Simulcast Systems for Public Safety

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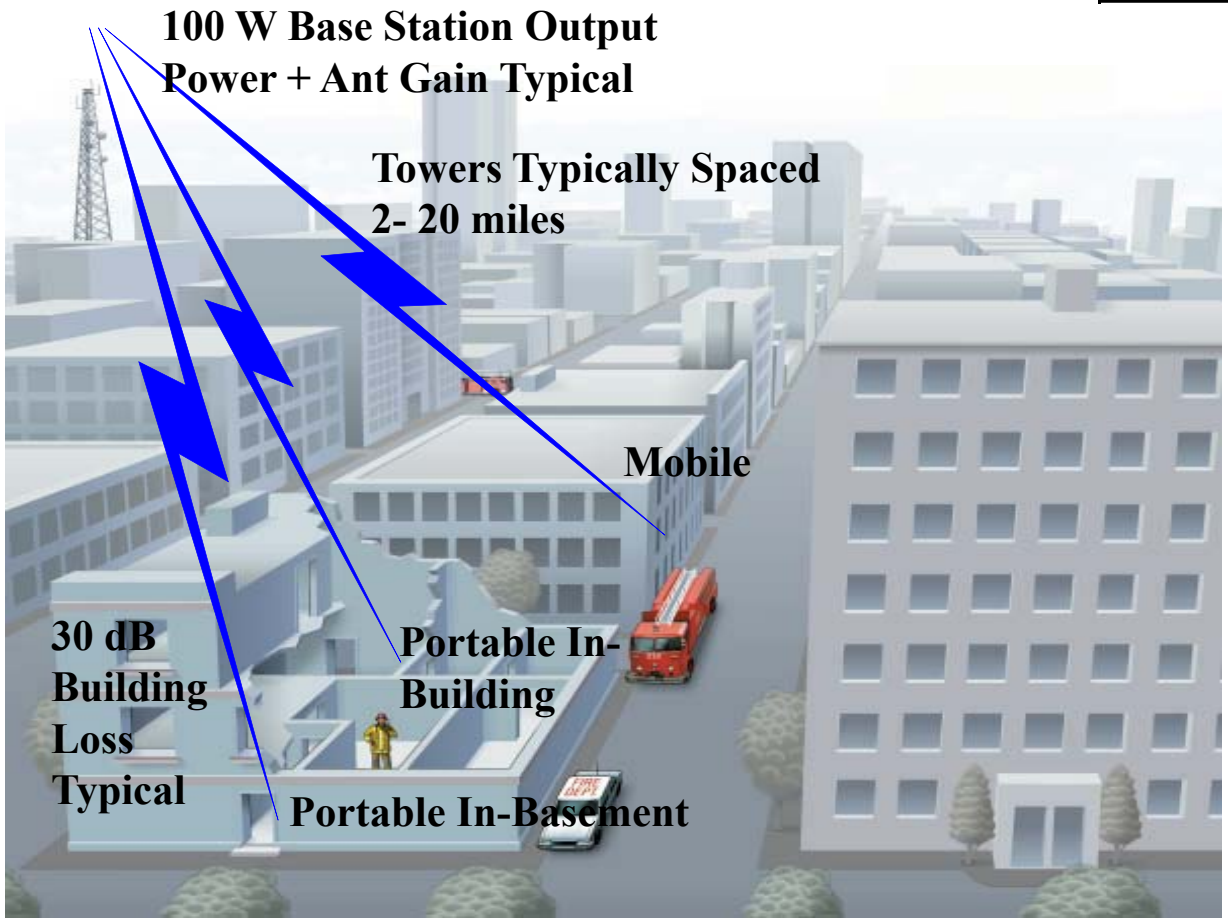
Public Safety Mission Critical Communications Systems

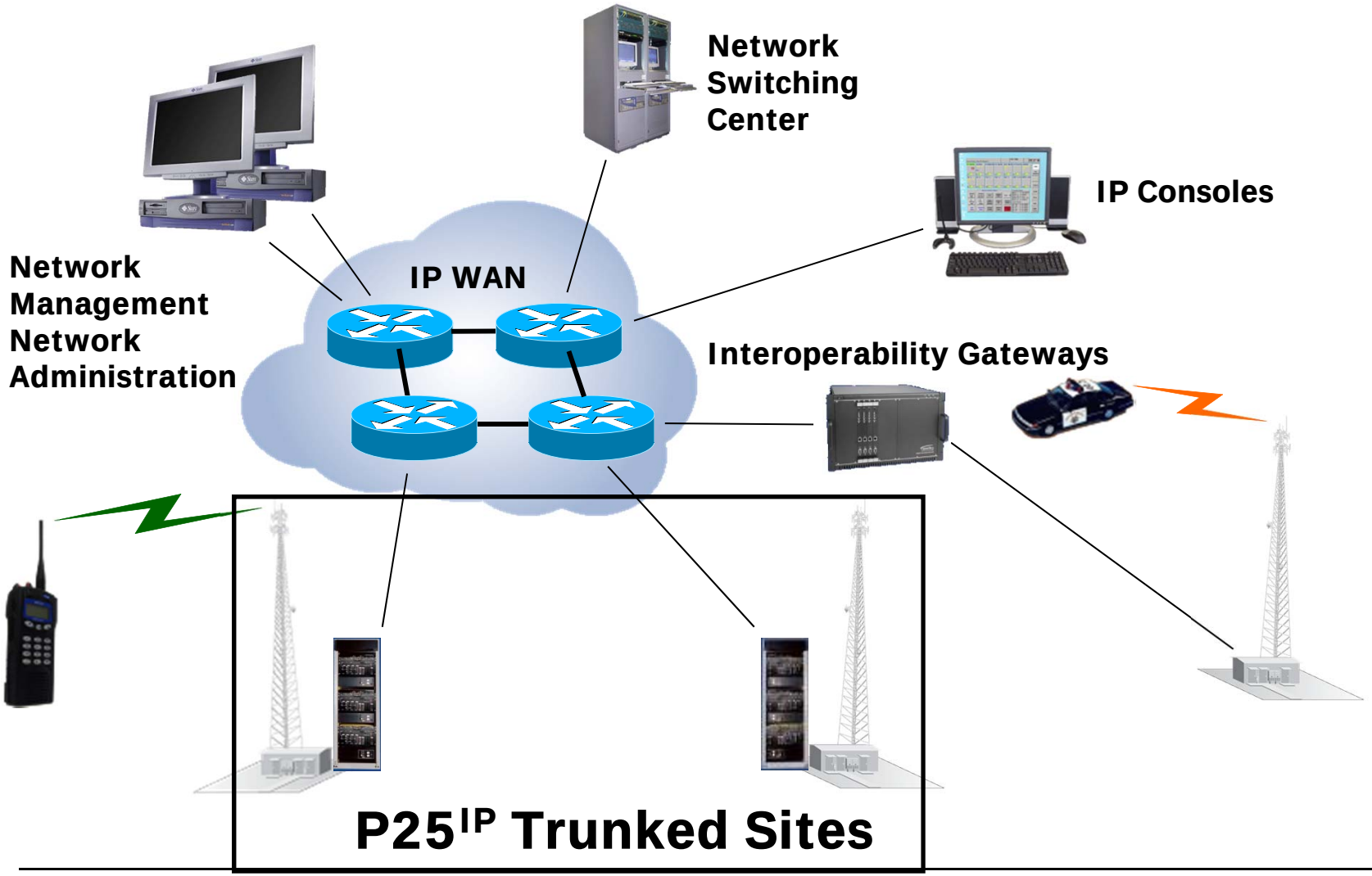
- **Secure Wide-area Voice and Data Networking**
- **Interoperability and Reliability are Key**
- **Fragmented Frequency Bands**
- **Rapid Access - Sub-second Across Network**
- **Mostly Group Calls (“One to Many”)**
- **Near Ubiquitous Coverage**

