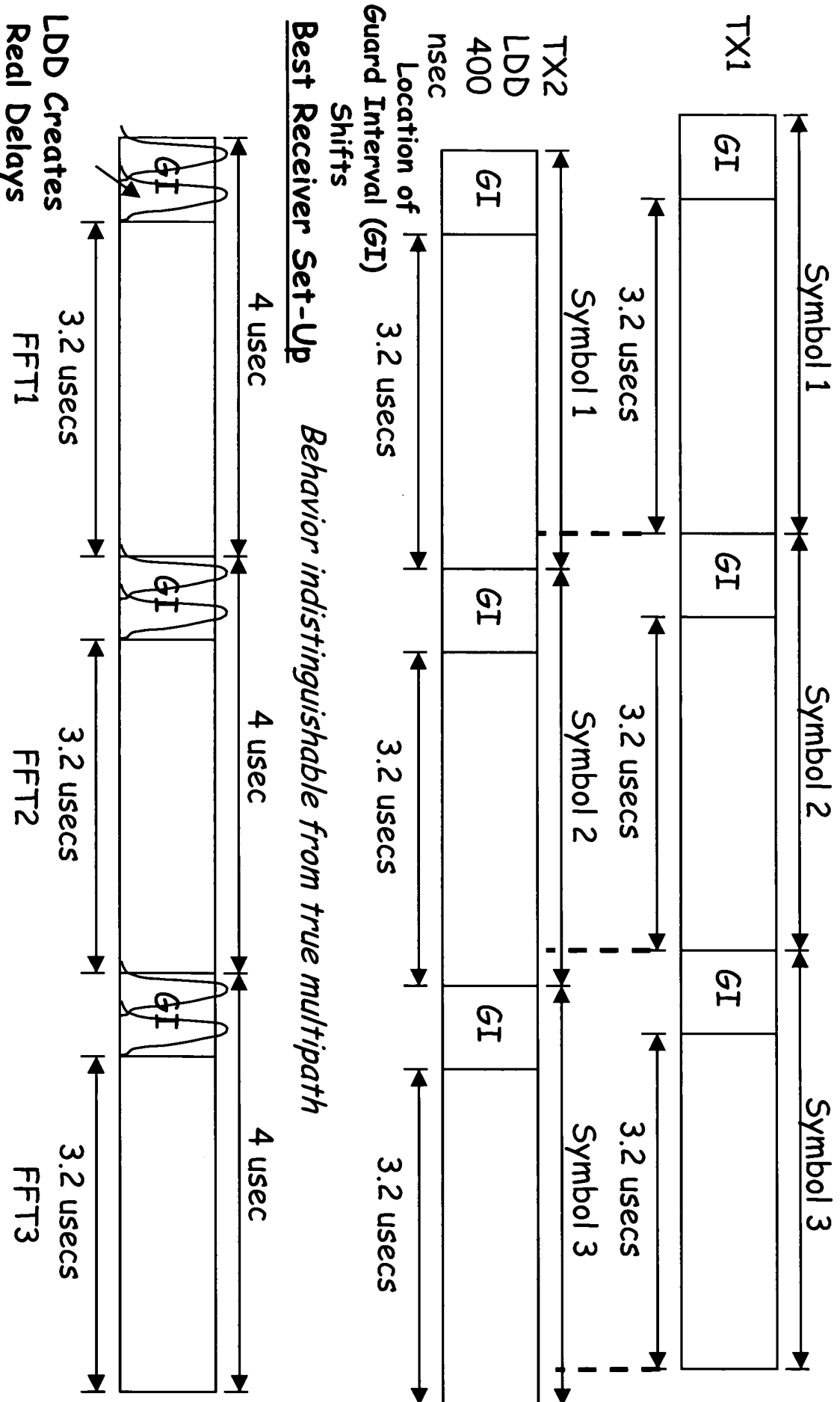


Assume receiver places FFT
Using knowledge