Project: IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)

Submission Title: [VLC application :Indoor Navigation / LBS using VLC]
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Abstract: [Indoor navigation system and location based service using the visible light communication are described in this document. The indoor Navi./LBS system is categorized. The possible scenario of the each categorized service is also presented in this presentation.]

Purpose: [Contribution to IEEE 802.15 SG-VLC]

VLC application :
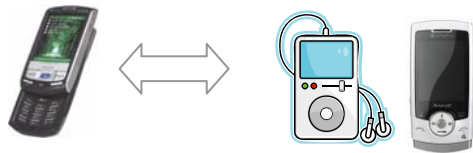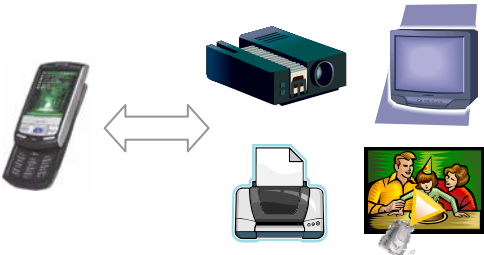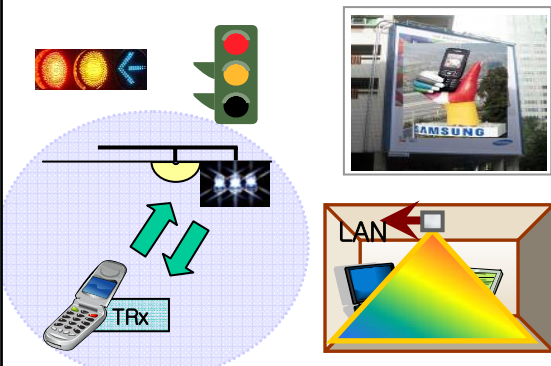
Indoor Navigation / LBS using VLC

2008.05

Samsung Electronics

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- GPS / LBS

- GPS / LBS: for the next generation

- Indoor Navigation / LBS

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- Indoor Navigation Scheme

  - Type I: Uni-direction
  - Type Iii: Hybrid

  - Type II: Bi-direction
  - Type IV: Hot spot

- Issue: Indoor Navigation / LBS using VLC

- Summary

VLC Applications

	Application	
Mobile to Mobile	**Handheld device Portable device**	• Contents-sharing • Data transfer
Mobile to Fixed	**CE Kiosk Portable device Handheld device**	• File transfer • Video streaming • M-commerce
Infra to Mobile	**CE Illuminator Sign-board Traffic Signal Portable device Handheld device**	• Information-broadcast • ITS • Indoor LBS • Indoor Navigation • Networked Robot • Vehicle to vehicle

GPS / LBS

- **GPS (Global Positioning System)**

  ❖ A Satellite Navigation System.