Near Ubiquitous Coverage



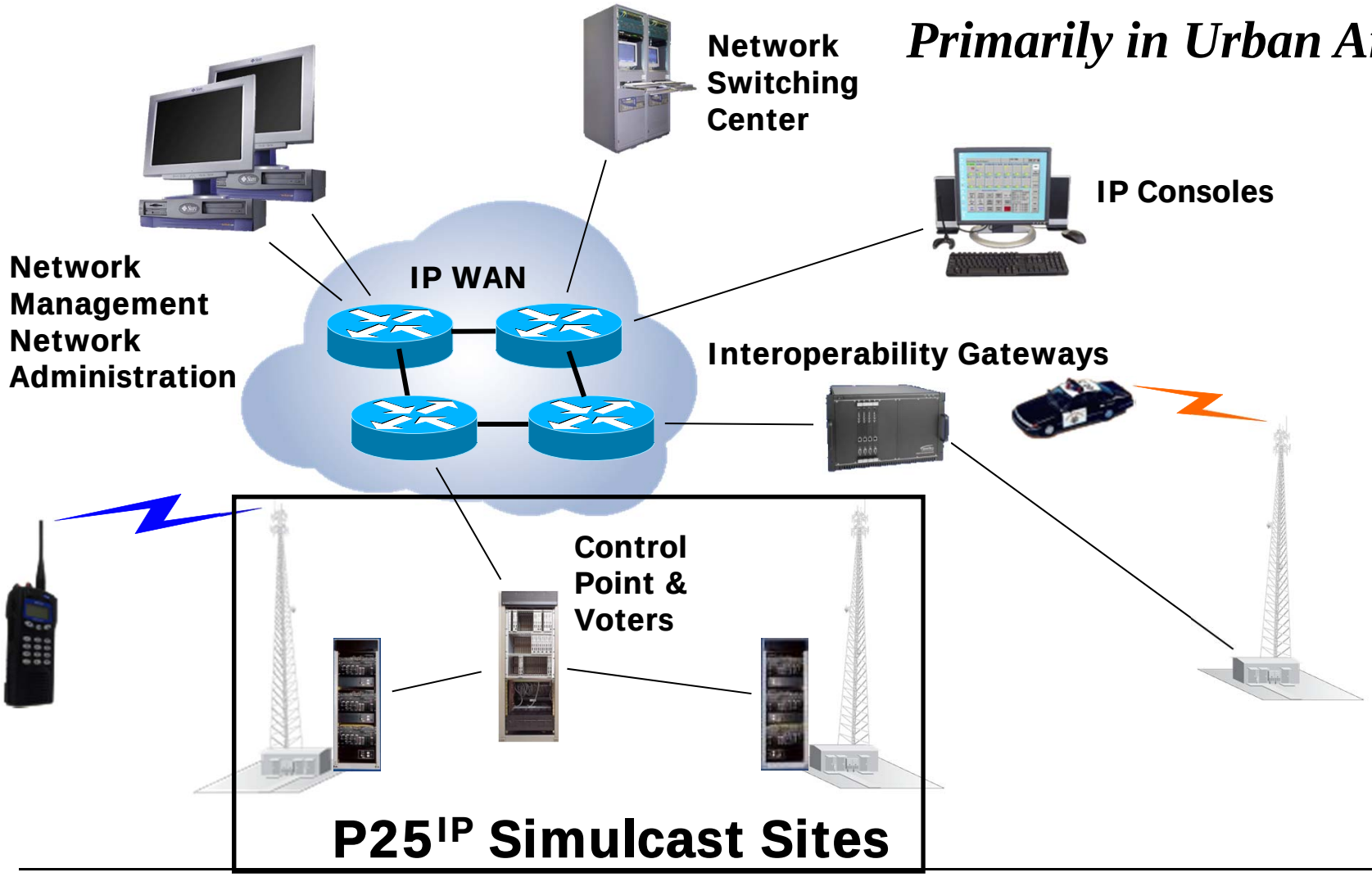
- Coverage Reliability Requirement is Typically 95-98%
- Service Areas: From Small Towns Through Statewide
- 3 Watts Portable Output Power

