

# Adaptive Parameter Control for Cooperative Spectrum Sensing for Wireless Vehicular Networks based on Measurement-based Spectrum Database

The University of Electro-Communications, Tokyo, Japan  
Advanced Wireless Communication research Center(AWCC)  
Kohsuke Nakagawa, Takeo Fujii

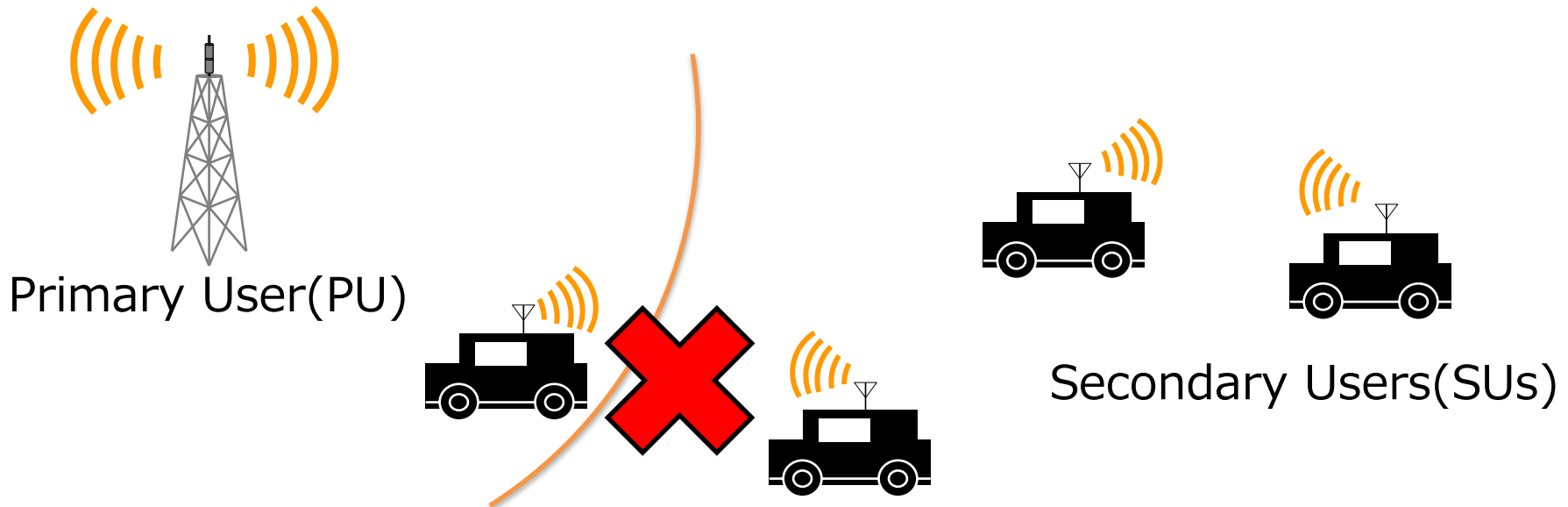
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# Spectrum lacking for Wireless Vehicular Networks

## ◆ Many applications work over WVN

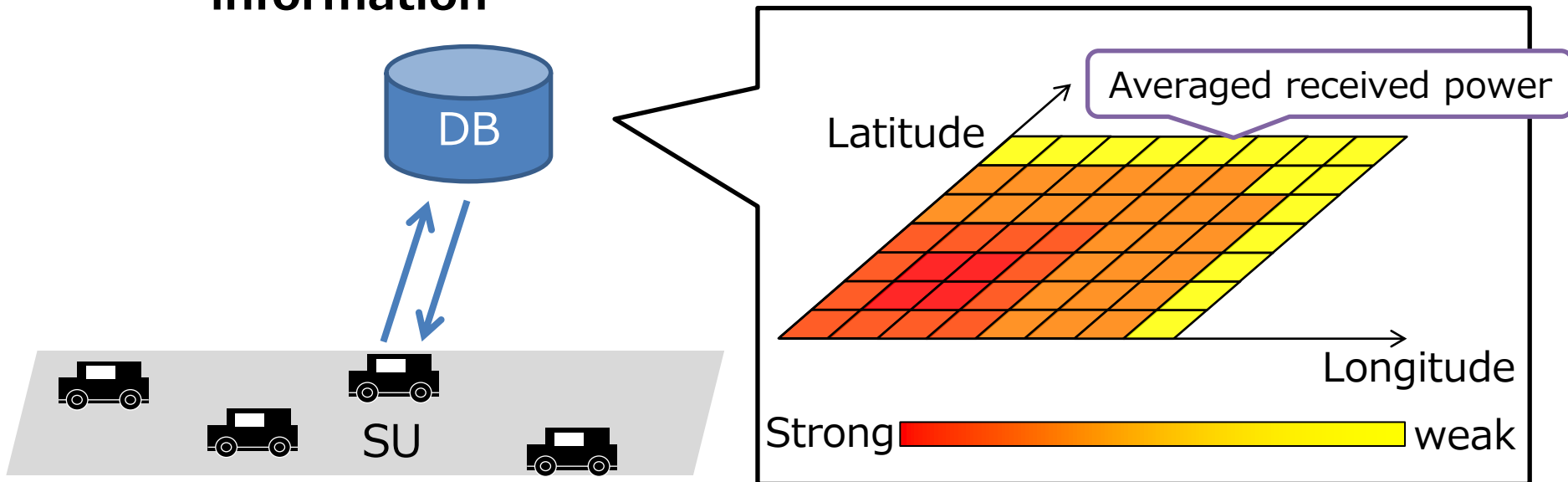
- Not only for safety driving but also entertainment
  - ✓ WVN requires high speed and large capacity communications
  - ✓ Spectrum resources are lacking due to the increasing wireless system