  ❖ Utilizing a constellation of 24 Medium Earth Orbit satellites

  ❖ The terminal (receiver) calculate the location / position, speed, direction and etc using the signal from the satellites.
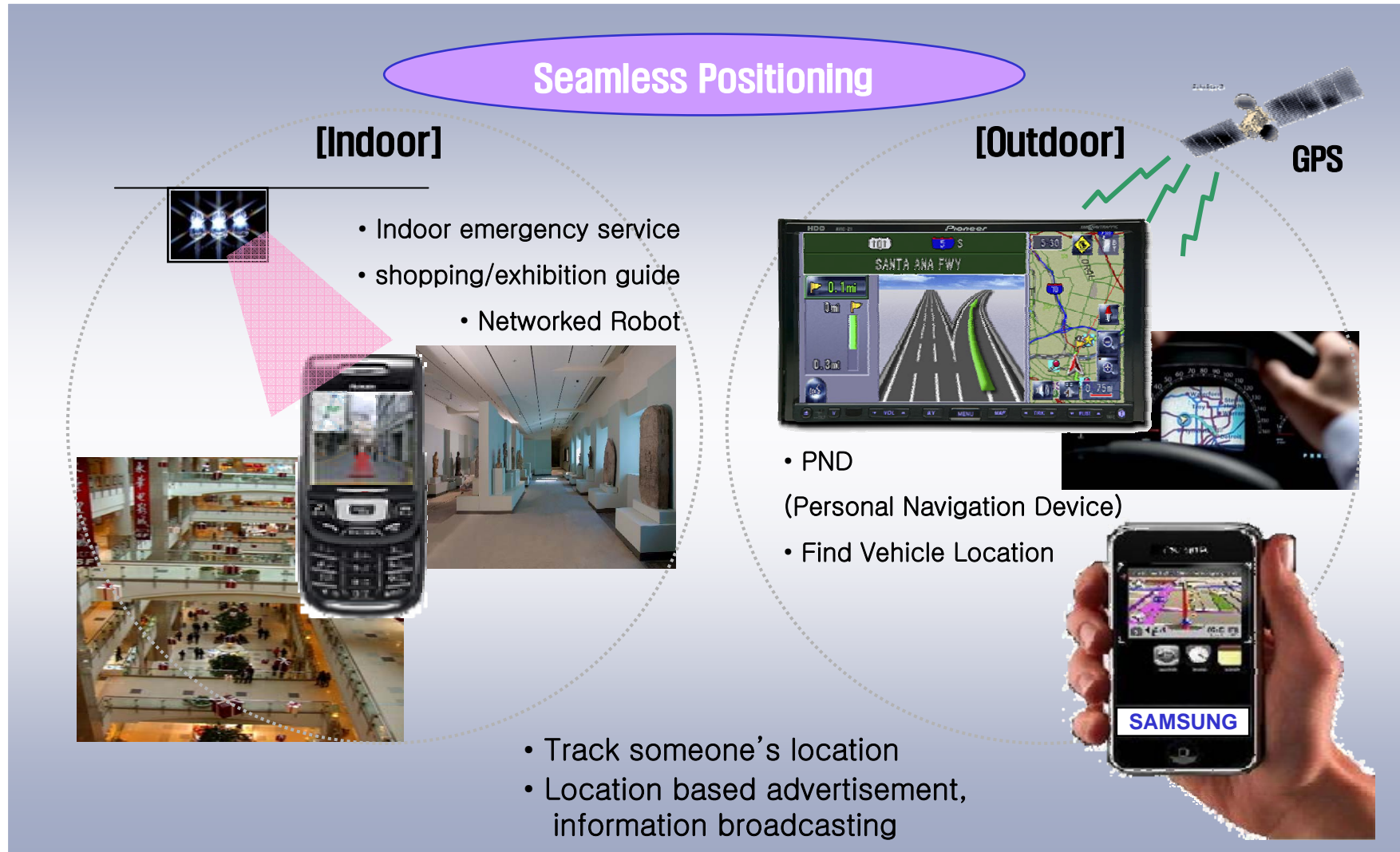
- **LBS (Location Based Service)**

  ❖ A kind of network based service.

  ■ Combine the location / position information of the mobile devices and the other information.

GPS / LBS: for the next generation

- **GPS / LBS market grow fast:**
  - ❖ Cost down
  - ❖ Geometric information
  - ❖ Infrastructure (ex: network, high technology)
  - ❖ Government policy

- Globally, the GPS market is expected to exceed **US$30 billion by 2008** as the market is being flooded by a number of affordable GPS components and receivers (Source: World GPS Market Forecast report) **An **estimated 63% of mobile phones sold in North America in 2007** will have GPS or assisted GPS functions (Source: Market researcher Gartner's Research)

- GPS overall production value globally is expected to grow to more than **$30 billion in 2008**, up from $**13 billion in 2003**

- Worldwide market for location based services (**LBS**) is growing from **around $200 million in 2006** to **$1.2 billion in 2011** (Source: The market analyst Strategy Analytics)

- The Indian GPS market is now at $**22 million**, but there is potential for growth to **$448 million in the next three to four years**. (Source: Location Conference 2006)

* Source: http://www.safp.ca/Technology/7322.html

GPS / LBS: for the next generation

Indoor Navigation / LBS

- ● **GPS**

  ❖ **Limited coverage**

  (Inside building, Condensed building area)

  ❖ **Limited precision**

- ● **Indoor Navigation/LBS**

  ❖ **Expect the spread of Indoor Navi./LBS.**
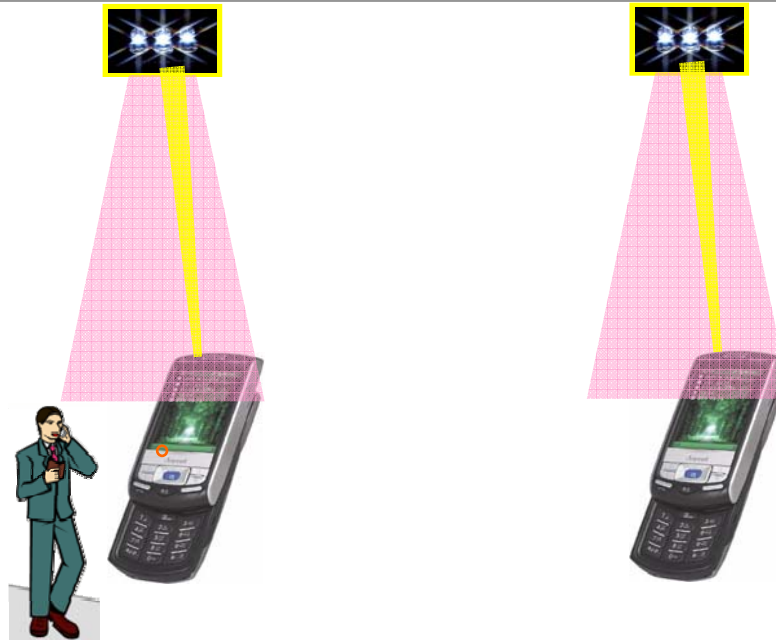
  ❖ **Find precise positioning technique.**