of CIR From LTS

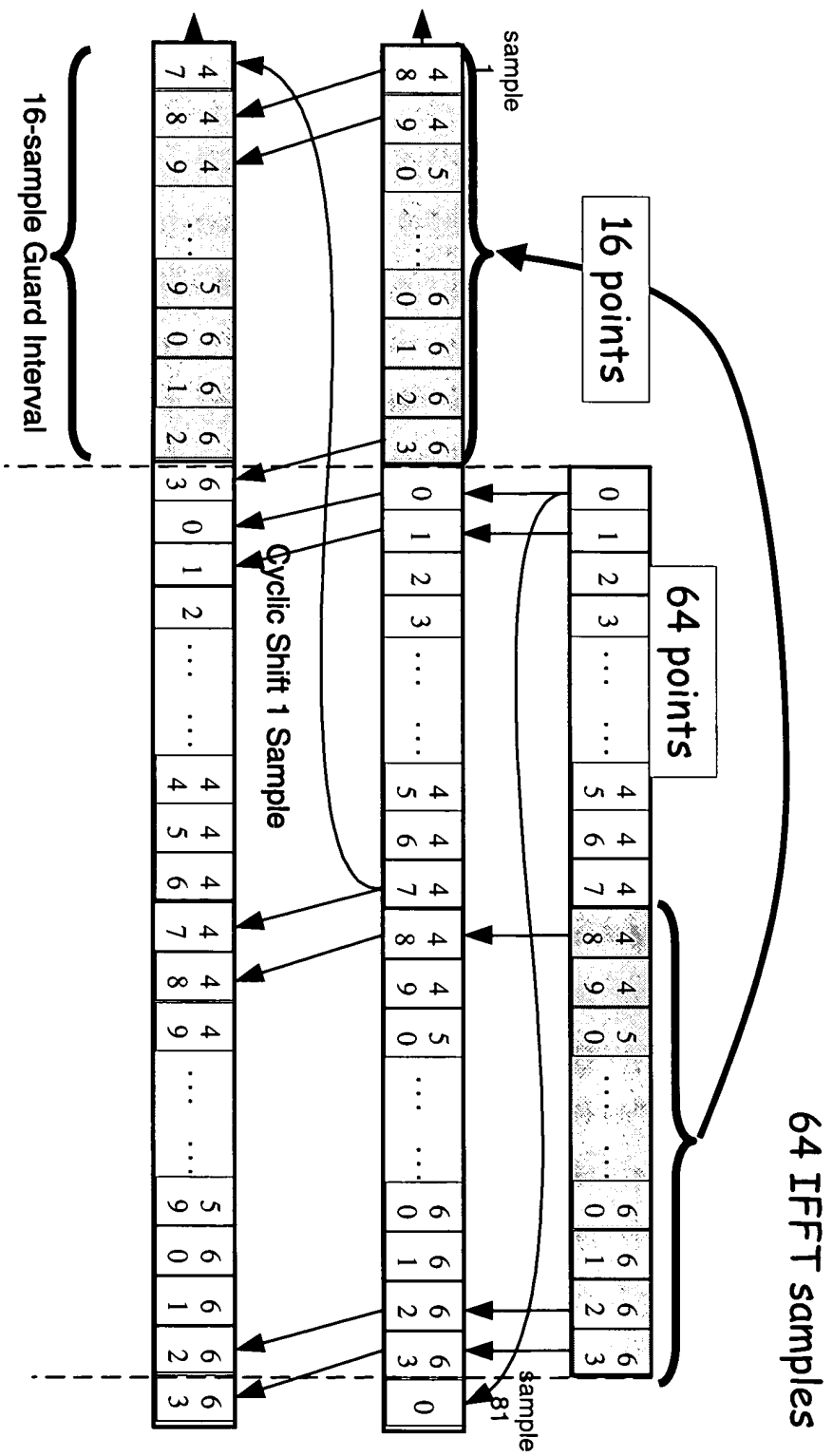
OFDM Data Symbols