## Spectrum sharing by using Cognitive Radio attracted attentions !



# Radio environment recognition method : Database

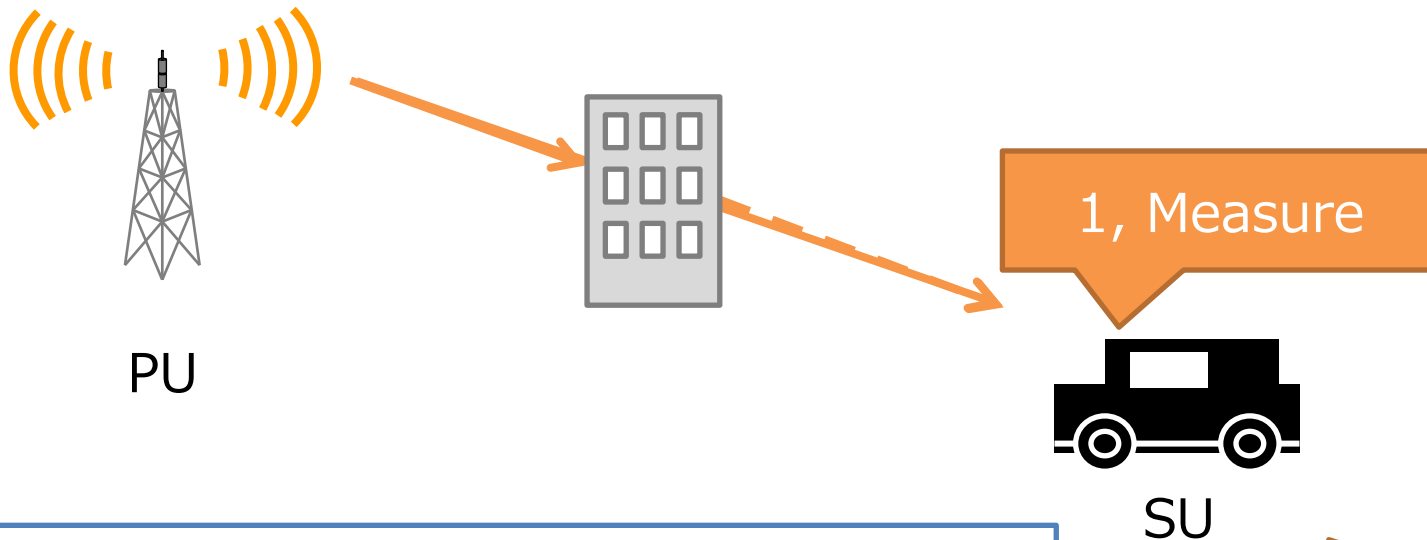
- ◆ SU shares PU's licensed band on CR
  - **Radio environment recognition methods** are needed to avoid interference
- ◆ Measurement-based radio environment database
  - **More precise recognition based on accumulated information**



**It cannot detect PU has ON/OFF states**

## ◆ Spectrum sensing: Energy detector

- SU detects PU based on test statistics made by power
- **It can detect PU has ON/OFF state**

