Designing a dual purpose indoor illumination and optical communication system

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1. Wireless bandwidth crunch

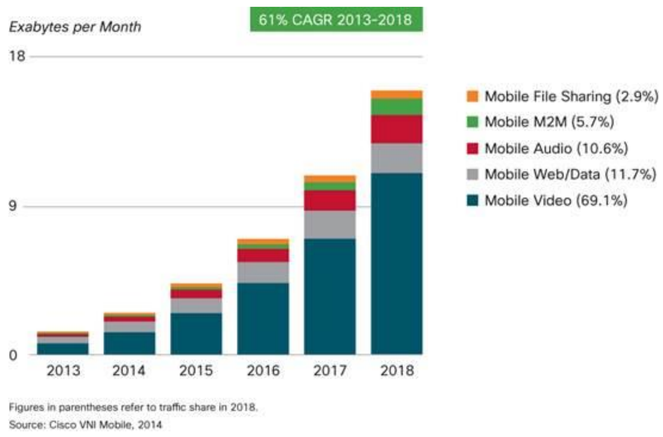

Figure 1: Wireless data demand will grow at CAGR 61%

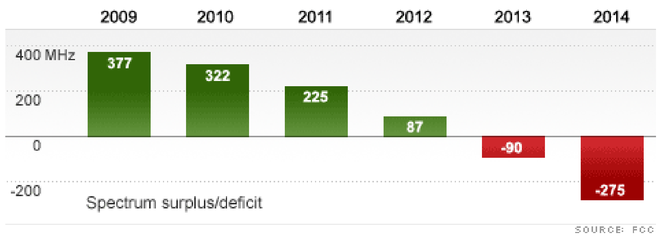

Figure 2: 275 MHz of spectrum deficit today.

- Wireless demand is outpacing supply.
- Need additional spectrum to mitigate wireless bottleneck.

2. Use visible spectrum

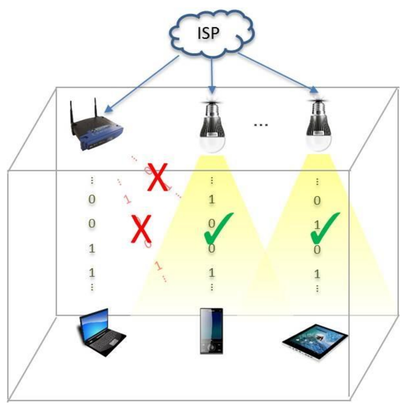

Figure 3: Wireless communications over visible spectrum

- LED lighting being rapidly adopted.
- Light bulbs are ubiquitous.
- Enables exploiting visible spectrum for opportunistic wireless access.
- Yet untapped.
- Not regulated.
- Use in addition to RF spectrum mitigates downlink bottleneck.