> ➤ **Where am I? / What is near by?**

> ➤ **Monitoring / Security (track the location)**
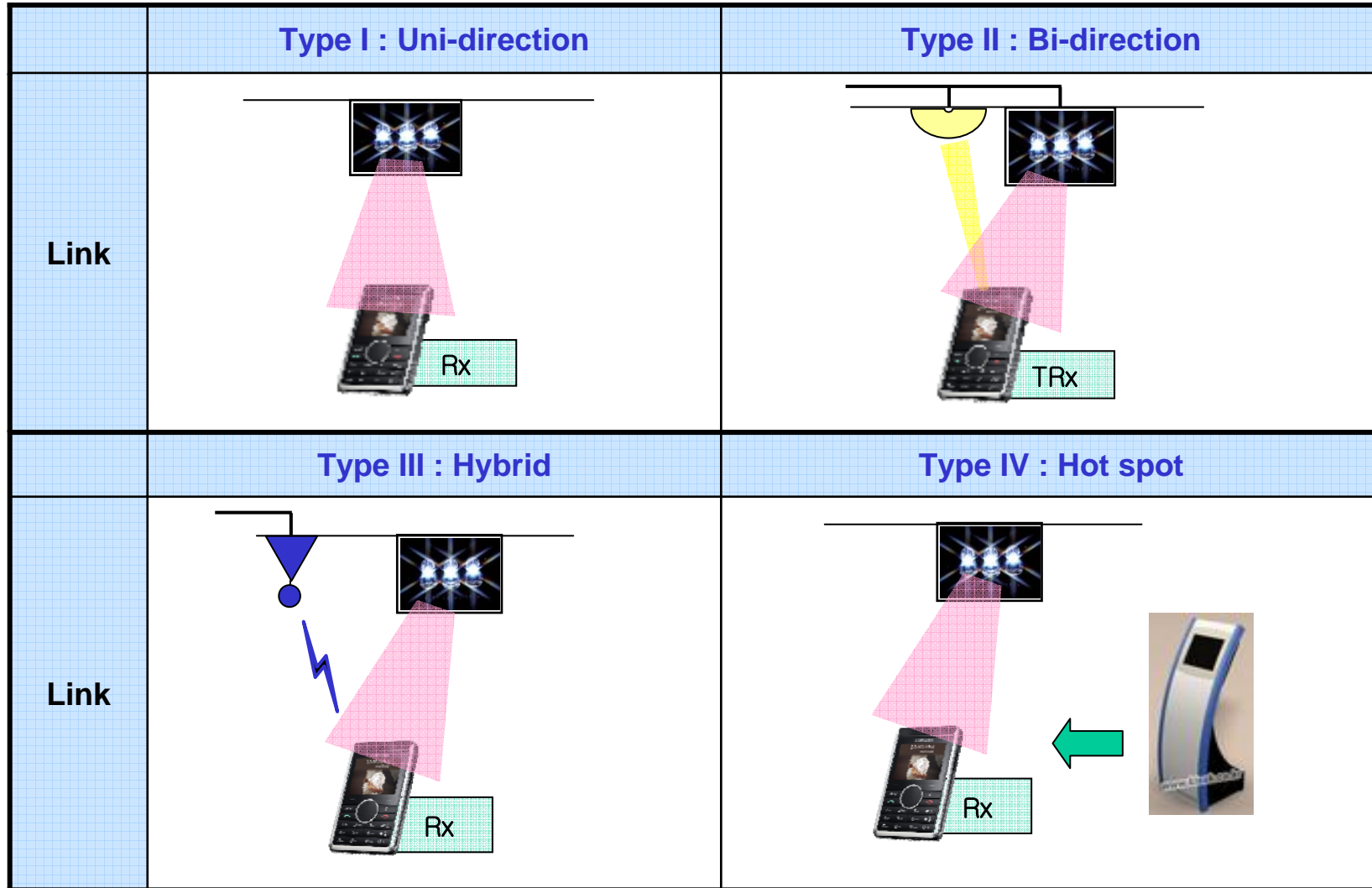
Indoor Navigation / LBS using VLC

● **Basic concept**

✦ the LED light can be used not only for the lighting system but also for the optical light source.