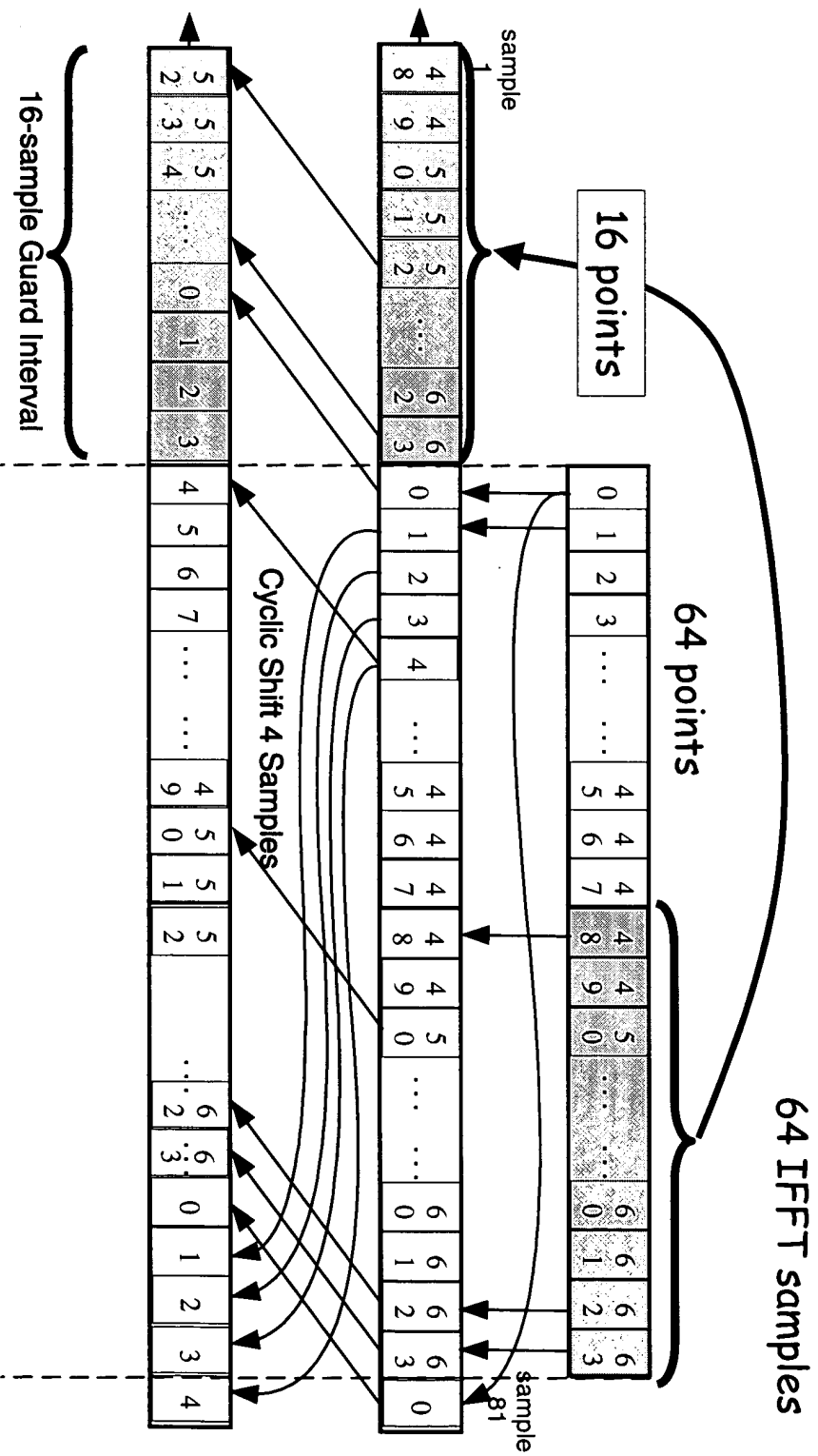
Legacy Radios and Linear Delay Diversity (LDD)