3. Block diagram

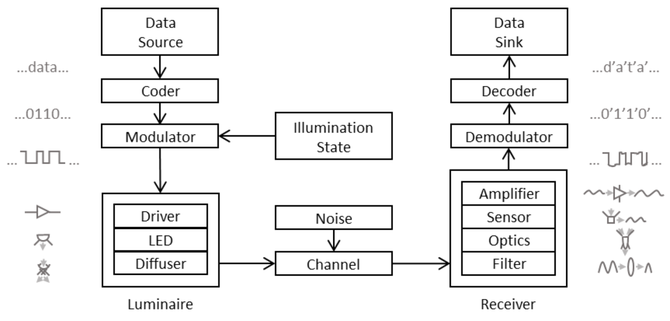

Figure 4: Optical downlink system block diagram

4. Illumination CCT

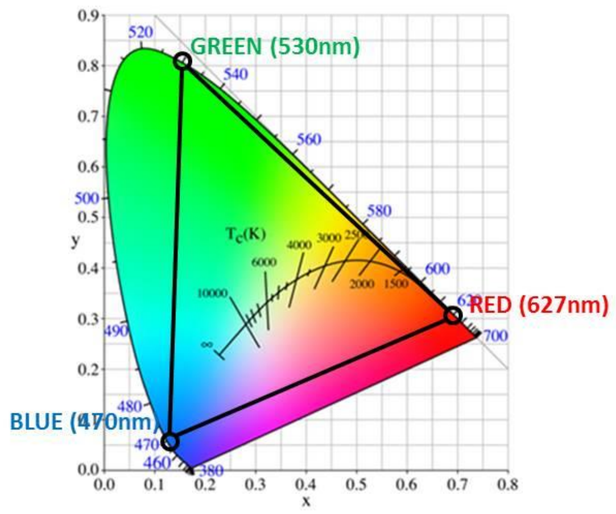

Figure 5:RGB LEDs and CIE 1931 XYZ color gamut

5. Transmitter

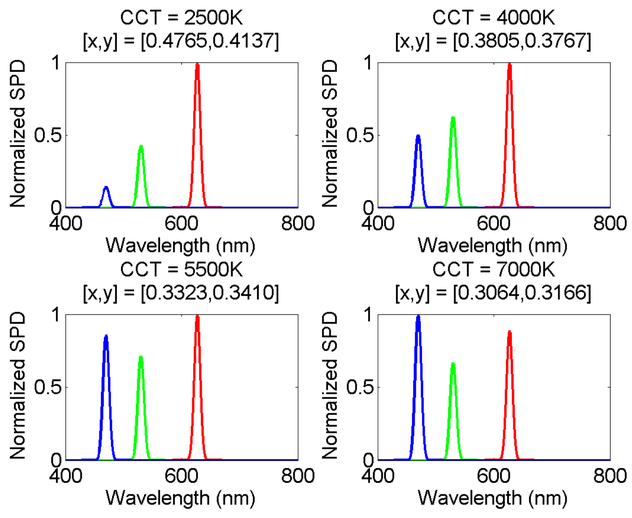

Figure 6: Generation of different CCT with RGB LEDs

6. Receiver

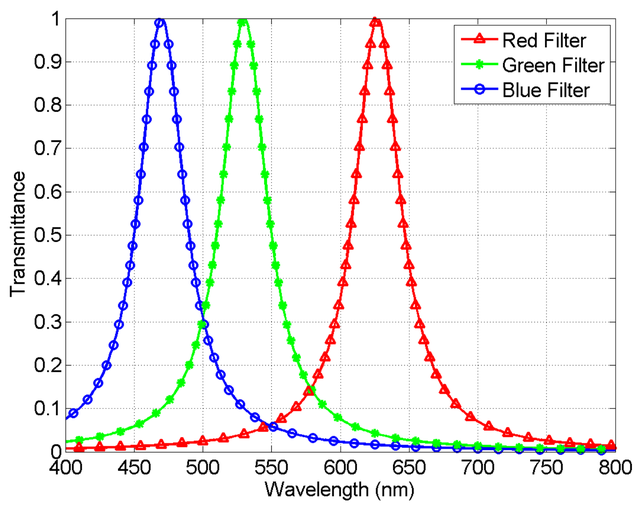

Figure 7: Optical filter transmittance – Lorentzian FWHM = 40nm

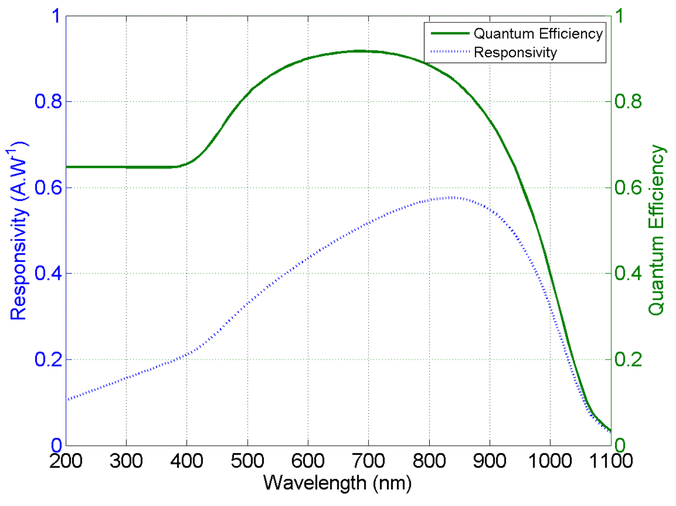

Figure 8: Receiver photodiode quantum efficiency and responsivity

7a. Optimal CCT

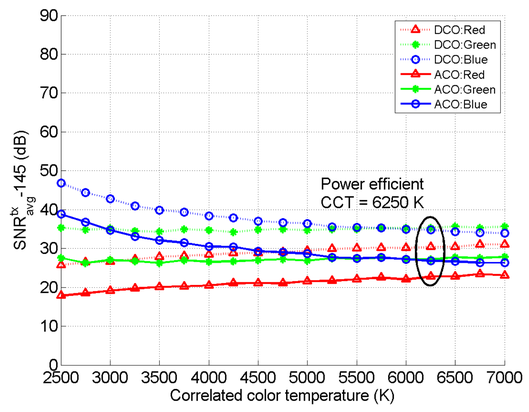

Figure 9: SNR vs CCT (No ICI)
SPD Tx = 5nm; FWHM Rx = 40nm

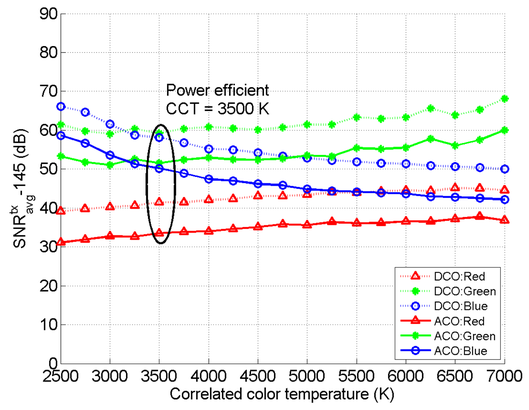

Figure 10: SNR vs CCT (High ICI)
SPD Tx = 50nm; FWHM Rx = 250nm

7b. Optimal SPD spread

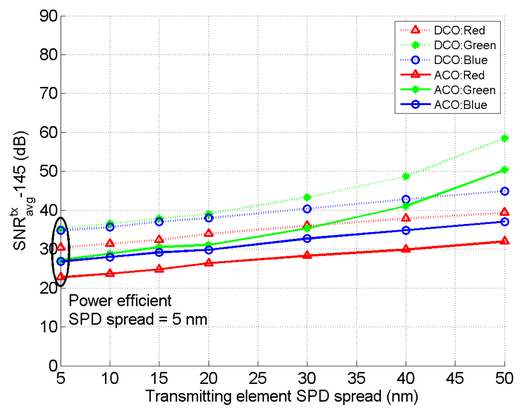

Figure 11: SNR vs SPD spread
FWHM Rx = 40nm; CCT = 6250K

7c. Optimal filter FWHM

Figure 12: SNR vs Filter FWHM
SPD Tx = 5nm; CCT = 6250K

Acknowledgements

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