



# ***“IEEE802.15.4-2006 Sub-1 GHz-Lösungen für Sensornetzwerke mit optimierter Funkabdeckung“***



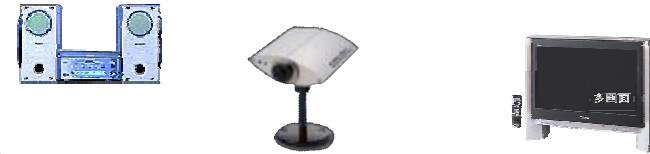
# Spectral Density is the Foundation of Wireless Communication

## Data Streaming (Access Points)



**250 – 100.000 Kbps**  
Voice & Data Communications

## Voice & Video Streaming



**5Mbps – 1Gbps**  
Multimedia

**Bandwidth  
Spectral Density**



**< 2.000 Kbps**  
Voice Communications

## Mobile Handsets (Voice)



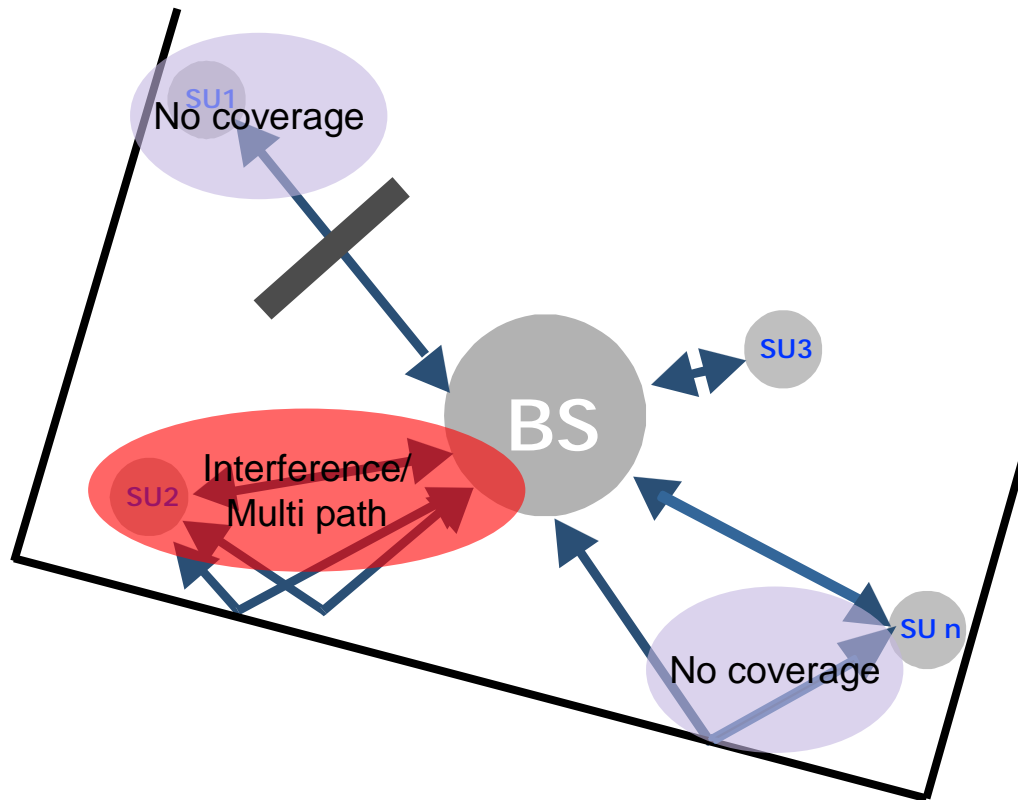
**<250 Kbps**  
Sensor Networks  
Building Automation

## Building Automation



## Wireless Application Challenges

**Real wireless applications (especially indoor) are challenged by various issues**



### Challenging Issues:

- § Interference
- § Multi-path fading
- § Range & coverage
- § NLOS
- § Spectral density (data rate)