✦ the LED light is modulated by a unique lamp ID and other information
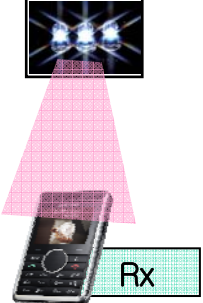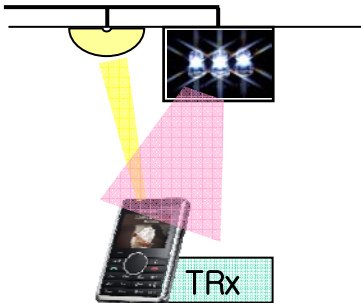
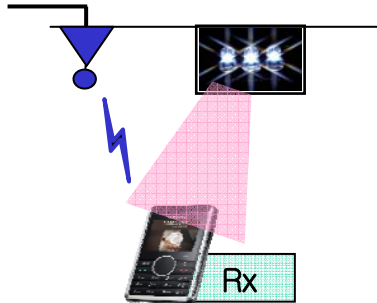LED Illumination Infrastructure

Indoor Navigation Scheme

	Type I : Uni-direction	Type II : Bi-direction
Link	Rx	TRx
	Type III : Hybrid	**Type IV : Hot spot**
Link	Rx	Rx

Type I : Uni-direction

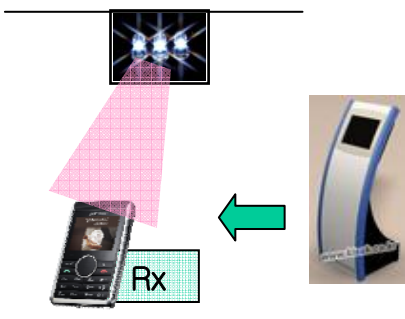|	Link	Rate	Infra	Mobile
Type I: Uni-direction		• Down : ~10kbps	• Lighting with optical ID	• Receiver • Large storage • Map info • Routing software
Possible Scenario / Note	• Download the whole map data at the entrance of the building. (or The terminal already included the map data) • The terminal should calculate the shortest route. • Each LED light has own ID that can give a location information. • Relatively low rate is needed • Complicated LED infrastructure is not necessary – possibly can be commercialized in the near future. • The terminal could be complicated. • Need a large storage memory for the Map data			

Type II : Bi-direction

	Link	Rate	Infra	Mobile
Type II: Bi-direction	TRx	• Down : ~10Mbps • Up : ~100Mbps	• Lighting with optical ID • Receiver • In-building network • Routing server	• Receiver • Transmitter
Possible Scenario / Note	• Request the map data and other information anytime, anywhere Download the only necessary map data or other information. • The server calculated the route and send the information to the terminal. • Each LED light has own ID that can give a location information and send the partial information to the terminal. •The location based service is possible. • The terminal is relatively simple. • Doesn't need a large storage memory for the map data • The LED infrastructure that can support the downlink and uplink is necessary.			

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Type III : Hybrid

	Link	Rate	Infra	Mobile
Type III: Hybrid	Rx	• Down : ~10kbps • Up : ~10Mbps	• Lighting with optical ID • RF access point • In-building network • Routing server	• Receiver • RF connectivity
Possible Scenario / Note	• Similar to Type II case except the uplink case. • Request the map data and other information using RF or other existing comm. method. • Download the only necessary map data or other information. • The server calculated the route and send the information to the terminal. • Each LED light has own ID that can give a location information and send the partial information to the terminal. • The location based service is possible. • The LED infrastructure is necessary.			

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Type IV : Hot spot

	Link	Rate	Infra	Mobile

Type IV: Hot spot		• Down (light) :
		  ~10kbps
		• Down (HS) :
		  ~100Mbps
			• Lighting with optical ID
			• Hot spot
				• Receiver
				• Relatively large storage
				• Routing software

Possible Scenario / Note	• Similar to Type I case except using the hot-spot when the large size data is needed. • Download the large size data like map data from the Hot-spot. • Each LED light has own ID that can give a location information. • The location based service is partially possible. • The LED infrastructure is not necessary.			

Issue: Indoor Navi./LBS using VLC

- ### LED light layout

  - ❖ Consider the Min. / Max. distance between the light

  - ❖ Consider the different environment (ex: lobby, office, exhibition etc.)

  - ❖ Consider the overlapped lighting area.

- ### LED lamp ID

- ### Outdoor Navigation and LBS system.

  - ❖ Can the VLC use outside environment?

  - ❖ There are lots of LED light outside.

    (ex. Traffic signal, Street lamp, Signboard etc)

Summary

- VLC Application

- Overview of the GPS & LBS

- Indoor Navigation / LBS using VLC

- 4 categorized Indoor Navigation Scheme

- Issue: Indoor Navigation / LBS using VLC

Thank you