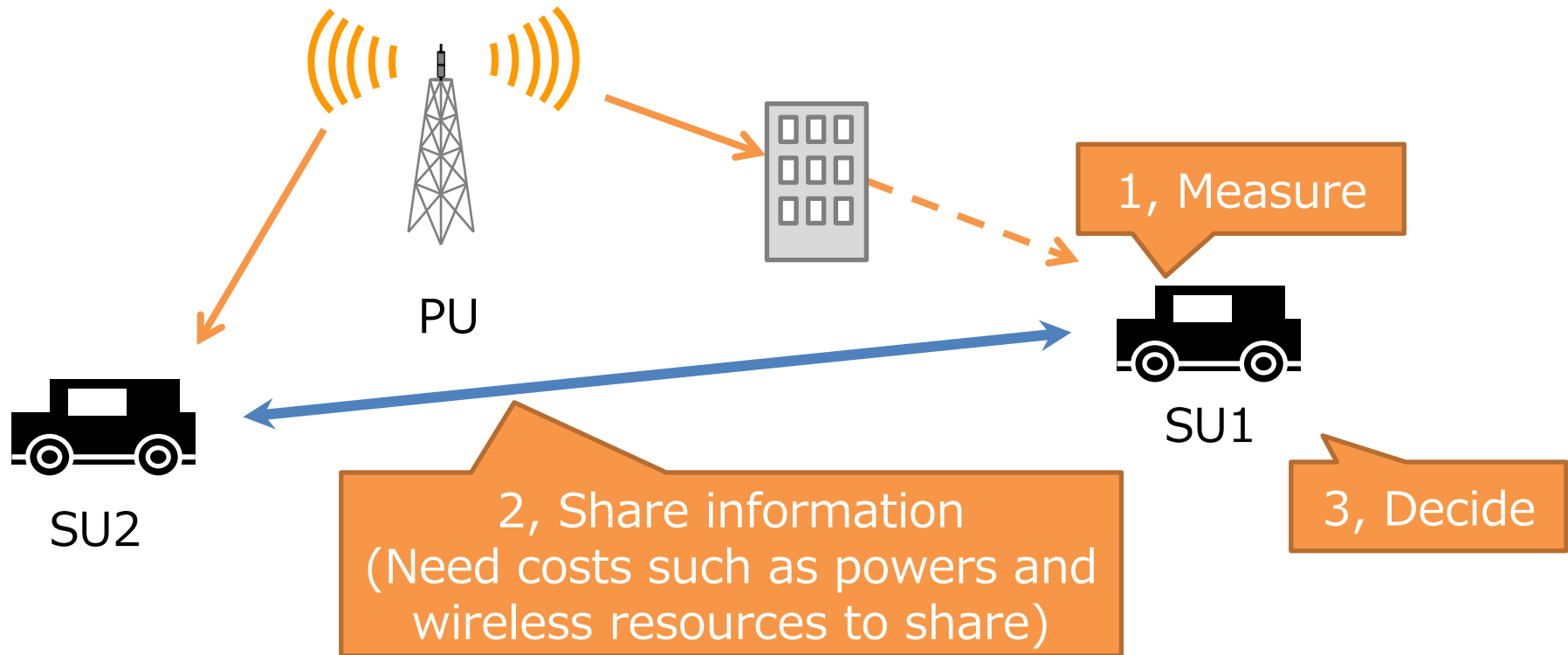


Compare test statistic  $T(x)$  and detection threshold  $\lambda$   
 $T(x) < \lambda$ : PU is idle  
 $T(x) > \lambda$ : PU exists

## Detection performance declines in low SNR

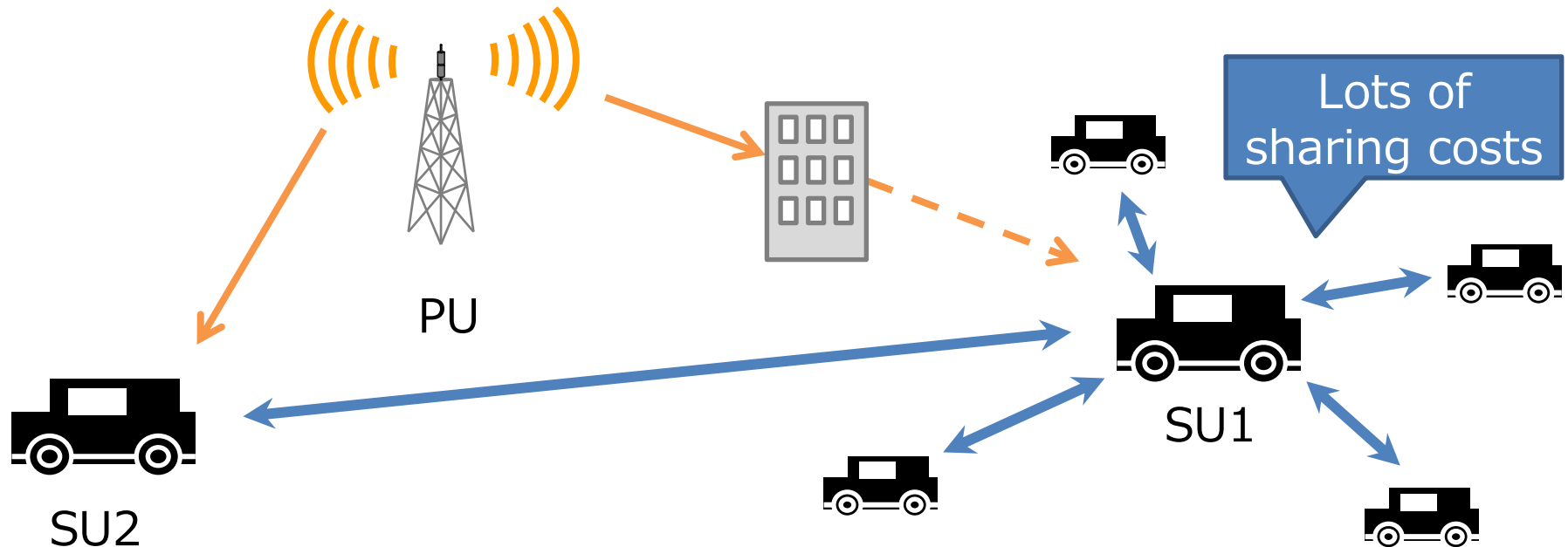
## ◆ Cooperative spectrum sensing

- **SU cooperates with other nodes to improve detection performance**
- **Communication overheads to exchange information**



## ◆ Cooperative spectrum sensing

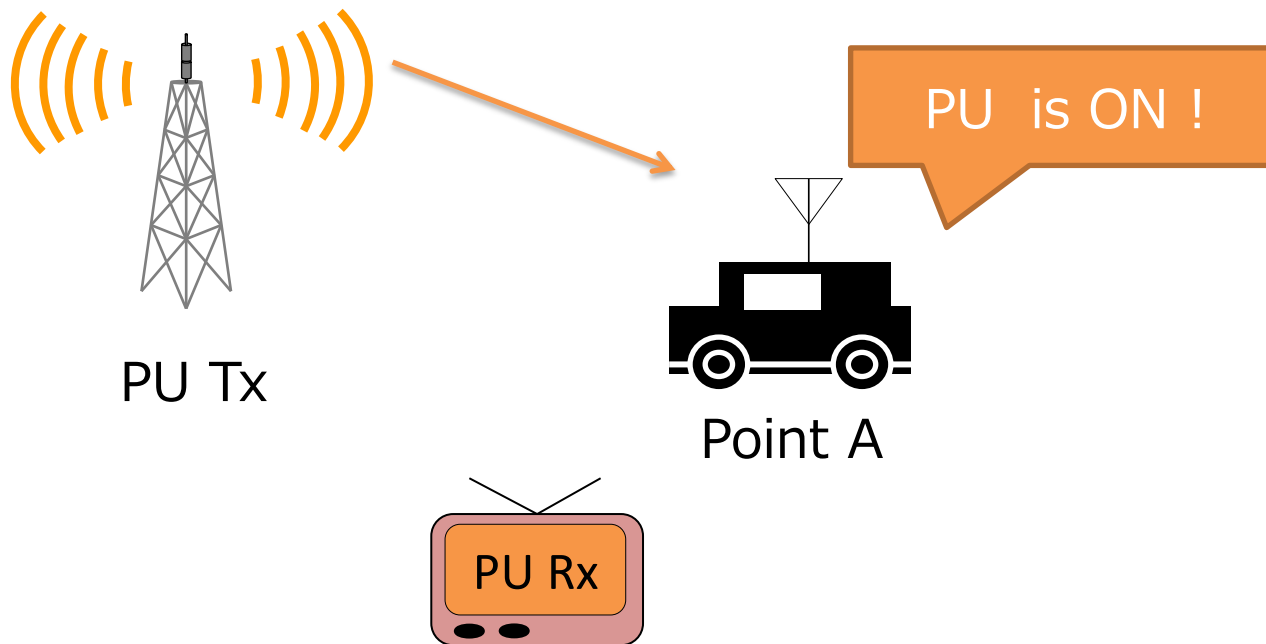
- **SU cooperates with other nodes to improve detection performance**
- **Communication overheads to exchange information**