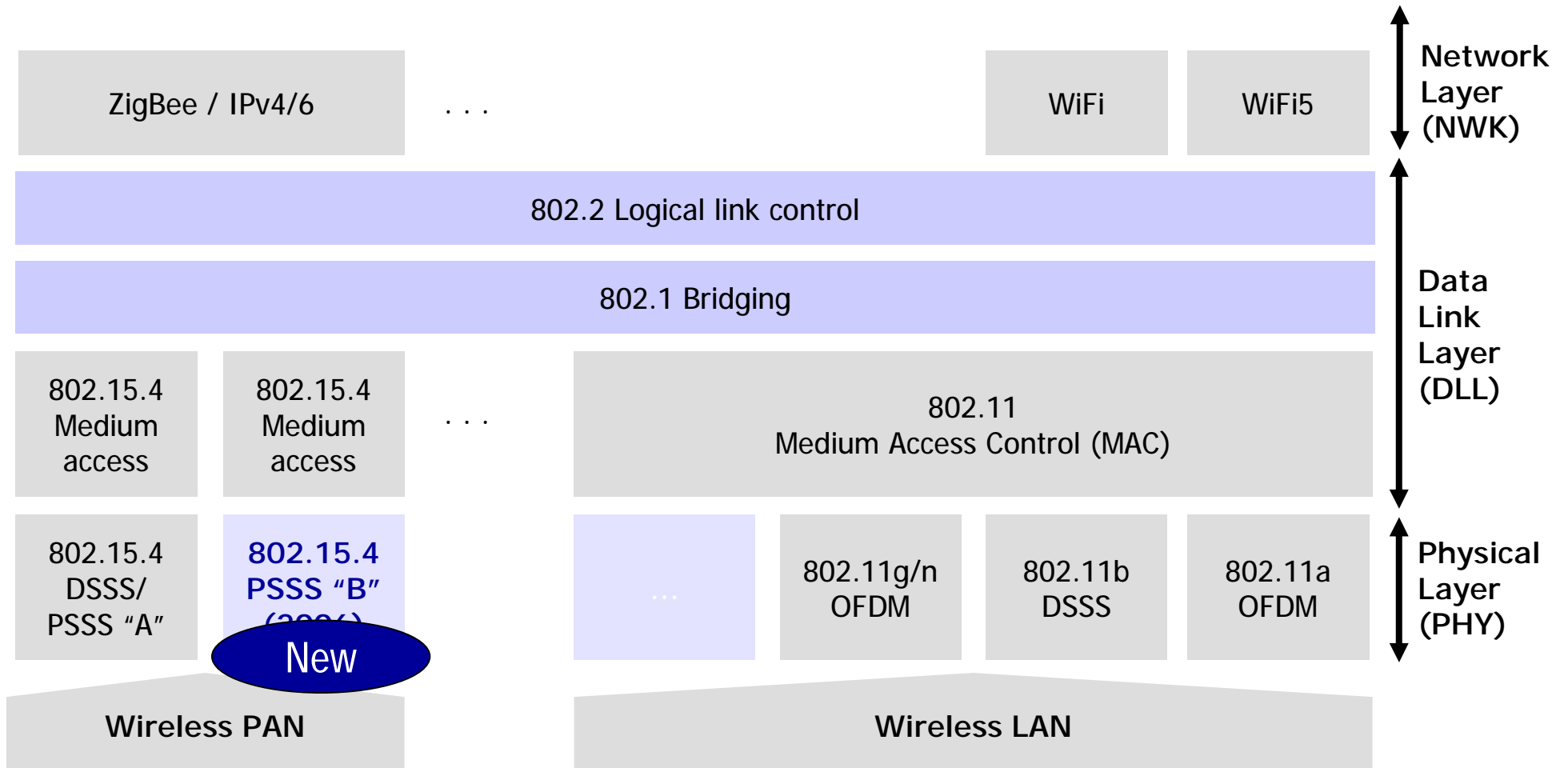
### Application demands:

- § Highest reliability / data rate (QoS)
- § Long range / Full coverage
- § Many subscribers (nodes)
- § Low power consumption
- § Low system cost
- § Co-Existence with e.g. WLAN, Bluetooth