P25IP Trunked Multisite System

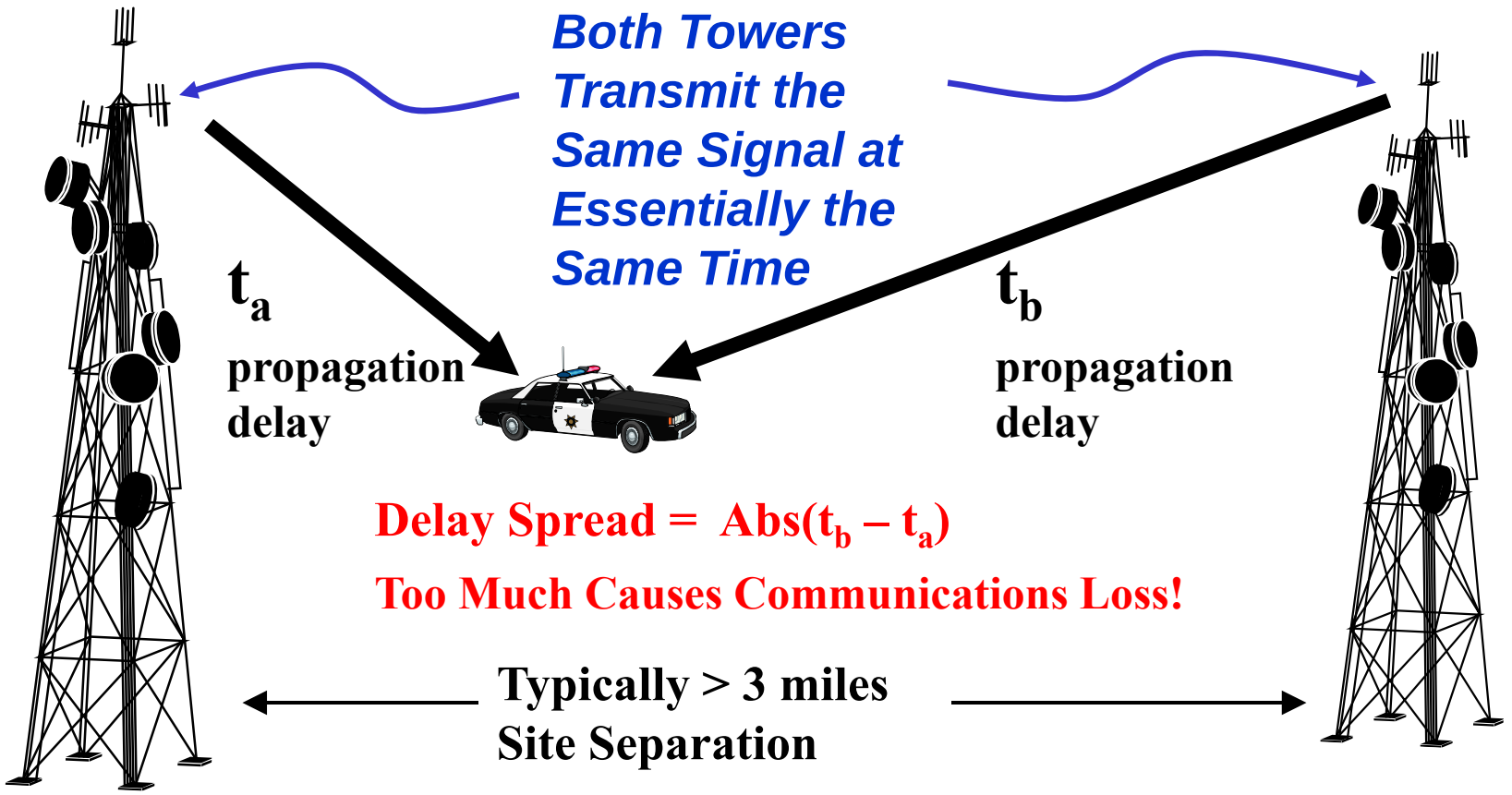


P25IP Simulcast Systems

- *Used Since the Late 80's Primarily in Urban Areas*



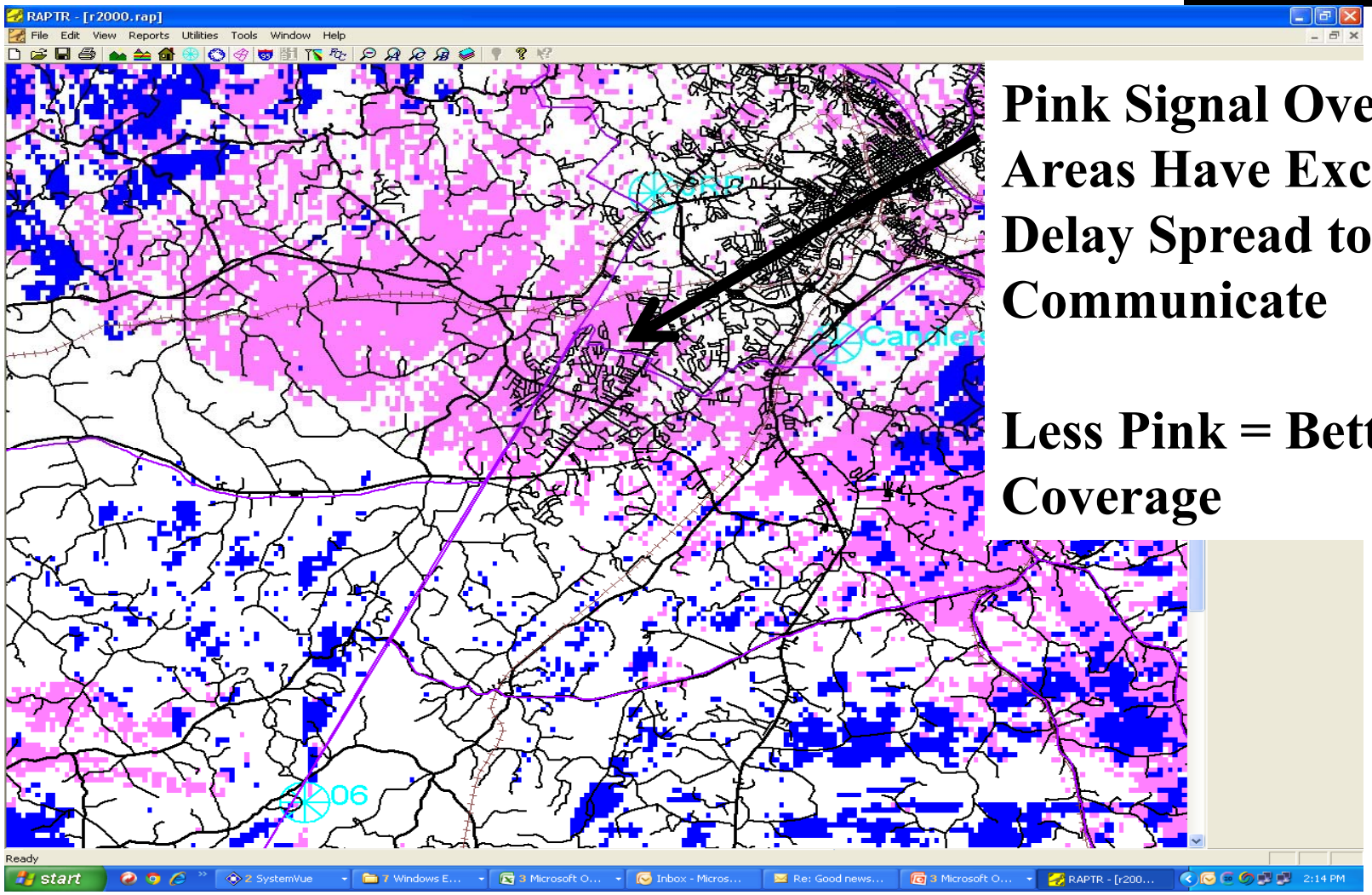
Simulcast System Transmit Overlap



(Delay Spread Only Significantly Effects the Sites' TX Signal)

Note: Typical Harris simulcast systems have more than two sites

Delay Spread from a P25 (C4FM) 3-Site Simulcast System



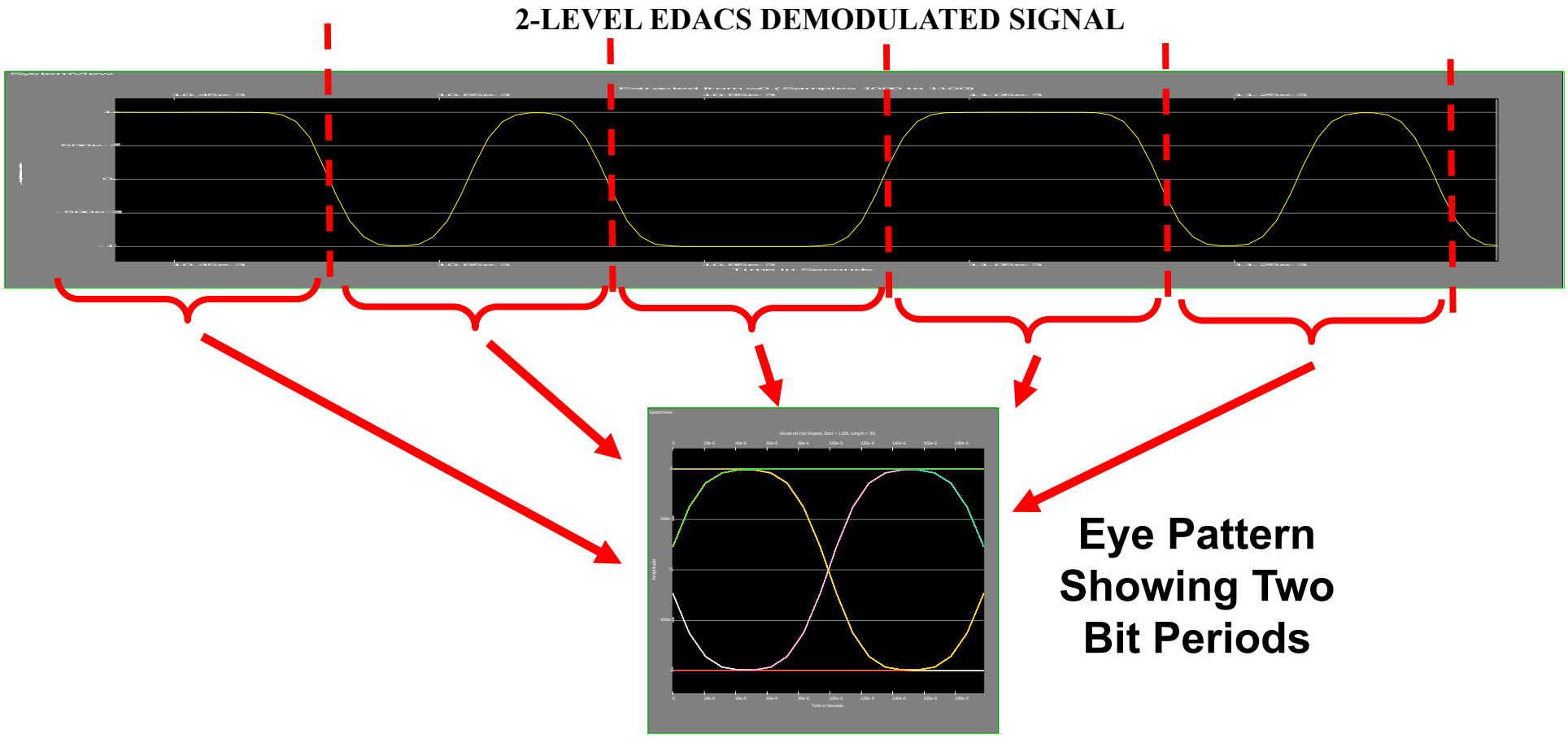
Pink Signal Overlap Areas Have Excessive Delay Spread to Communicate