**Smaller number of cooperation nodes is needed**

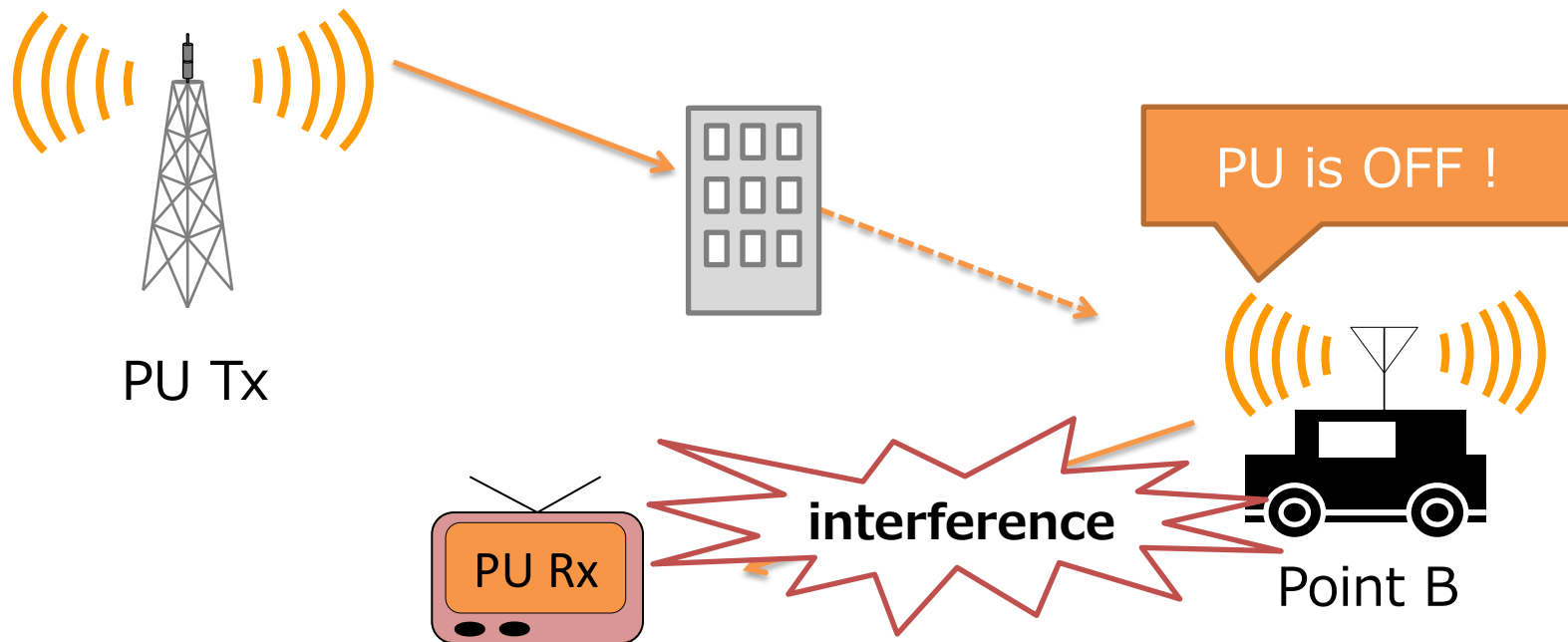
# Variety of Detection probability caused by mobility

- ◆ Received power changes variously
  - **Performance of sensing unstable**
  - SU interferes to PU caused by changing radio environment