# IEEE Solutions

## IEEE Standards of 802.15.4-2006 PHYs

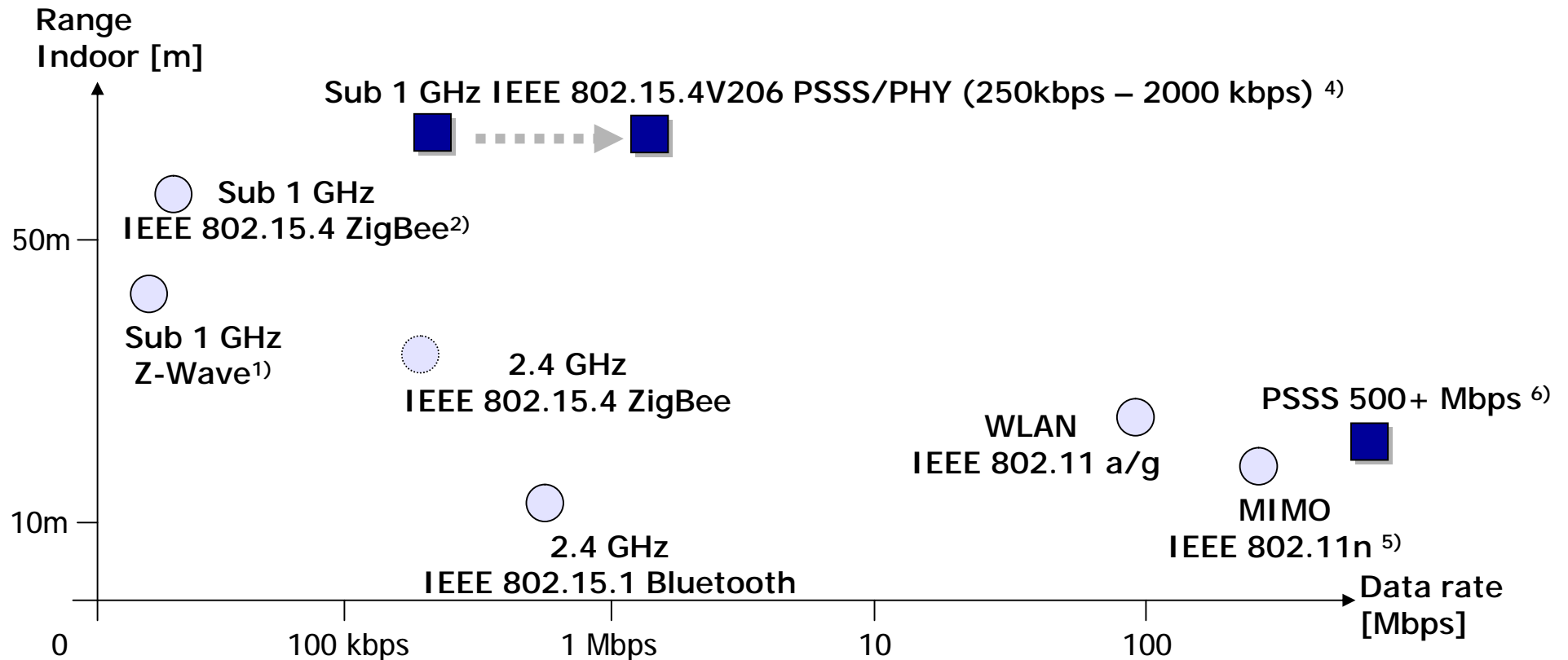


PSSS: Parallel Sequence Spread Spectrum



## IEEE Standards Data Rate vs. Range

**IEEE802.15.4-2006 PSSS/PHY solution improves existing wireless IC solutions from 20 kbps to 250 kbps – with performance mode up to 1000 kbps and even more.**



1) Z-Wave FSK based 10/40 kbps EU/US. No IEEE Standard.

2) IEEE 802.15.4 868/915 MHz system 20/40 kbps EU/US.

3) In combination with OFDM (high complexity of IC).

4) 1 Mbps proprietary.

5) Draft IEEE Standard.

6) Factor 10 less complex (gate count) than Mimo OFDM. Could be build with today in mass markets available components.



