

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]

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VLC application :

Indoor Navigation / LBS using VLC

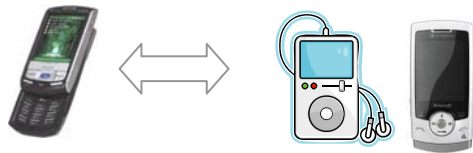
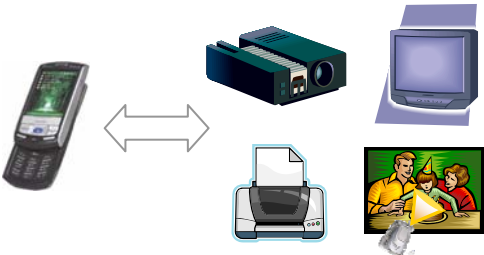
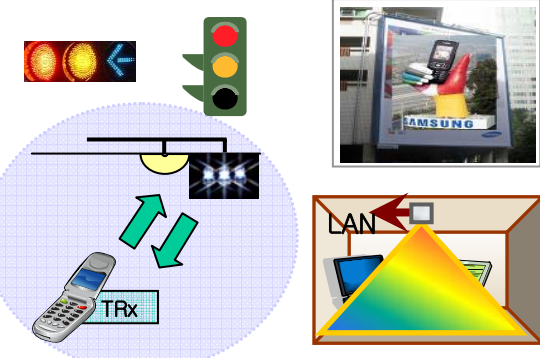
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Samsung Electronics

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VLC Applications

	Application	
<p>Mobile to Mobile</p>	 <p>Handheld device Portable device</p>	<ul style="list-style-type: none"> • Contents-sharing • Data transfer
<p>Mobile to Fixed</p>	 <p>CE Kiosk Portable device Handheld device</p>	<ul style="list-style-type: none"> • File transfer • Video streaming • M-commerce
<p>Infra to Mobile</p>	 <p>CE Illuminator Sign-board Traffic Signal Portable device Handheld device</p>	<ul style="list-style-type: none"> • 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)**

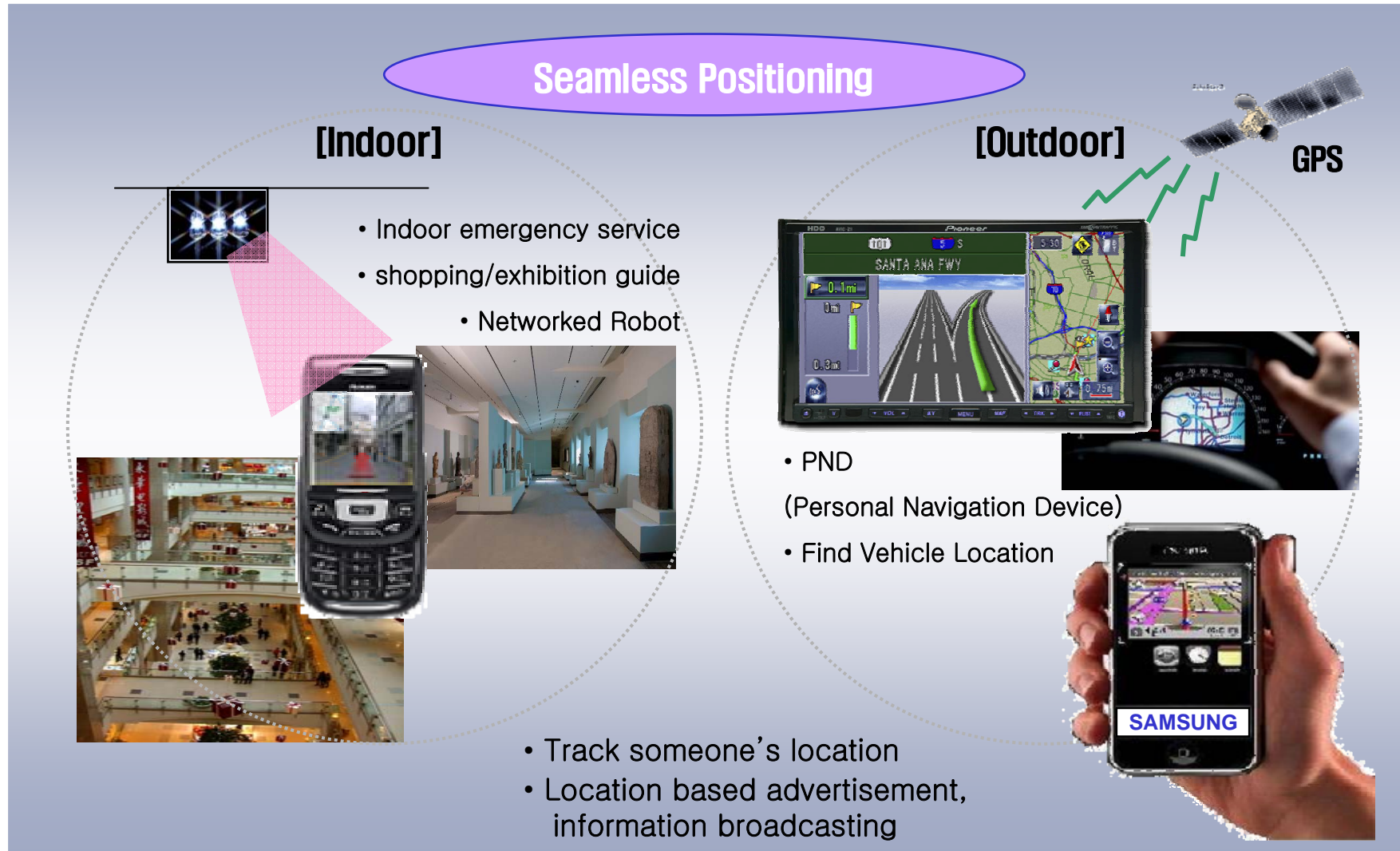
- ❖ A kind of network based service.
 - Combine the location / position information of the mobile devices and the other information.

