The left side of the slide features a decorative vertical bar with a grid pattern, a solid orange vertical line, and several orange circles of varying sizes. The main title is centered on the right side of the slide.

THE DESIGN AND EVALUATION OF A WIRELESS SENSOR NETWORK FOR MINE SAFETY MONITORING

Haitao Bian ECGR6185

BACK GROUND

- ⌘ Coal Mine Fatalities
- ⌘ Methane Explosions
- ⌘ Requirement for Monitoring
- ⌘ Current Systems



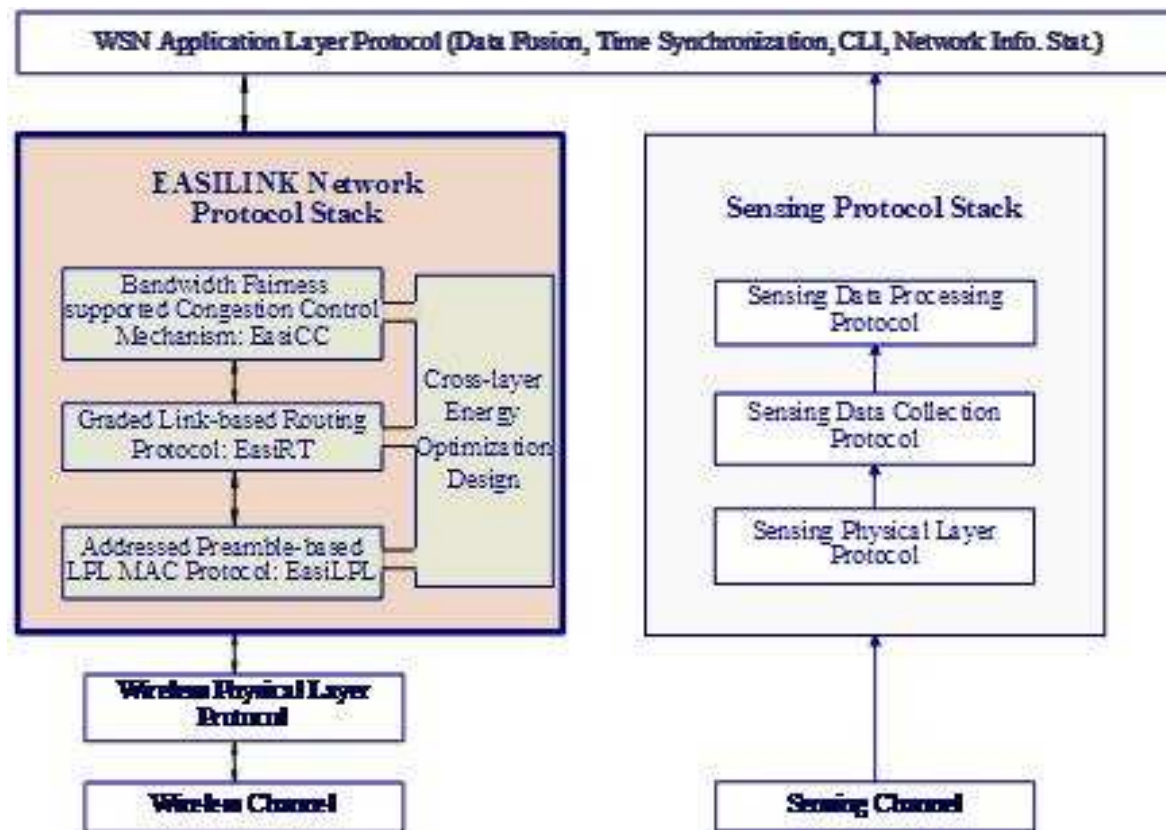
RELATED RESEARCHES

- ⌘ Wireless LAN
IEEE 802.11
- ⌘ Hybrid Wireless Network
IEEE 802.11 + PAN
- ⌘ Energy Efficiency in WSN
Reduce Redundancy



EASINET

Protocol of EasiNET



CONTRIBUTIONS

❖ Hierarchical Network (EasiNET)