## IEEE 802.15.4-2006 Performance Facts

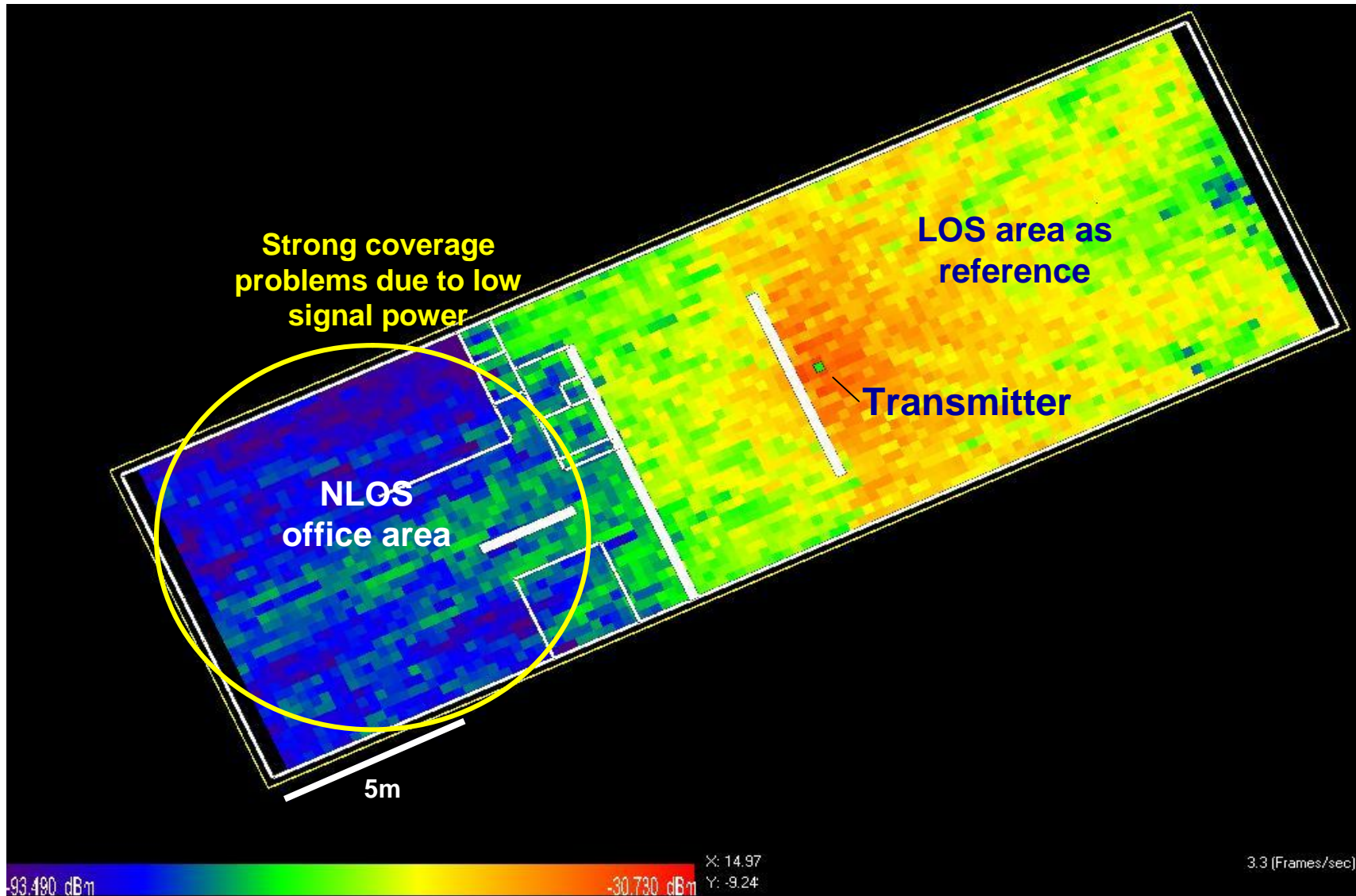
- § **2.4 GHz based solutions will cause performance problems due to interference with WLAN and Bluetooth. <sup>1)</sup>**
- § **Sub 1 GHz band is highly attractive due to less inference probability and better physical range. <sup>1)</sup>**
- § **Existing Sub 1GHz solutions limited to 20/40 kbps EU/US data rate (old IEEE 802.15.4).**
  - § Limited number of nodes due to 1% duty cycle limitation by ETSI.
  - § Not usable i.e. for Building Automation <sup>2)</sup>
- § **ZigBee offers 250 kbps in 2.4 GHz.**
- § **IEEE 802.15.4-2006 base for 250 kbps even in Sub 1 GHz (EU and US) with low cost and lower power consumption.**