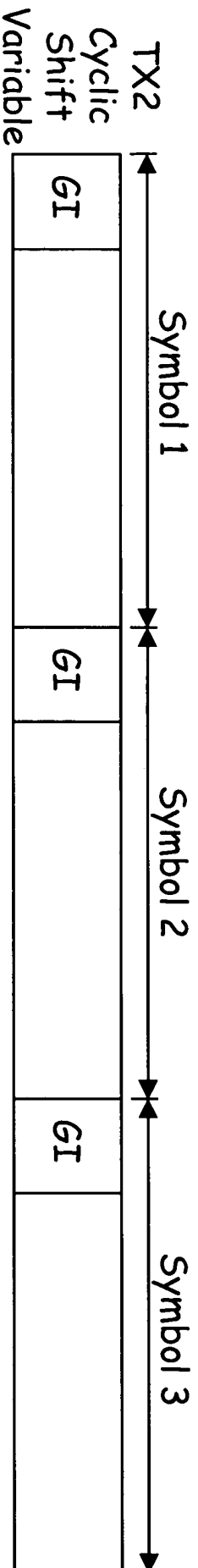
Example of Cyclic Delay Diversity: 1-sample CDD



Example of Cyclic Advance Diversity: 4-sample CAD

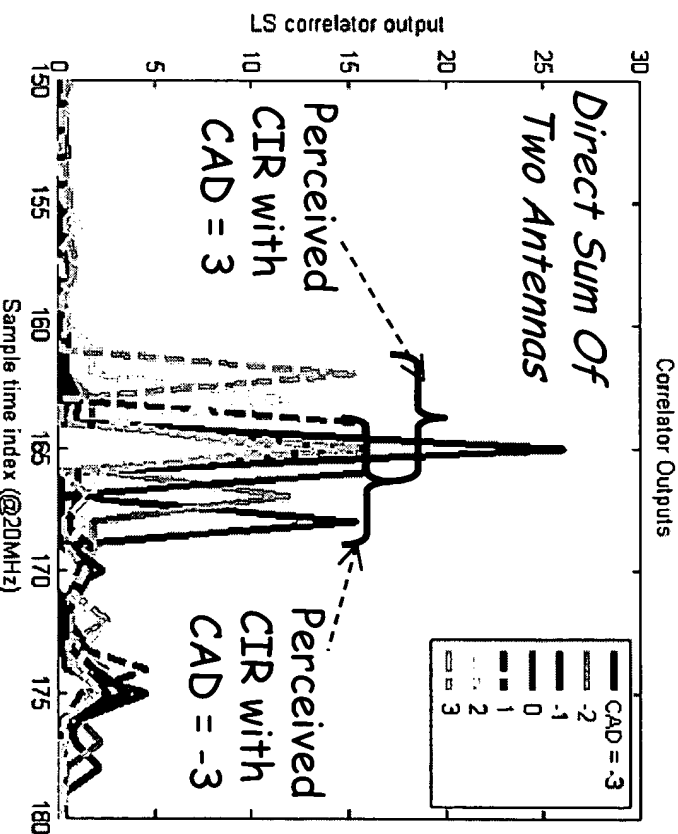
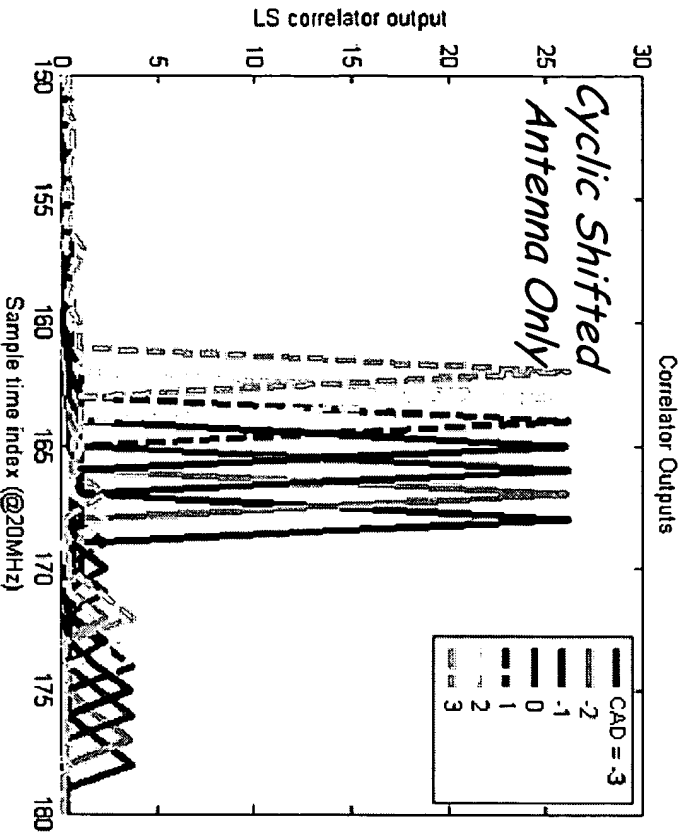