# Variety of Detection probability caused by mobility

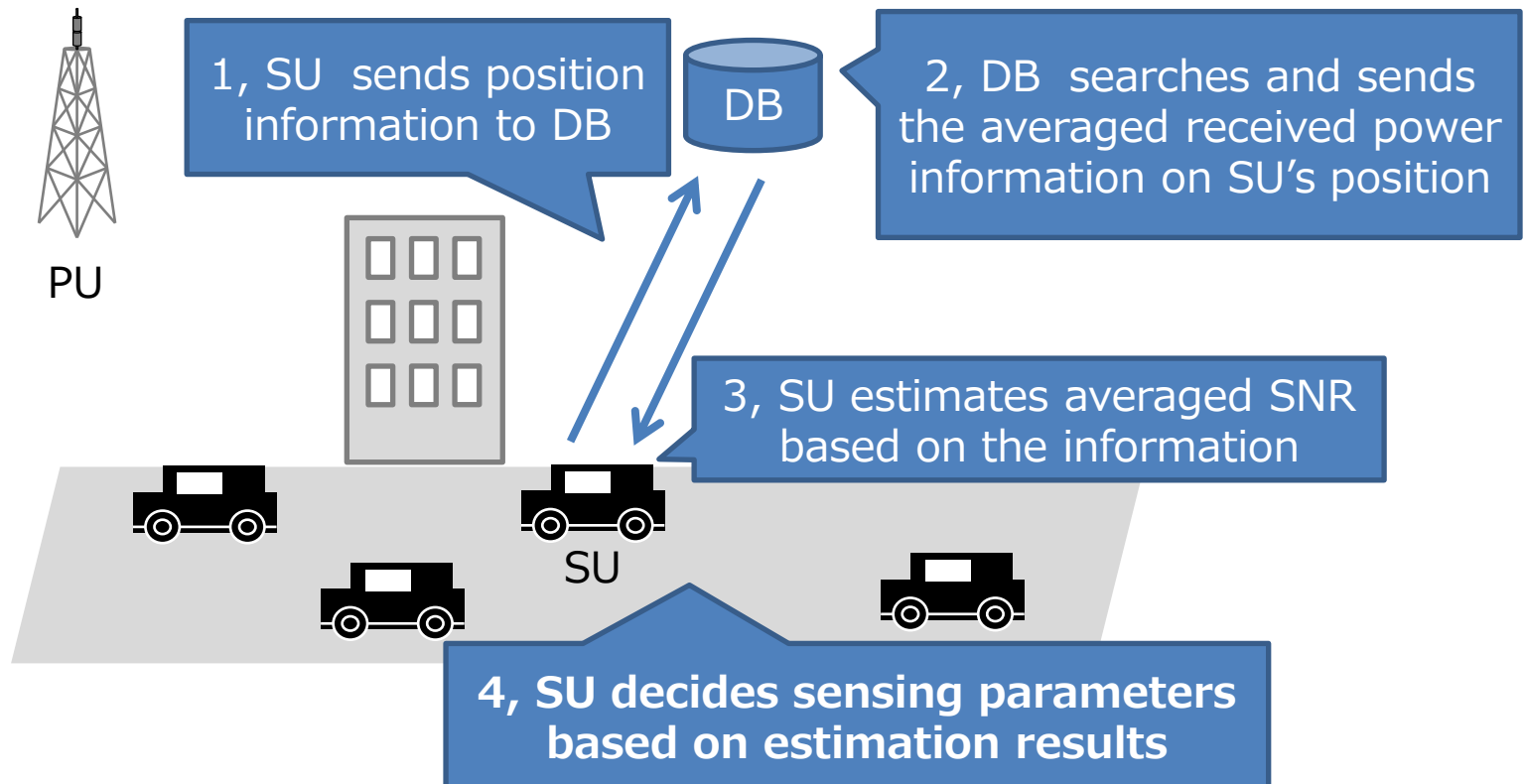
- ◆ Received power changes variously
  - **Performance of sensing unstable**
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**Stably recognition method can adapt to surrounding radio environment is needed**



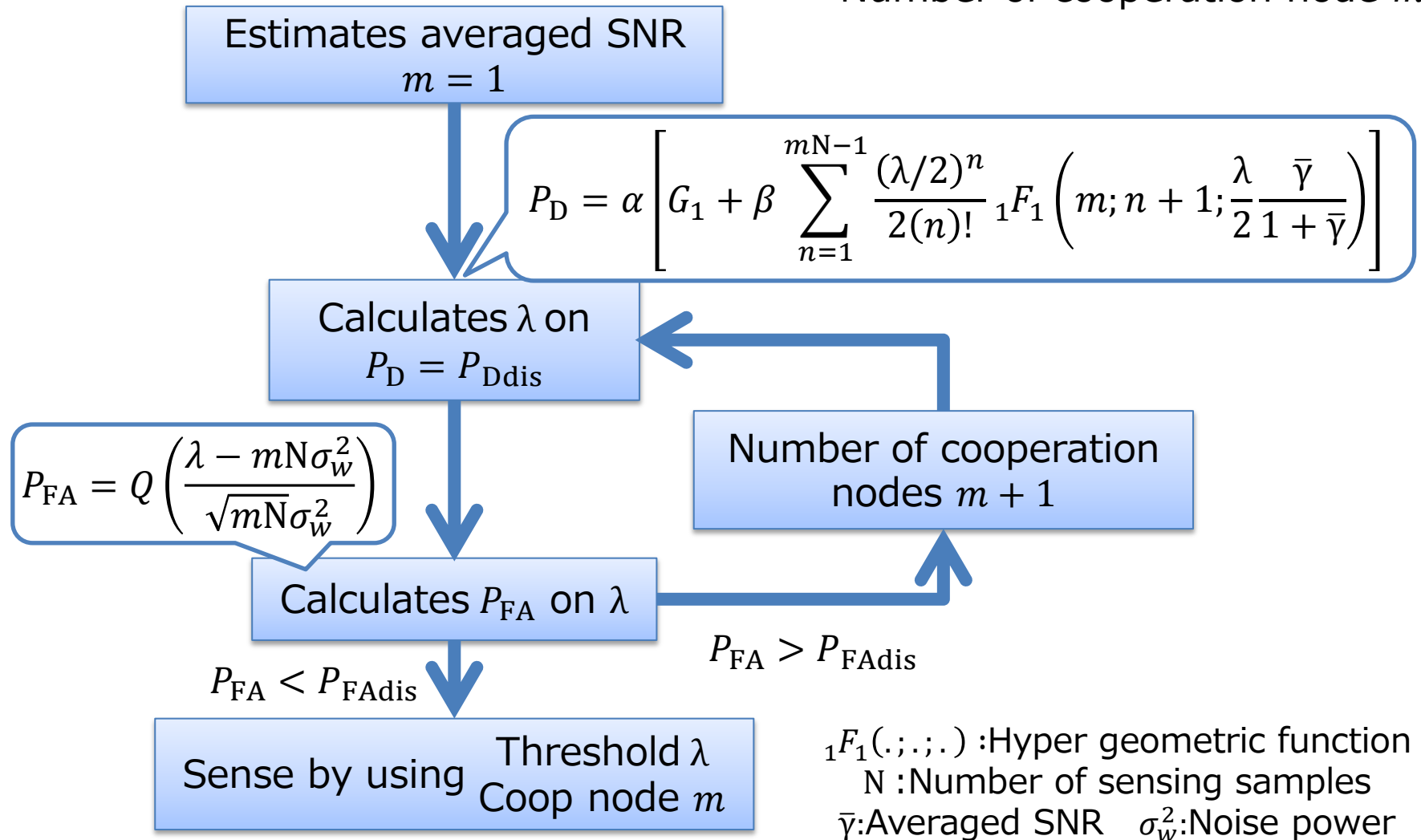
- ◆ Adaptive sensing based on Database
  - **SU can set appropriate sensing parameters to fulfill desired detection performance**