1) Søren Hansen, Danfoss A/S, Nordborg, DK, Experience with Mesh Network Stacks in residential applications, Z-Wave Alliance- Z-Wave vs. ZigBee - CTC - 14 June 2005.

2) Dipl.-Ing. Kurt Speelmans, Bundesamt für Bauwesen und Raumordnung, VDI Fortschritt-Berichte VDI, Wireless Technologies, 8. Kongress Sept. 2006, page 219.



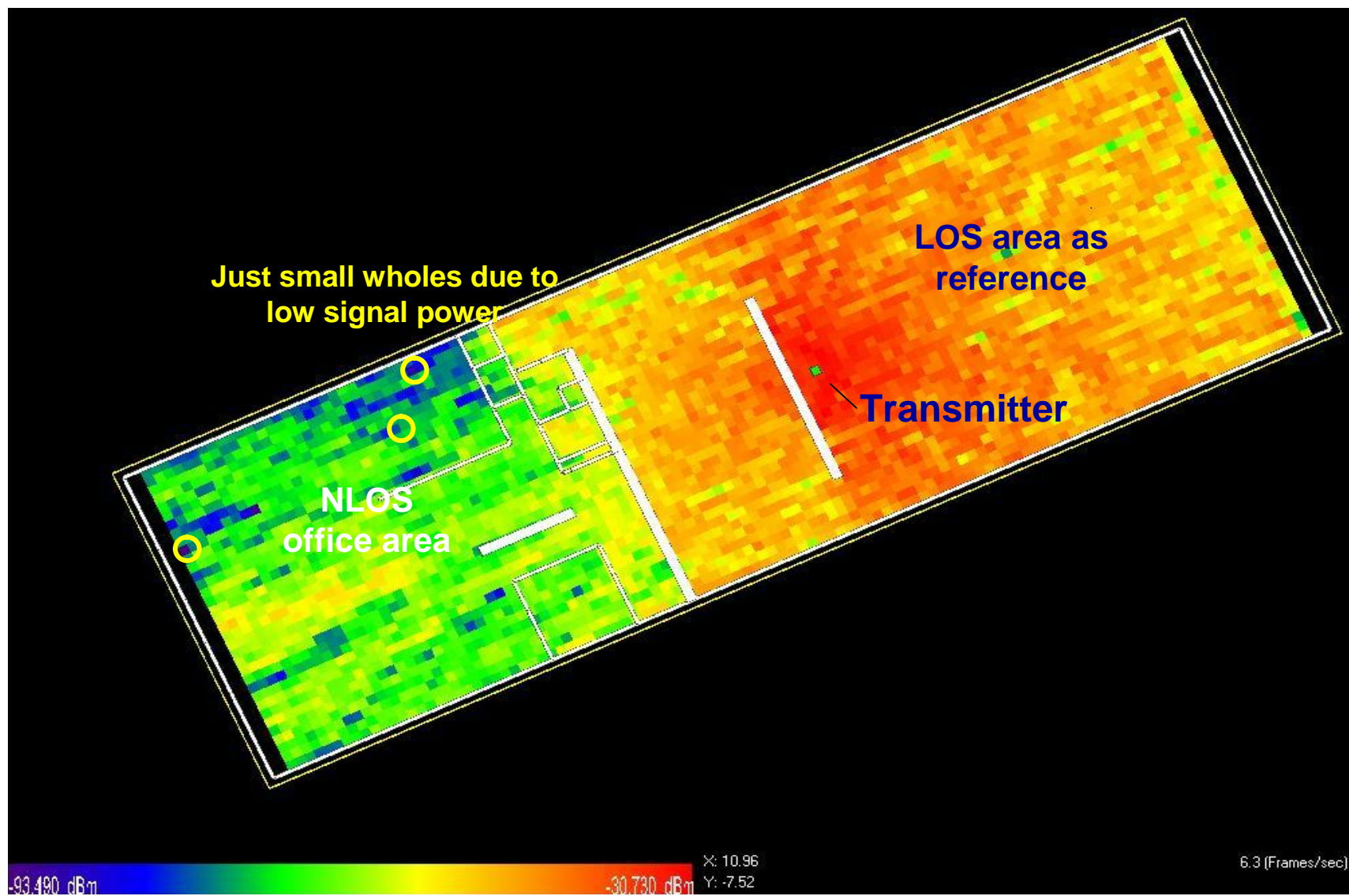
Typical Office Environment  
IEEE 802.15.4 Transceiver 2.4 GHz, 250 kbps  
Received Power in dBm