Legacy Radios and Cyclic Shift Diversity



Location of Guard Interval (GI) Held Constant

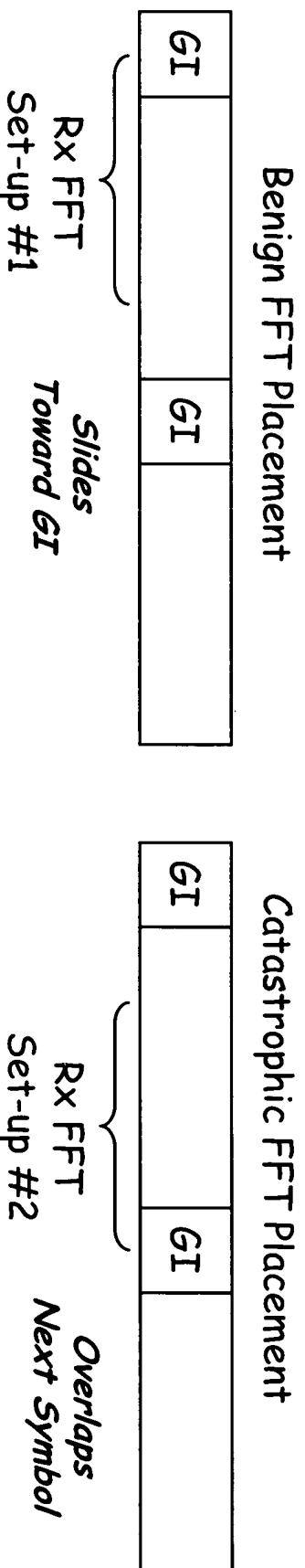
64 point Correlations for LTS



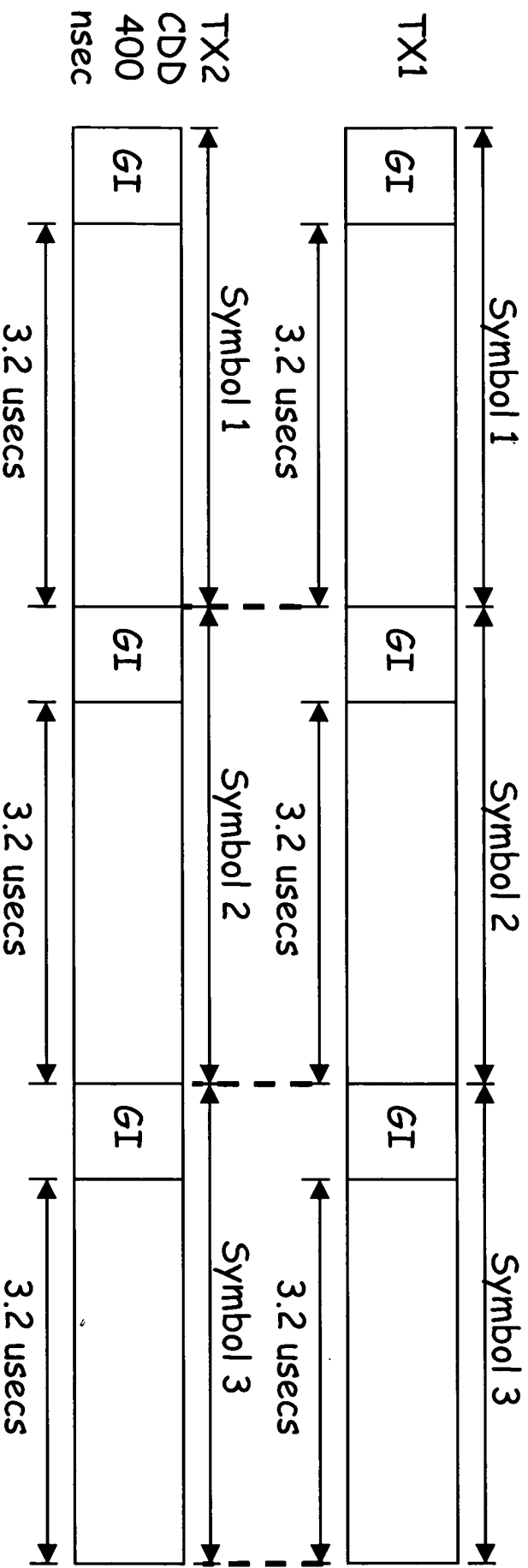
Effect of Cyclic Shifts on Legacy Radios



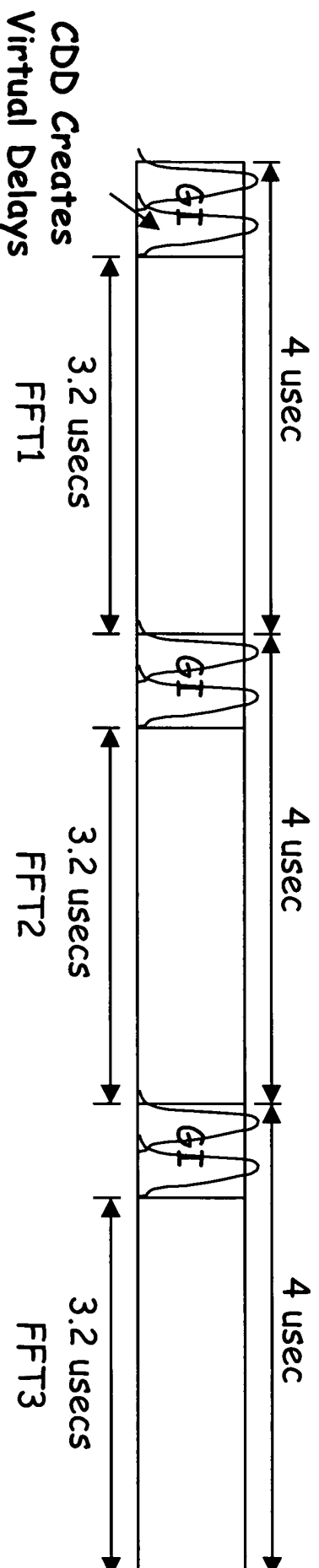
- Legacy radios sometimes perform a channel impulse response (CIR) estimate using the LTS
- The FFT placement may use this impulse response to center the GI on the transients, so ISI is minimized
- The CIR appears to shift directly with the cyclic shift
- However, the true location of the GI does not change because the transmitter is using cyclic shifts
- This can spoof the receiver so the FFT placement is erroneous
 - The FFT tends to shift erroneously in the direction of the cyclic shift



