

#### Study Session on Phosphor-Free White LEDs for Solid-State Lighting

### White LEDs for Visible Light Communications

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Study Session: White LEDs for Solid-State Lighting

## **Motivation**



 Indoor wireless communication systems for broadband connectivity



## **Visible Light Communications**



- Separate red, green, and blue (RGB) LEDs
  - Higher modulation
    bandwidth
  - Allows for the possibility of WDM to increase transmission capacity

- White LEDs
  - -Generally, based on wideband phosphors
  - Simple and potentially low-cost
  - Limited modulation bandwidth due to relaxation time of phosphor

## White LED Modulation BW Limit



 Typical frequency response of phosphor-based white LED



C. H. Yeh et al., Opt. Express, 20(15), 16218, 2012

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# **Overcoming the Modulation BW Limit**



- Use spectrally efficient modulation formats
  - -Quaternary-amplitude-shift-keying, e.g., 4-ASK
  - Orthogonal frequency division multiplexing (OFDM)
- Use phosphor-free white LEDs



 Unite the technologies developed in other projects, e.g., phosphor-free nanowire white LEDs with graphene transparent electrodes, in the form of practical systems demonstrations



 To develop a visible light communication system/testbed for broadband indoor wireless communications





- Available infrastructure
  - -32 GHz arbitrary waveform generator
  - -33 GHz real-time oscilloscope
- Build on experience in fiber optic and free-space optical communications
  - Spectrally efficient modulation formats for longhaul transmission, including coherent communications and optical OFDM
  - Demonstrations of large channel count free-space optical backplanes



- To characterize the modulation bandwidth of phosphor-free nanowire white LEDs and investigate the generation of spectrally efficient modulation formats, including 4-ASK and M-QAM OFDM
- Available infrastructure
  - -Nanopositioning equipment
  - -DC and RF probes
  - -20 GHz and 50 GHz RF synthesizers
  - Digital communication analyzers with 65 GHz optical sampling modules and 80 GHz electrical sampling modules

## **Previous Results**



• 4-ASK



C. H. Yeh et al., Opt. Express, 20(15), 16218, 2012

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## **Previous Results**





G. Cossu et al., Opt. Express, 20(26), B501, 2012

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 To demonstrate visible light communications using phosphor-free nanowire white LEDs at transmission speeds in excees of 5 Gb/s