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.**



SG-VLC



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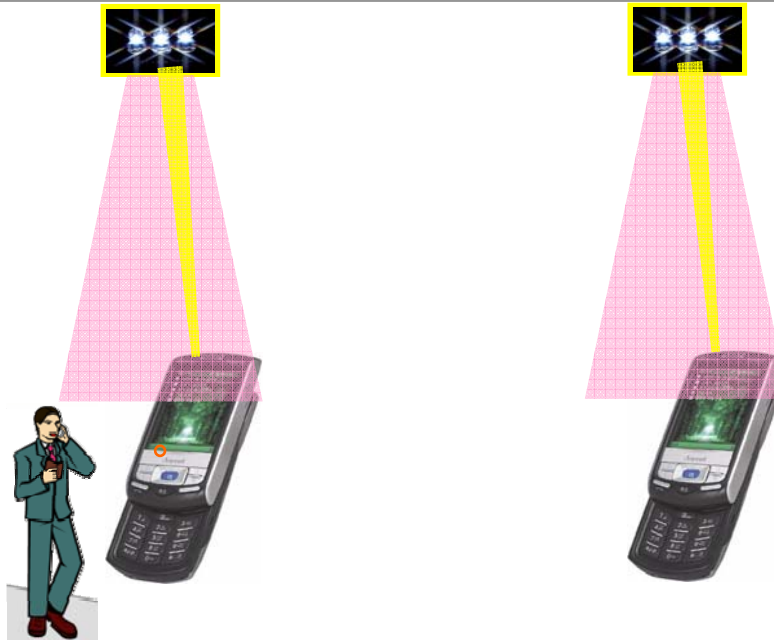
Taehan Bae et al., Samsung