Legacy Radios and Cyclic Delay Diversity

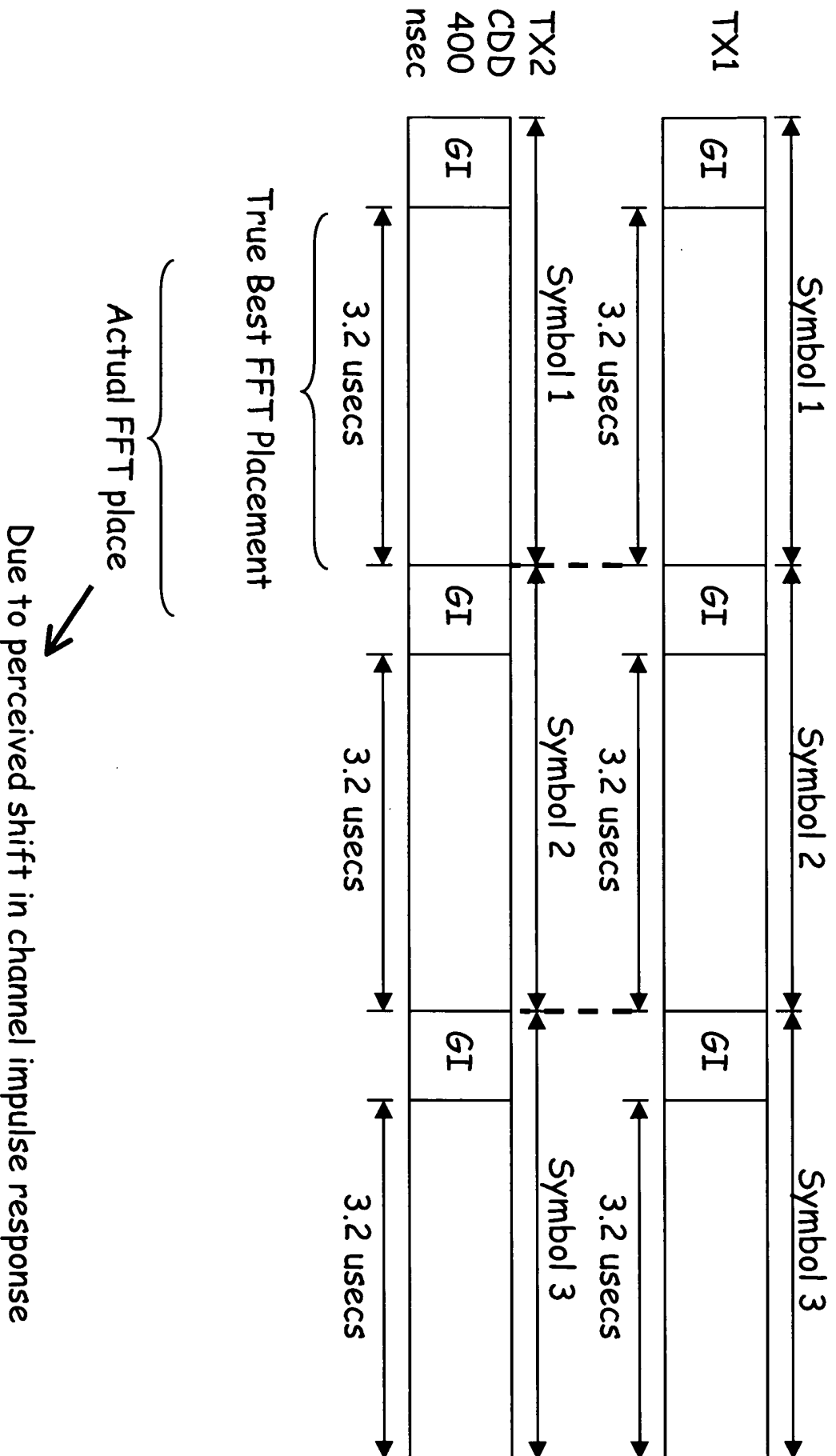


Best Receiver Set-Up



Behavior indistinguishable from LDD

Legacy Radios and Cyclic Shift Diversity

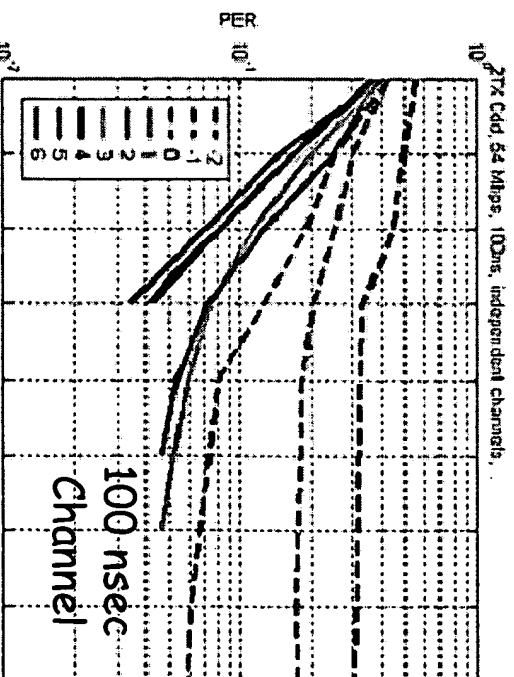
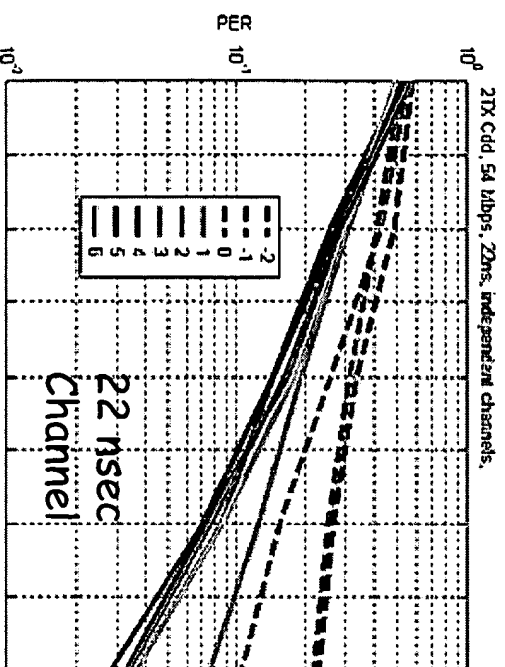
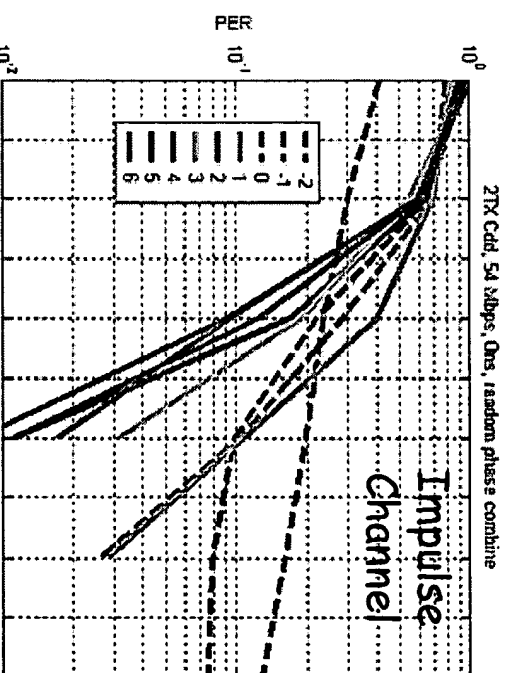


Two Antenna CDD vs. CAD for 54 Mbps PER Experiments



CONEXANT

- Set-up FFT by “centering” legacy LTS correlation spread in GI
- Legend shows CAD sample shift in 20 MHz samples
- Performance is robust with cyclic advances. Poor with delays.
- Relative average SNR shown



Conclusion



- The mixed-mode LTS still needs to be specified
- We have stated that legacy radios may prefer smaller cyclic shifts
- This presentation shows that small CAD may be better than CDD
 - With exponential decayed channels
- Testing also showed LDD was inferior to CDD
- The innovation here is to use CAD versus CDD
- CDD is described in the literature

PATENT APPLICATION SERIAL NO. _____

U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE
FEE RECORD SHEET

05/21/2004 BSAYASI1 00000033 500206 60572481

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