Less Pink = Better Coverage

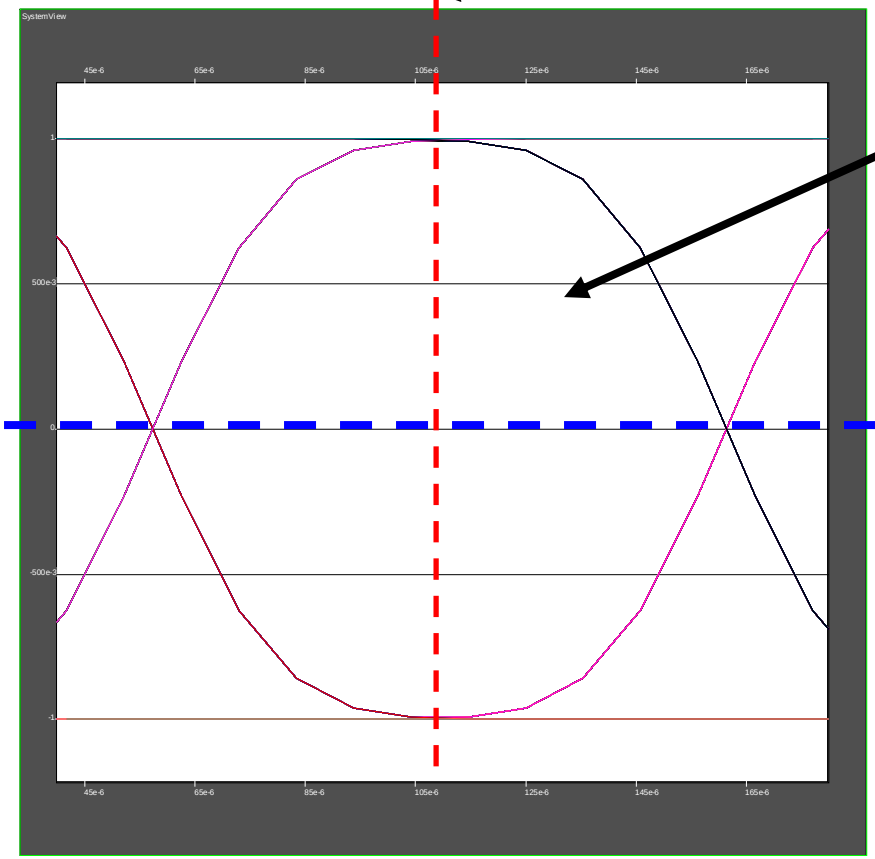
What Can Be Done with the Modulation to Improve the Tolerance to Delay Spread?

Backround: Review of Eye Patterns

- **An Overlay of Time Segments of the Demodulated Digital Signal, with Each Segment an Integer Multiple of the Bit (or Symbol) Period**



Background: Recovering the Information from a 2-Level FSK Modulation



Desired Sample Point

Eye

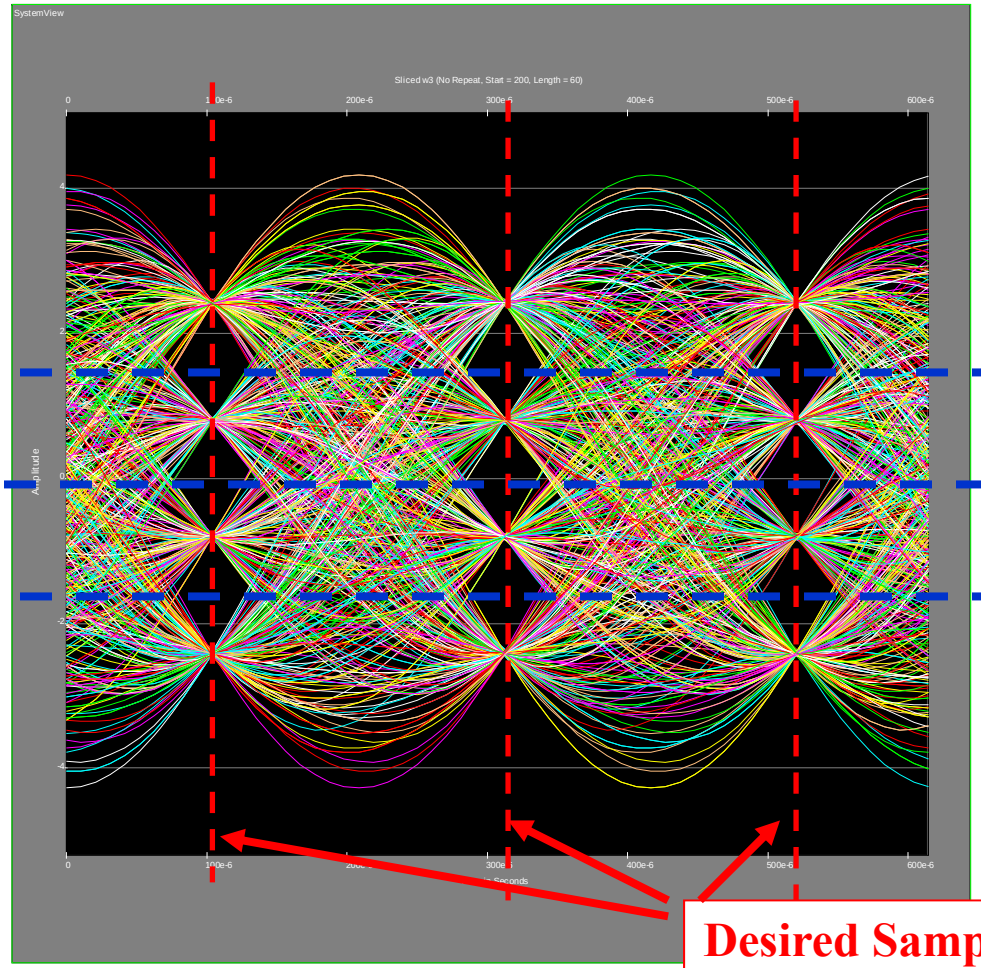
Declare "1"

Threshold

Declare "0"

An "Open" Eye Reduces Errors in Data Recovery (i.e. Lowers Bit Error Rate)

Eye Pattern of P25 Phase 1 4-Level C4FM Modulation



3 Thresholds

Di-Bits Declared:

0,1

0,0

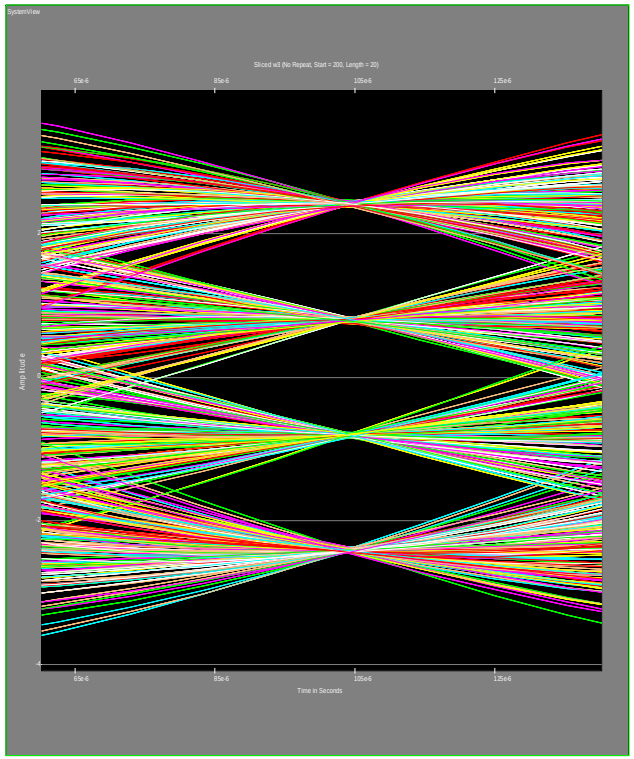
1,0

1,1

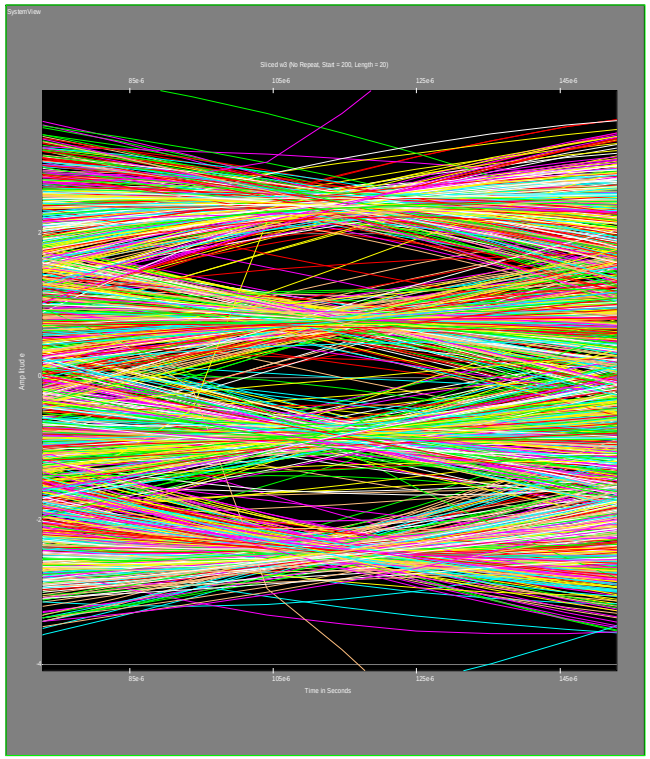
Desired Sample Points

(Figure shows three symbol periods)

Deterioration of P25 Eye Due to Simulcast Delay Spread



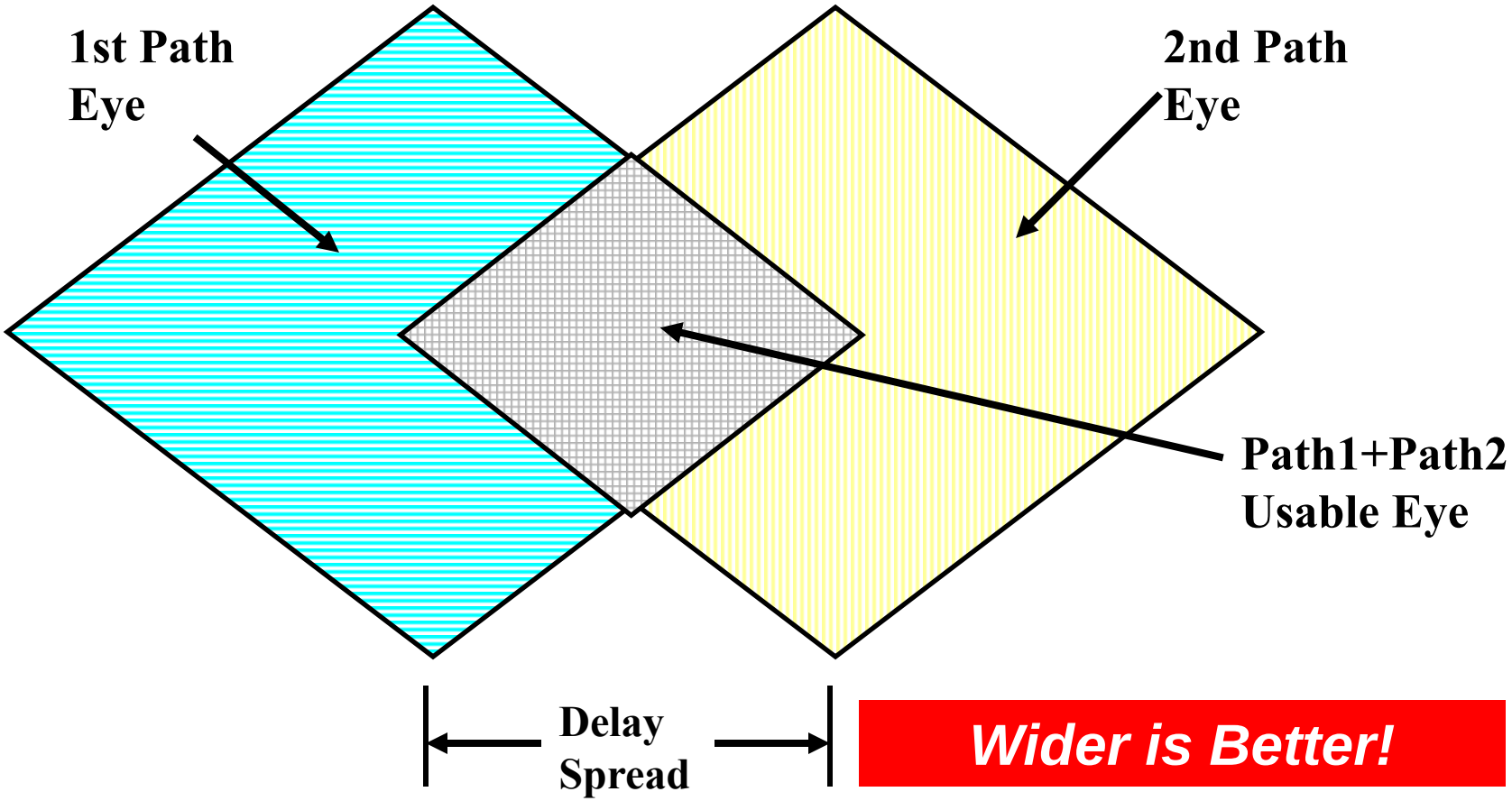
Strong Signal, no Fading



Strong Signal, 25 usec Delay Spread Fading

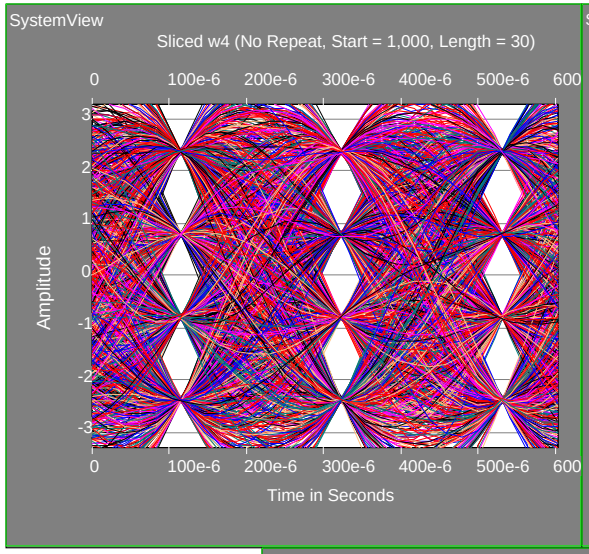
Strong Signal, 50 usec Delay Spread Fading