- ◆ Targets of detection performance
- ◆ Lower limit of detection probability :  $P_{Ddis}$ 
  - ◆ Probability of SU decides “PU exists” when PU exists
  - ◆ Higher  $P_D$  means SU can protect PU more stably
- ◆ Upper limit of false alarm rate :  $P_{FAdis}$ 
  - ◆ Probability of SU decides “PU exists” but PU is idle
  - ◆ Lower  $P_{FA}$  leads the chance for SU to share spectrum

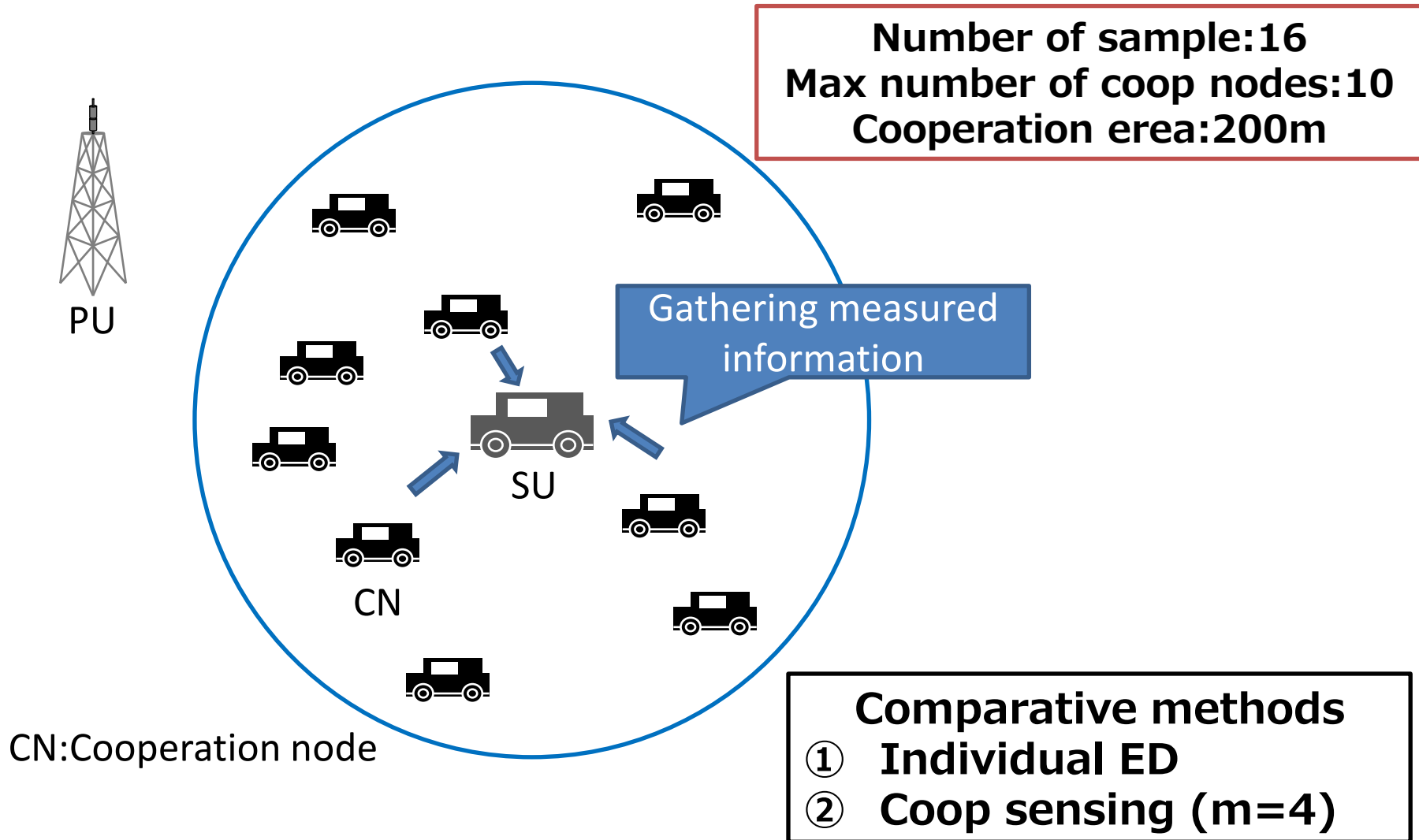
**SU sets sensing parameters to fulfil those targets**

