


ZigBee 기술 및 시장 동향

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김학선 상무
중앙연구소/삼성전기

1 삼성전기



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2. ZigBee Applications
3. 기술적 주요 이슈 사항
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2 삼성전기

1. Wireless Sensor Networks

◆Wireless Sensor Networks ?

Robust → Can ensure reliable data transmission in a state of continuous change of network structure
 Responsive → Can quickly adapt itself to the change of topology
 Power Efficient → Can run for years on a single battery or be completely energy independent
 Scalable → Can scale with the application with minimal overhead

출처: Millennial Net

3 삼성전기

1. Wireless Sensor Networks

◆Wireless Sensor Networks 구성


End Node
 Direct interface to analog and digital sensors

Mesh Node
 Extends range of network
 Routes around obstacles
 Forms redundant routes
 Interfaces to sensors

Gateway
 Interface between network and Application
 Monitors data links, devices, battery status

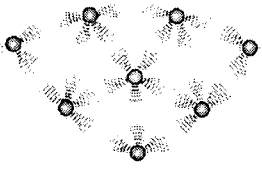
4 삼성전기

1. Wireless Sensor Networks



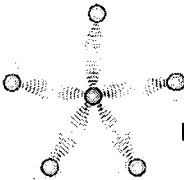
◆ Topologies

Mesh Topology



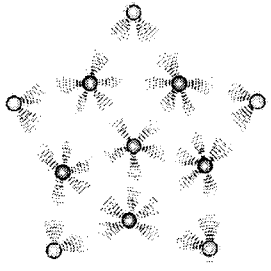
**Most Robust,
Extended Coverage**

Star Topology



Lowest Power


Star - Mesh Topology



Extended coverage, conserve power

5 삼성전기

1. Wireless Sensor Networks



◆ Data Flow 특성

Collect

Event Driven	Periodic Sampling	Store & Forward
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Broadcast

Burst	Stream
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Dialog

Polling	On Demand
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Collect Data

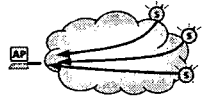

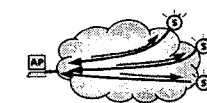
1. Event Driven (Fire Alarm)
2. Periodic Sampling (Environmental Monitoring)
3. Store & Forward (Cold Chain Mgmt)

Broadcast Data

4. Burst Broadcast (Lighting)
5. Stream Broadcast (Network Upgrade)


Bi-Directional Dialog

5. Polling (Building Automation)
6. On Demand (Medical Equipment)






출처: Millennial Net 6 삼성전기

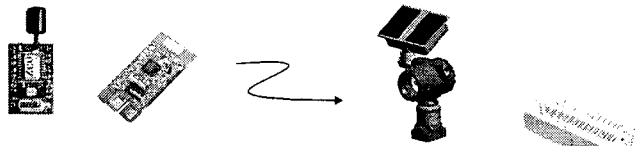
1. Wireless Sensor Networks




◆ Sensor Networking Modules

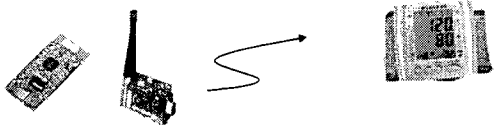



End Node



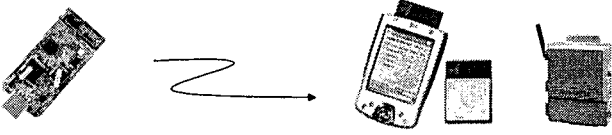


Mesh Node






Gateway









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삼성전기

2. ZigBee Applications



◆ WLAN, Bluetooth, ZigBee 비교

WLAN 802.11	Bluetooth/WPAN 802.15.1	LR-WPAN 802.15.4
Centralized Wireless Networking (WLAN) in the office environment	Cable replacement for consumer devices in the personal operating space	Low-cost wireless link for industrial/commercial sensor and actuator devices
 Embedded Sensors	 Video WLAN	 Voice/Video Real-Time
		

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삼성전기

2. ZigBee Applications

The diagram illustrates ZigBee applications across five main categories, each represented by a circular icon with a central image and a list of applications around it:

- BUILDING AUTOMATION** (Icon: Buildings): security, HVAC, AMR, lighting control, access control.
- CONSUMER ELECTRONICS** (Icon: TV): TV, VCR, DVD/CD remote.
- PC & PERIPHERALS** (Icon: Computer): mouse, keyboard, joystick.
- RESIDENTIAL LIGHTING COMMERCIAL CONTROL** (Icon: Lightbulb): security, HVAC, lighting control, access control, lawn & garden irrigation.
- INDUSTRIAL CONTROL** (Icon: Factory): asset mgt, process control, environmental, energy mgt.

Additional applications shown in separate circles include:

- PERSONAL HEALTH CARE** (Icon: Person): patient monitoring, fitness monitoring.

ZigBee
Wireless Control that Simply Works

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2. ZigBee Applications

The diagram illustrates ZigBee market size across five main categories, each represented by a circular icon with a central image and a list of applications around it:

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ZigBee
Wireless Control that Simply Works

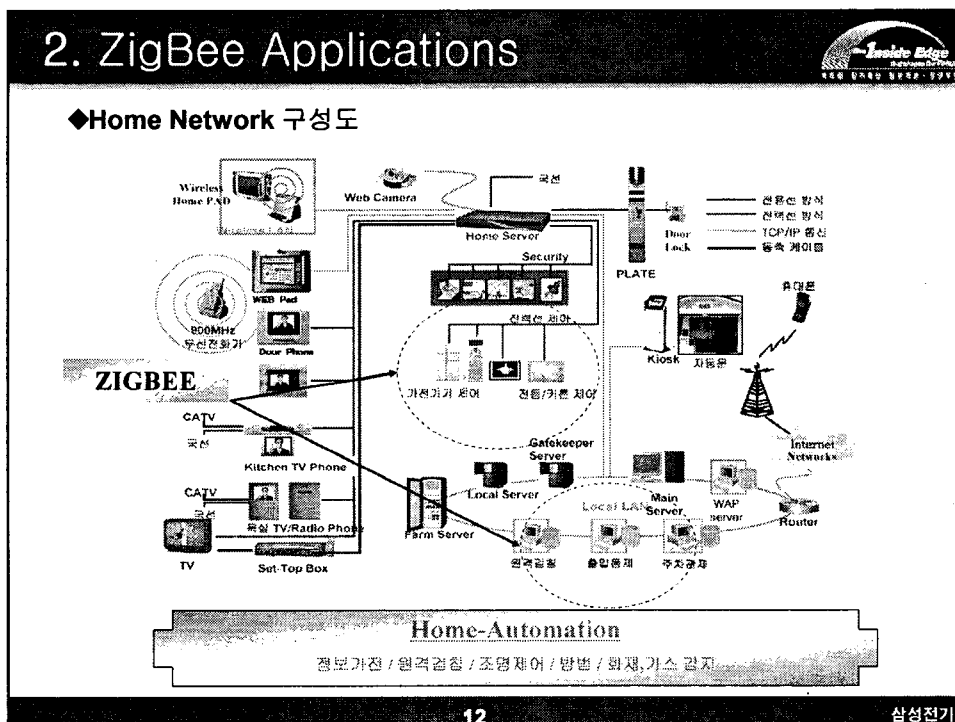
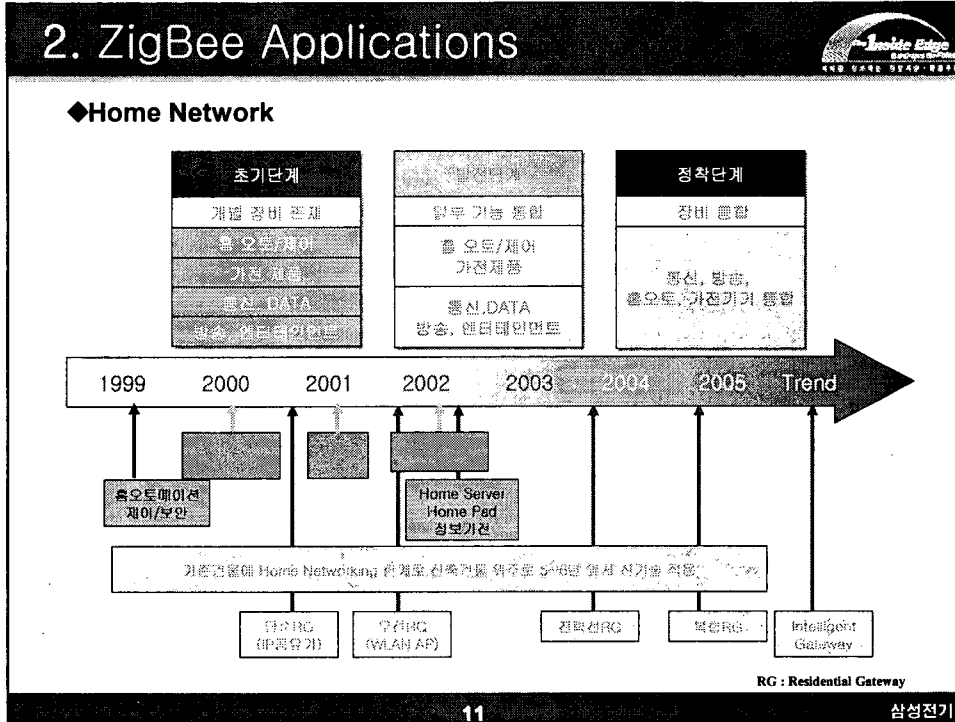
◆ZigBee 시장 규모