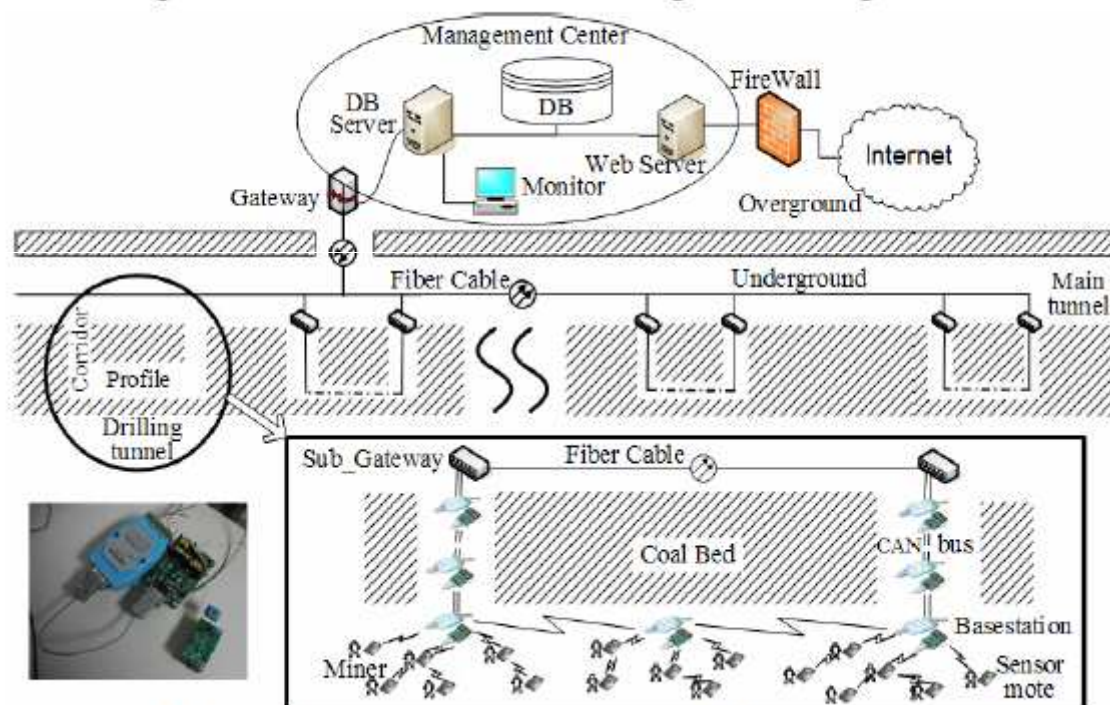


Fig. 1. HHMSM system architecture and hardware platform



CONTRIBUTIONS

☞ Overhearing-based Data Collection Algorithm

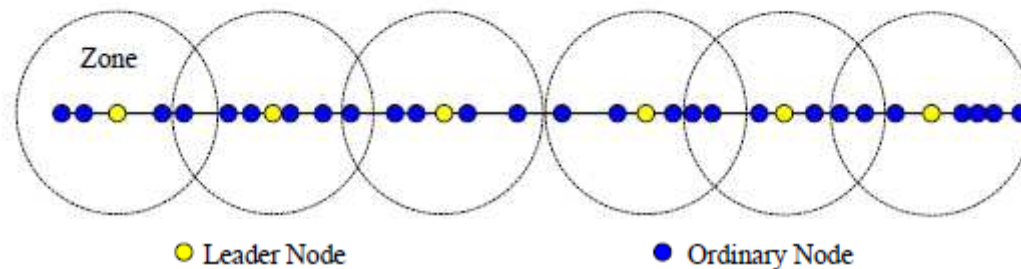


Fig. 2. An overhearing-based network for HHMSM

Zone Leader (with highest value)

Ordinary Node (overhearing)



CONTRIBUTIONS

⊕ Adaptive sampling rate adjusting mechanism

TABLE I
NOTATIONS

Notation	Description
$C(x, t)$	The function of concentration diffusion process
$\tilde{C}(x, t + \tau)$	The observation of $C(x, t)$ at the server
X	The distance of the diffusion process in $C(x, t)$
t	The time of the diffusion process in $C(x, t)$
D	The diffusion coefficient
τ	The duration of sampling result delivering
Δ	The offset error of sampling result at the server
Δt	The sampling interval
Φ	The maximal acceptable offset error

Methane Diffusion Process (Fick's Second Law)

$$\frac{\partial C(x, t)}{\partial t} = D \frac{\partial^2 C(x, t)}{\partial x^2}$$