Model of Delay Spread's Effect On the Eye

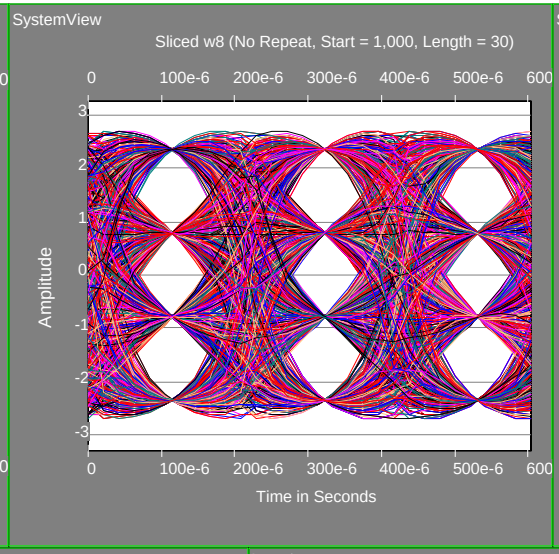


Eye Patterns of Different Modulations

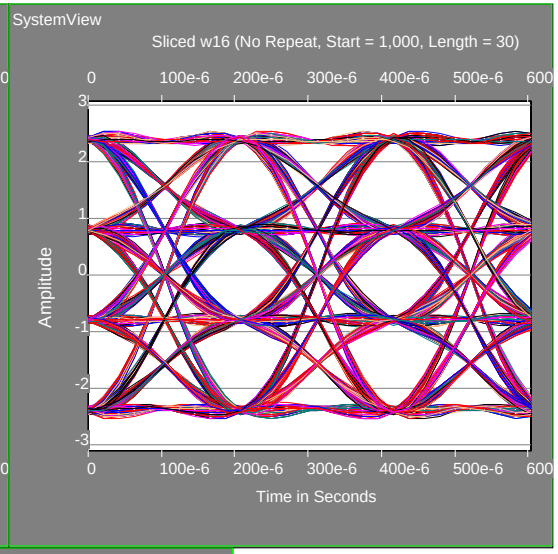
C4FM, α =0.2 (Present P25)