## ◆ Parameter setting sequence detection threshold $\lambda$ , Number of cooperation node $m$



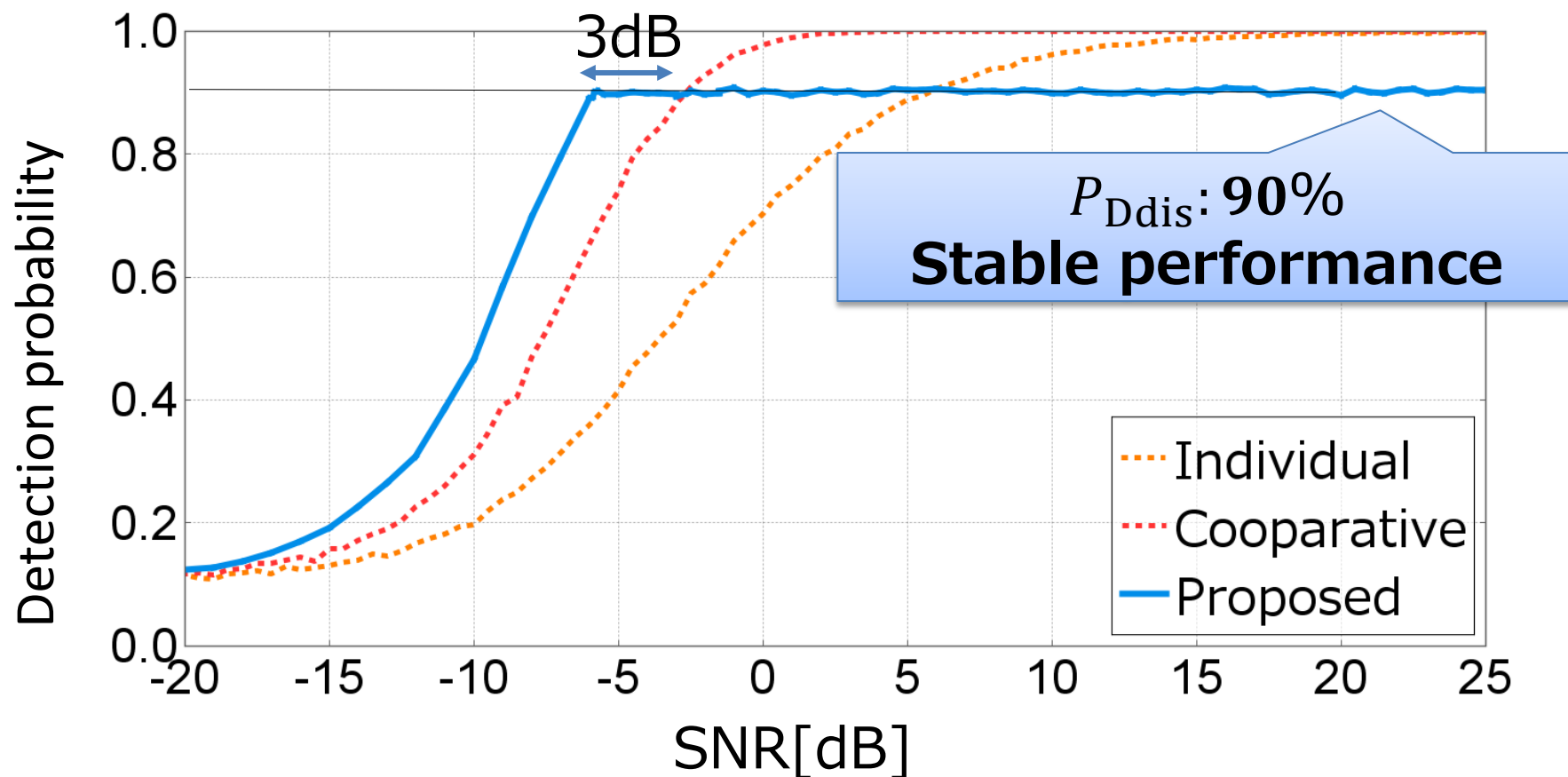
- ◆ Parameter setting sequence  $\lambda$ ,  
Number of cooperation node  $m$
- ◆ No parameters to fulfill  $P_{Ddis}$  and  $P_{FAdis}$  together
  - Number of cooperation nodes is set to maximum
  - Detection threshold is set to fulfill “ $P_{FA} = P_{FAdis}$ ”