CONTRIBUTIONS

♣ Adaptive sampling rate adjusting mechanism

Reduce the offset error

$$\tilde{C}(t + \tau) = C(t) + \frac{C(t) - C(t - \Delta t)}{\Delta t} \cdot \tau$$

τ - Duration of sample result delivering

Optimized sampling interval

$$\Delta t = \frac{2\varphi}{\tau \cdot C_t''(\xi_3)} - \tau$$

$C_t''(\xi_3)$ - Second order Partial Derivative of Concentration
Diffusion



EXPERIMENT

System Architecture

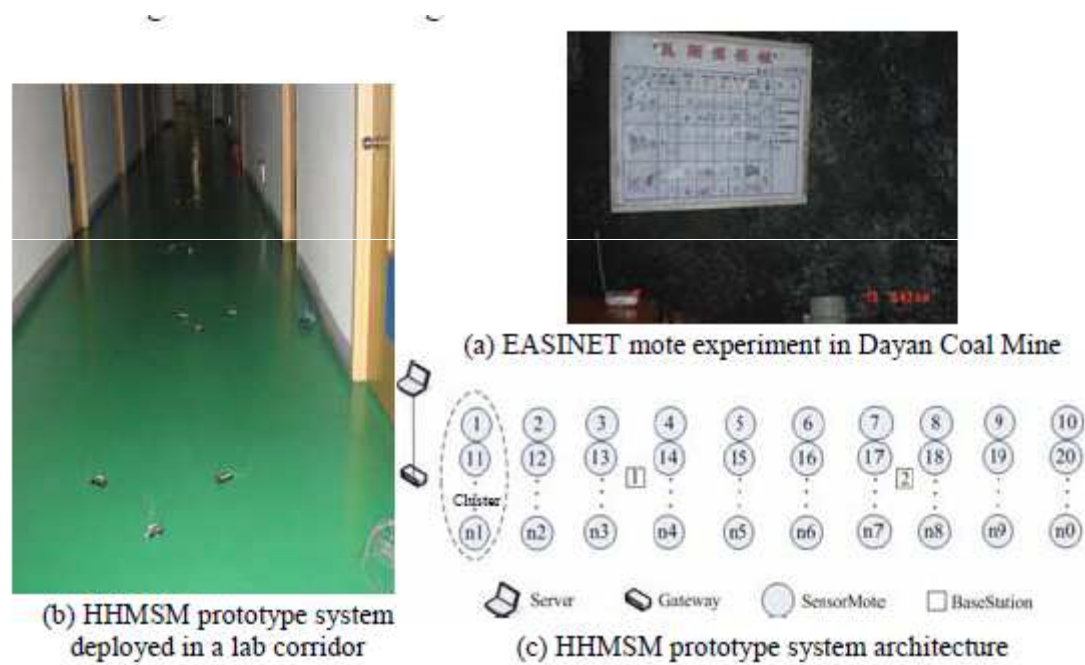


Fig. 3. HHMSM prototype system experiments in a corridor



EVALUATION

Change Density of Motes

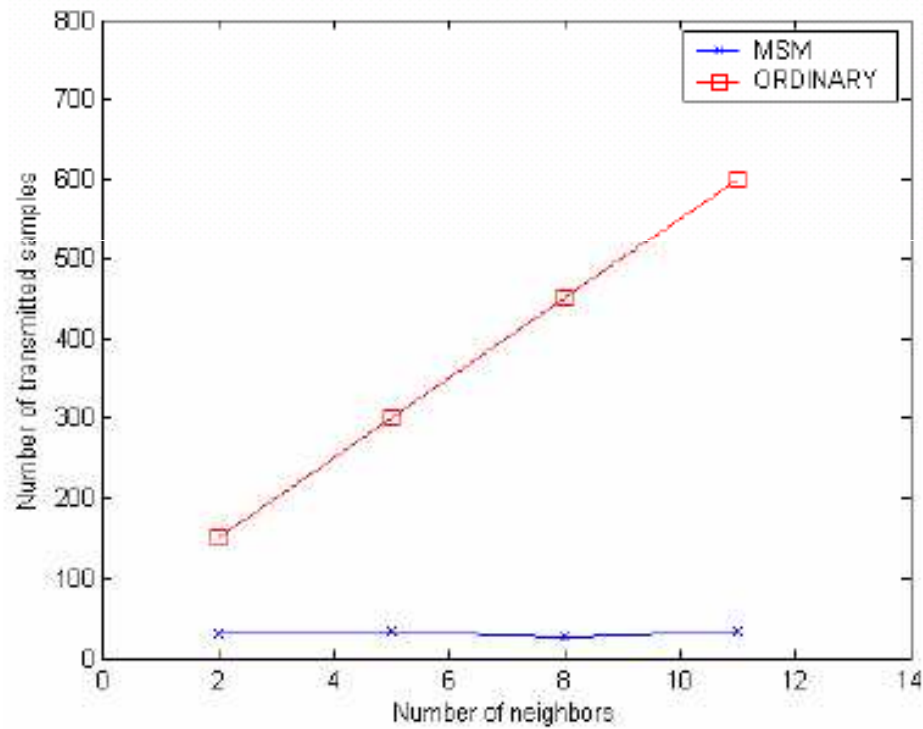
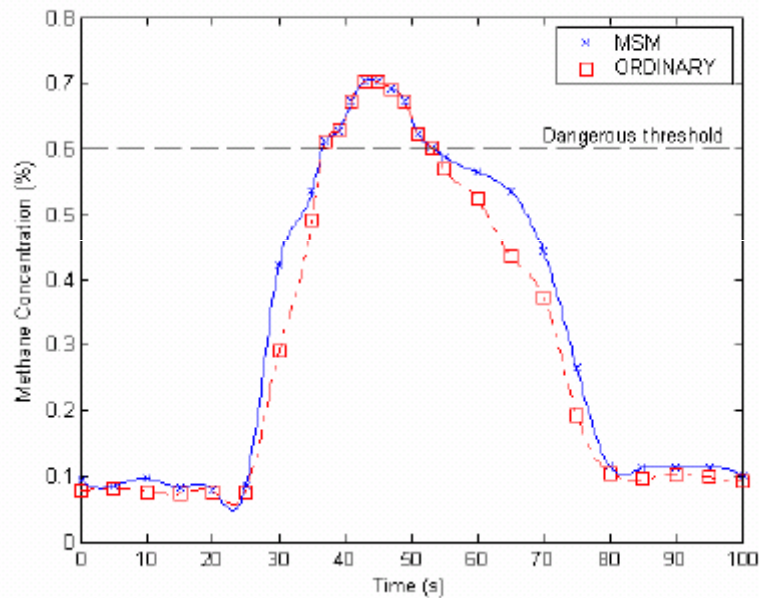


Fig. 4. Impact of network density on transmission overhead

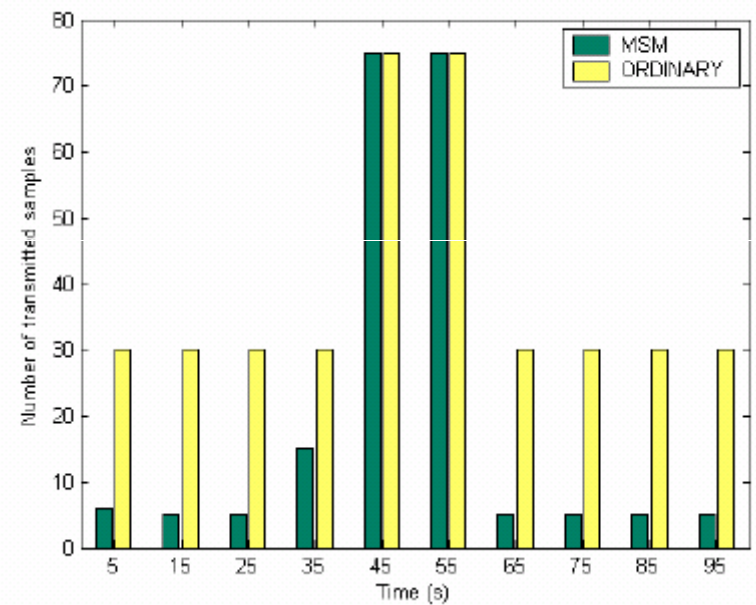


EVALUATION

Change methane concentration



Concentration



Traffic