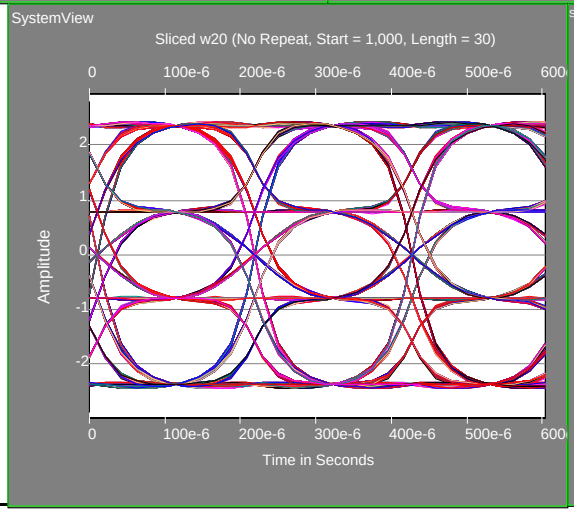
CQPSK, α = 0.2

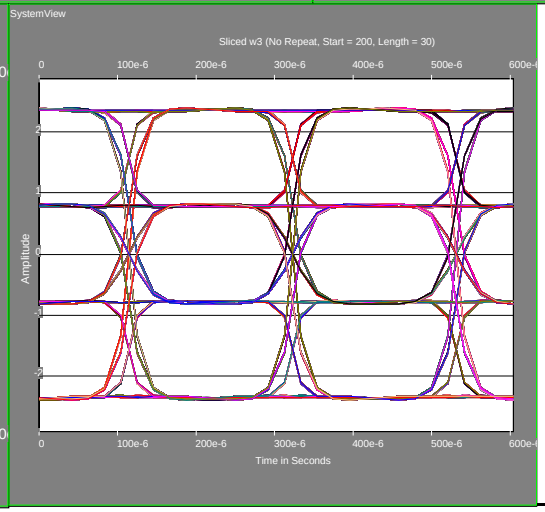


C4FM, α =1



CQPSK, α =1



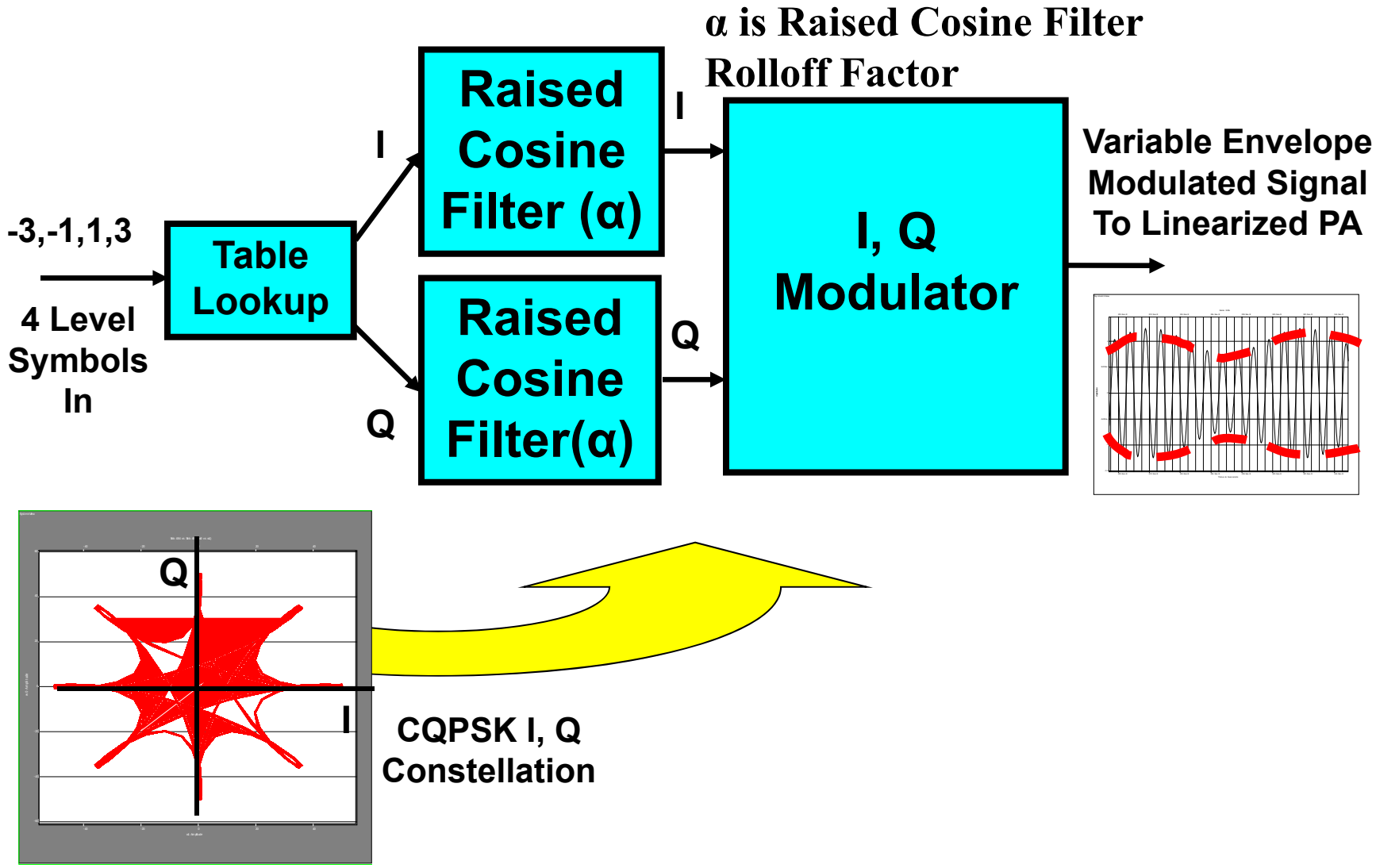


Note: α is the filter rolloff factor

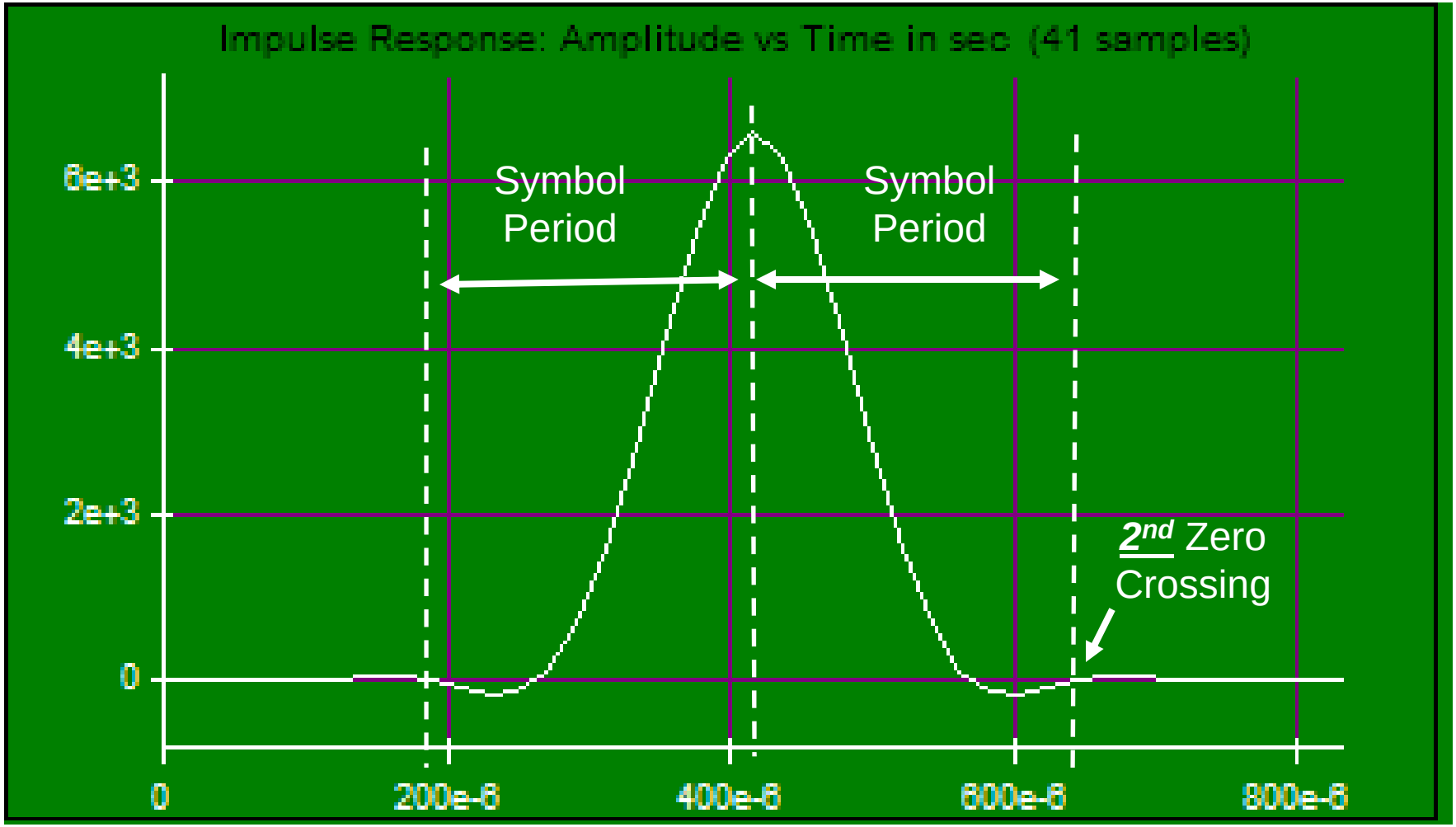
Preferred Wide CQPSK

(Denoted WCQPSK)

WCQPSK π/4 Differential Phase Modulation



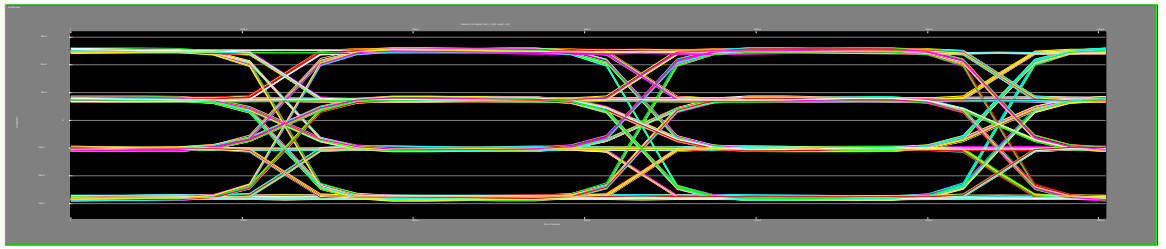
Our Patented WCQPSK Modulation Filter 's 2nd Zero Crossing Impulse Response Enables a Wider Eye



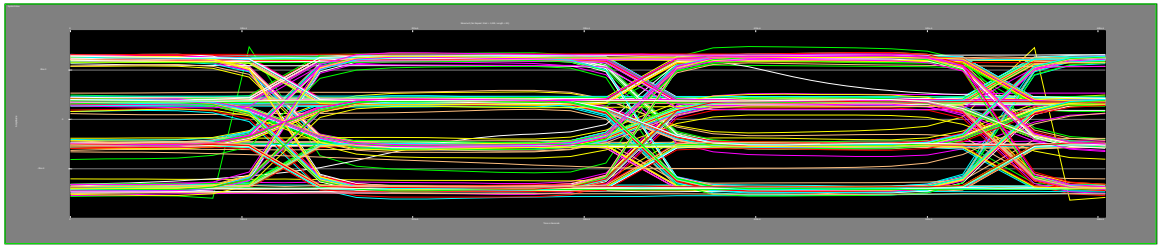
Discernible WCQPSK Eyes Remain Even for 120 usec Delay Spread