Indoor Navigation / LBS using VLC

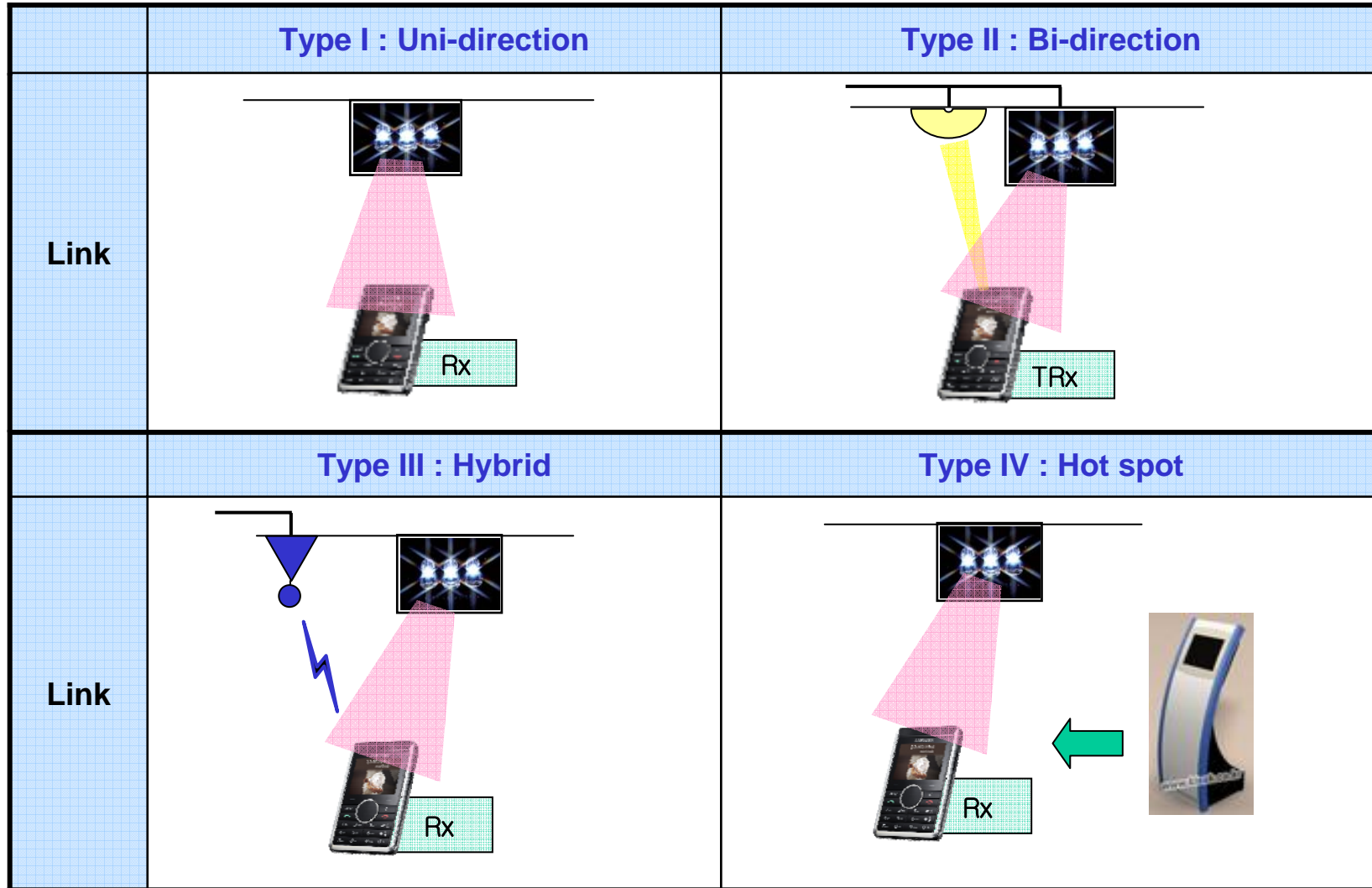
● Basic concept

- ❖ 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

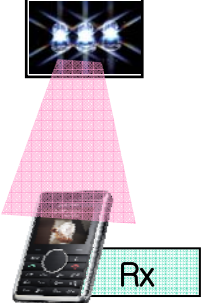
LED Illumination Infrastructure



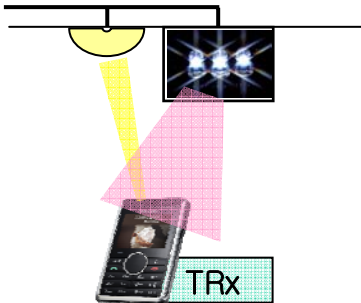
Indoor Navigation Scheme



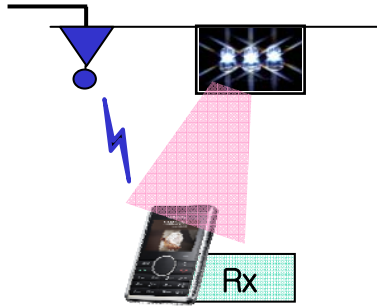
Type I : Uni-direction

	Link	Rate	Infra	Mobile
Type I: Uni-direction		<ul style="list-style-type: none"> • Down : ~10kbps 	<ul style="list-style-type: none"> • Lighting with optical ID 	<ul style="list-style-type: none"> • Receiver • Large storage • Map info • Routing software
Possible Scenario / Note	<ul style="list-style-type: none"> • Download the whole map data at the entrance of the building. (or The terminal already included the map data) • Each LED light has own ID that can give a location information. • The terminal should calculate the shortest route. • 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 			

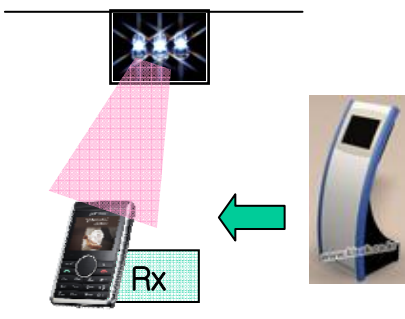
Type II : Bi-direction

	Link	Rate	Infra	Mobile
<p>Type II: Bi-direction</p>		<ul style="list-style-type: none"> • Down : ~10Mbps • Up : ~100Mbps 	<ul style="list-style-type: none"> • Lighting with optical ID • Receiver • In-building network • Routing server 	<ul style="list-style-type: none"> • Receiver • Transmitter
<p>Possible Scenario / Note</p>	<ul style="list-style-type: none"> • 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. 			

Type III : Hybrid

	Link	Rate	Infra	Mobile
<p>Type III: Hybrid</p>		<ul style="list-style-type: none"> • Down : ~10kbps • Up : ~10Mbps 	<ul style="list-style-type: none"> • Lighting with optical ID • RF access point • In-building network • Routing server 	<ul style="list-style-type: none"> • Receiver • RF connectivity
<p>Possible Scenario / Note</p>	<ul style="list-style-type: none"> • 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 • The location based service is partially possible. • The LED infrastructure is necessary. 			

Type IV : Hot spot

	Link	Rate	Infra	Mobile
Type IV: Hot spot		<ul style="list-style-type: none"> • Down (light) : ~10kbps • Down (HS) : ~100Mbps 	<ul style="list-style-type: none"> • Lighting with optical ID • Hot spot 	<ul style="list-style-type: none"> • Receiver • Relatively large storage • Routing software
Possible Scenario / Note	<ul style="list-style-type: none"> • 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