Typical Office Environment  
IEEE 802.15.4-2006 Transceiver Sub 1 GHz, 250 kbps  
Received Power in dBm







## DWW Solutions

§ **Discrete Prototype now.**

§ **Discrete Eval Board Q1 2009.**

§ **Single Chip Q4 2009**

§ PSSS

§ 802.15.4-2006 PSSS 250 kbps at 868/915 MHz

§ PSSS enhanced, down compatible to 802.15.4-2006, up to 1... 2 Mbps

§ FSK

§ EN 13757-4

§ 2,4 / 16,384 / 66,6 kbps

§ Proprietary FSK

§ PHY-Auto Detect without increased current consumption.

§ AES Encryption



## Link Budget DWW Chip

### § **Transmit Power:**

§ +15 dBm

### § **Sensitivity:**

§ -105 dBm@250kbps ETSI

§ -115 dBm@250kbps FCC

### § **Link Budget IEEE 802.15.4**

§ > 120 dB at 250 kbps ETSI, Unique

§ about 130 dB at 250 kbps FCC

### § **Extreme robust against Multipath Fading.**

§ High performance due to 32 chip ideal orthogonal PSSS spreading with delay spread adapted code coherence length.

### § **Proprietary data rate up to 1 Mbps (2 Mbps).**

### § **Power consumption as low as leading competitors**

### § **Complexity not higher than IEEE802.15.4 competitor chips**



## Summary

### § **PSSS based IEEE802.15.4-2006 platform**

- § Best-in-Market spectral efficiency AND all advantages of spread spectrum system.
  - $\frac{1}{2}$ ...4 bit/s/Hz compared to 1/16 bit/s/Hz in 15.4 / 2.4 GHz.
- § 250 kbps rate – plus enhanced modes with up to 2 Mbps.
- § Superior Link Budget of 130dB in low cost single chip.
- § 5–10x range compared to 15.4 / 2.4 GHz due to high link budget and Sub 1GHz band.
- § >5x multipath fading robustness compared to 15.4 / 2.4 GHz – >1 $\mu$ s delay spread.
  - 32 chip orthogonal PSSS spreading + delay spread adapted code coherence length.
- § Lower analog and digital complexity than 15.4 / 2.4 GHz and COBI designs.
- § ZigBee and TCP/IP and other Stacks available.

### § **Additional, flexible FSK mode implemented**

- § Compliant with EN 13757-4 FSK (Wireless M-Bus) and other standards.
- § Auto-detect of FSK / PSSS modes enables “transparent” multi-mode devices
- § Standards-based PSSS modes provide attractive upgrade path for EN13757 et al.
  - Higher bitrate – Larger networks – Faster readings – Longer battery life
  - Better multipath fading robustness – More reliable operation in basements etc
  - Longer range.

### § **Discrete prototype boards in evaluation – Single chip transceiver in development**



Further Questions?



§ Thank You

§ Contact:

§ [www.dw-w.com](http://www.dw-w.com).

§ [info@dw-w.com](mailto:info@dw-w.com).