# Simulation model



# Simulation results (1/3)

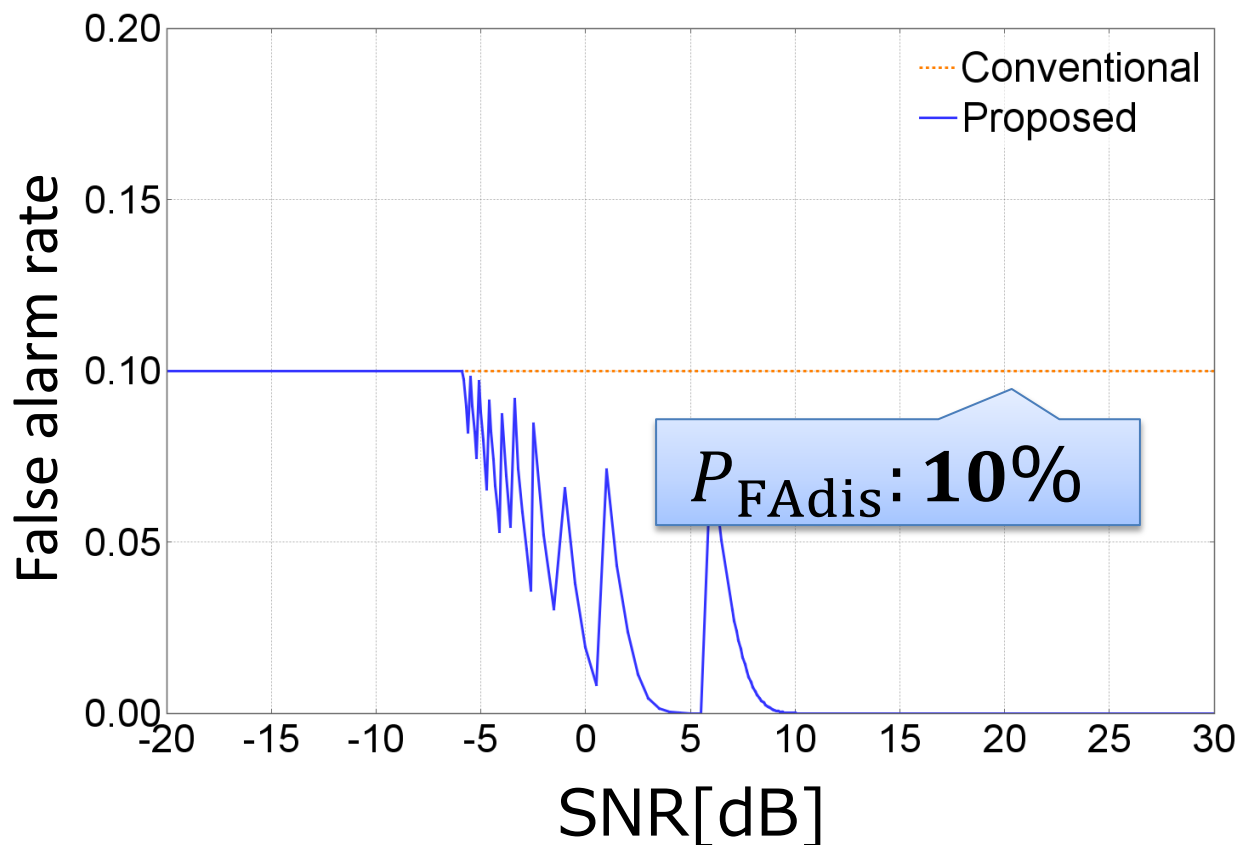
## ◆ Detection probability evaluation



**It can adapt to environment and protect PU stably**

# Simulation results (2/3)

## ◆ False alarm rate evaluation



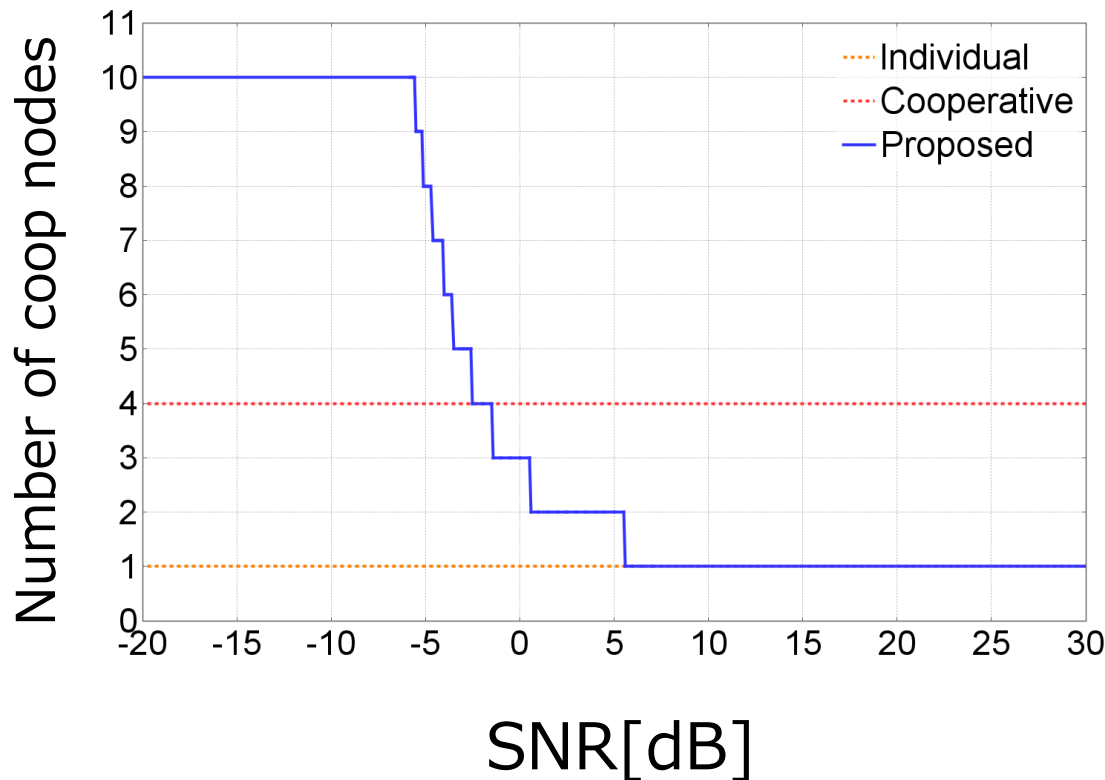
**<False alarm rate>  
SU decides "PU ON"  
but PU is idle**

**Lower  $P_{FA}$   
SU gets chances to  
share PU's band**

**$P_{FA}$  lower than  $P_{FA\text{dis}}$  on all SNR**

# Simulation results (3/3)

## ◆ Number of coop nodes evaluation



**<High SNR environment>**  
Enough performance  
Small number of nodes

**<Low SNR environment>**  
Not enough performance  
Large number of nodes

**Minimum number of cooperation nodes can be set to fulfill desired sensing performance**



# Conclusions

- ◆ To get new spectrum for WVN...
  - Spectrum sharing by using Cognitive Radio
  - **Radio environment recognition methods for mobile is needed**
- ◆ **Adaptive parameters control for cooperative sensing based on measurement-based DB**
  - Parameter settings based on radio environment
  - It can achieve desired performance with minimum cooperation nodes on high to low SNR environment

**Achieve stable PU protections with only minimum costs**

Thank you for your attention