HARRIS

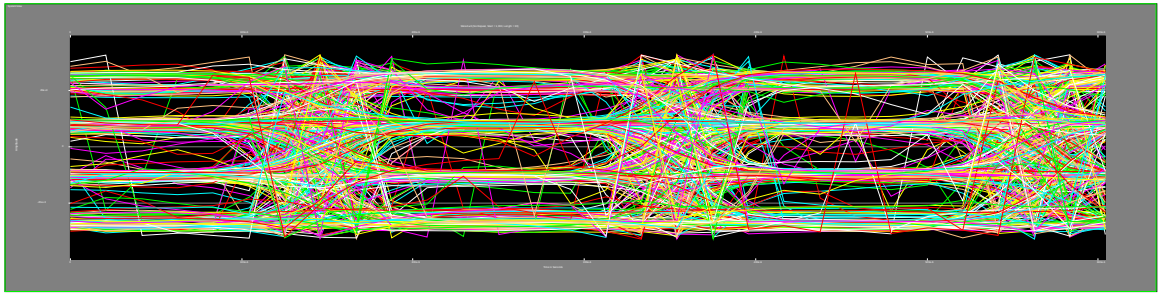
Static, Strong Signal



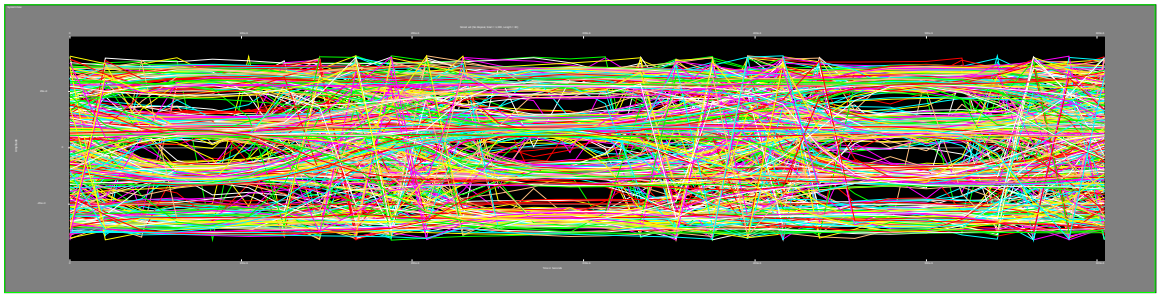
Faded, Delay Spread=0



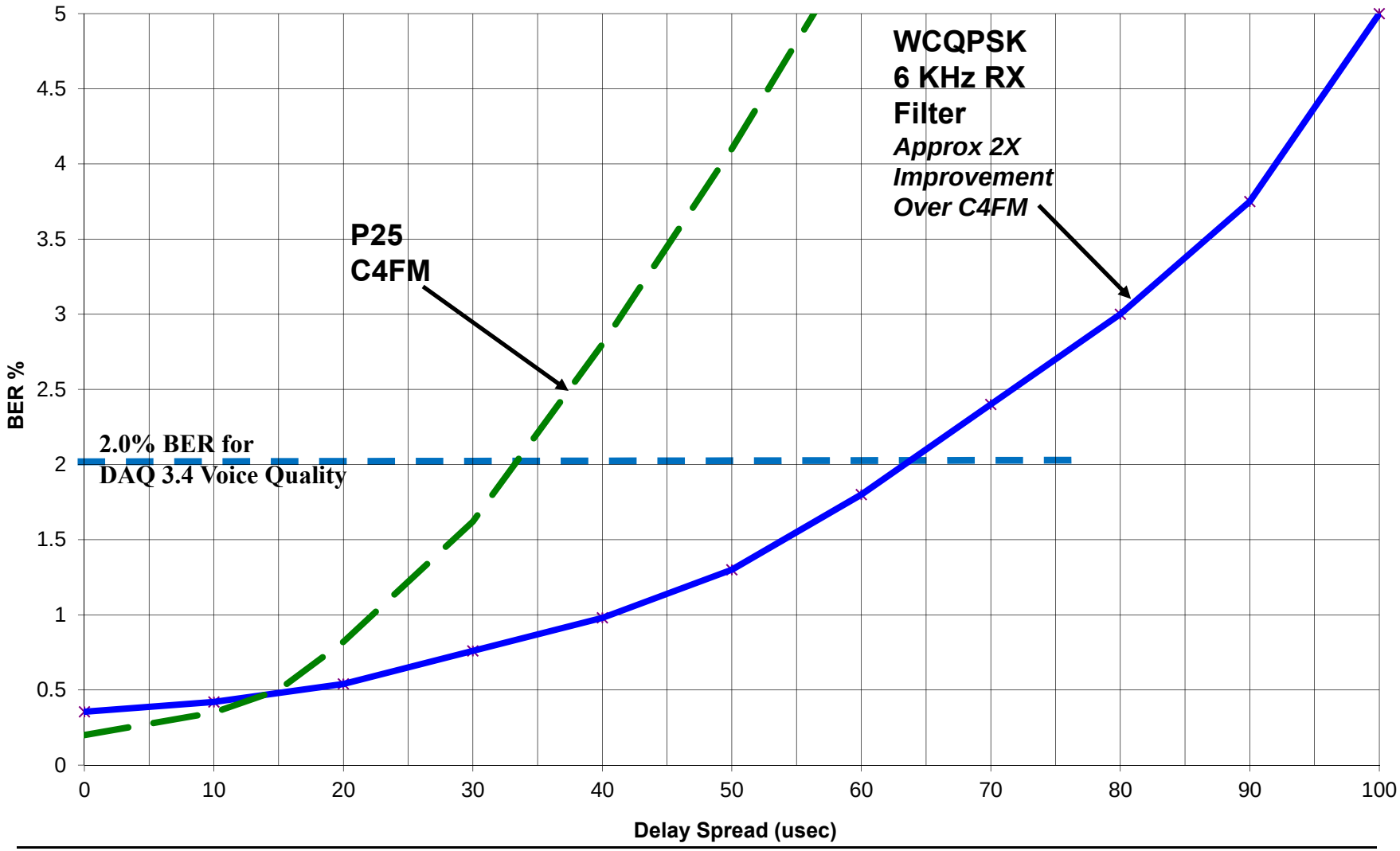
Faded, Delay Spread=40 usec



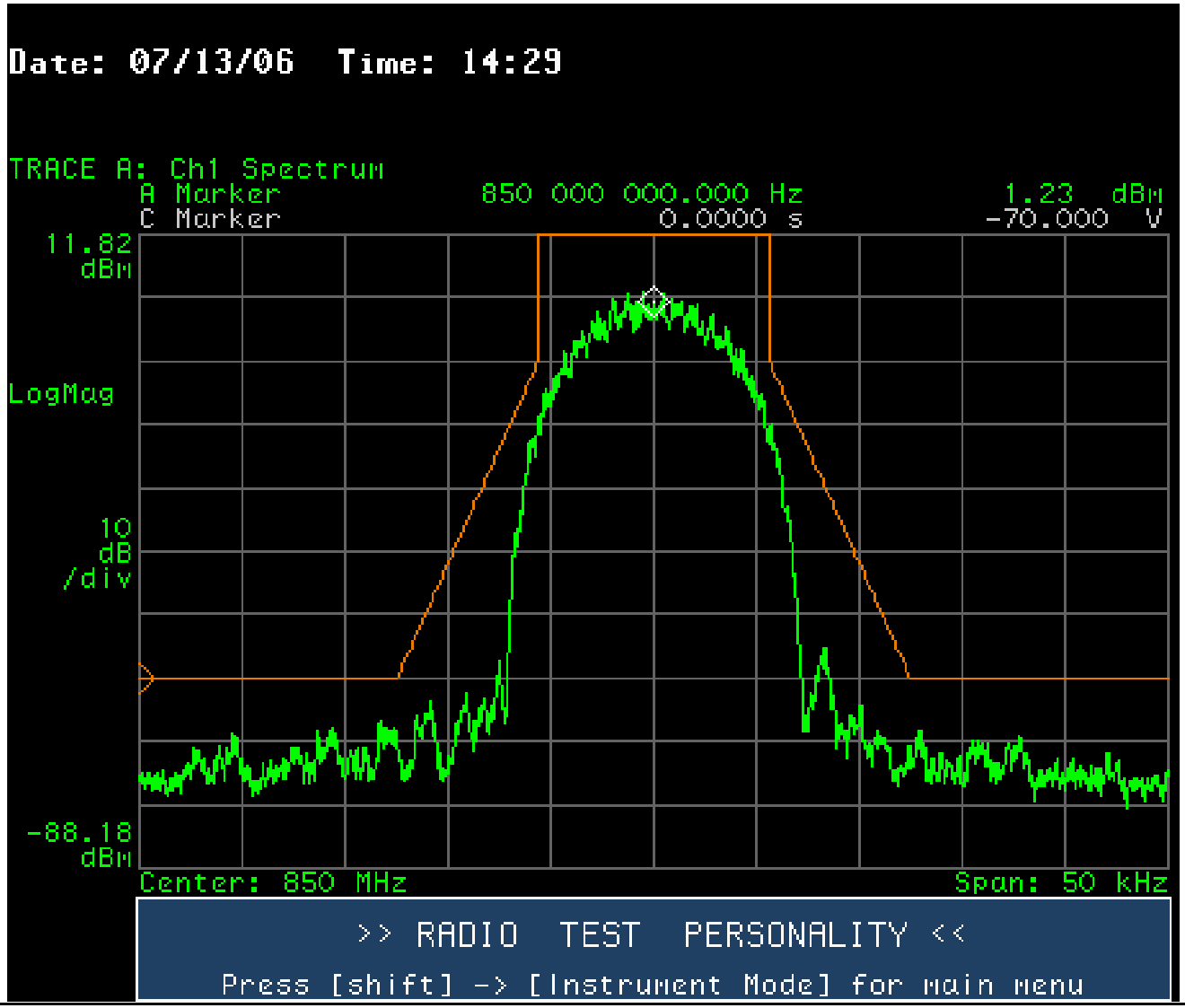
Faded, Delay Spread=120 usec



BER Versus Delay Spread Comparison



WCQPSK Spectrum Out Of Our Base Station's Linearized PA Meets the Stringent 210d NB Mask



- Peak Hold Measurement
- 100 W Avg Power

Summary of WCQPSK Conceptual Design

- **Simulcast Delay Spread BER Can Be Greatly Improved with PSPC's WCQPSK Linear Modulation that Has "Wider" Eyes**
  - ✓ **> 2X Delay Spread Improvement Over P25 C4FM**
  - ✓ **Meets Required FCC Masks and has Low TX ACP**
  - ✓ **Has Slightly Better Sensitivity than P25 Phase 1 C4FM Systems**

Questions?

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