Unit %	2005	2006	2007	2008	2009
Home Automation	28	56	60	63	62
Home Networking	28	12	17	16	16
Industrial Automation	26	20	13	12	13
Building Automation	9	7	6	5	6
Toys & Gaming	9	5	4	4	4


Ref. : WTRS, Aug 2004

- 가장 비중이 큰 시장은 Home Automation 임
 - Home Security, Electric & Heating Systems, Lighting Control
 - 한국 인구의 빠른 노화현상과 미국의 baby boomer세대 (67 mil in 2011)가 늘어남으로 인해 실버타운식의 건물수령 지속적 성장
- Home Networking
 - 컴퓨터 주변기기, Tablet PC (저가, 저전력 최대한 활용)
- Industrial Automation
 - Utility - Automatic Meter Reading System (AMR)
 - Energy Policy Act of 2003 - 미터기 사용률 증가
 - Monitors, Sensors (temperature, pressure, flow etc)
- Building Automation
 - Wireless Door Openers, Smoke Detectors, Lighting Control

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2. ZigBee Applications




◆Home Network 구성도

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2. ZigBee Applications

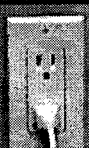


◆Home Control




To obtain remote or automated control of a light or appliance, simply plug the lamp or appliance into the base of the lamp or appliance module.


Controlling X10 is Easy!



Plug transmitters such as the mini controller into any other 110V wall receptacle.




Plug the module into any 110V wall receptacle.



Set the House Code and the transmitter to match the module.

All X10 compatible products work together.

You're Done!



You now have remote control over the lamp/appliance. Your light/appliance is controlled by a central PDP or a switch. Simply replace the switch with the appropriate X10 compatible switch.

Put together any combination of modules. Set one's controller and direct appliances in your home. Add additional X10 anytime. X10 LLC.

Unit Code Dial

House Code Dial

출처 : OFDM Technologies

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2. ZigBee Applications

◆Building Automation 구성도

Building-Automation
공조제어 / 전력제어 / 조명제어 / 화재감시 / 출입감시 / 원격감청 / 주차관리 / 승강기제어

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2. ZigBee Applications

◆주차 요금 시스템

- Stop in payment areas (e.g. Blue Lines)
- Extract Mobile Phone and Write into e-tags:
 - Park Rate (depending on Park Zone)
 - Credit Recharge (obtained by Cellular Network)
 - Start/Stop Payment with Mobile Phone
- Park Inspector and verification:
 - Node reading with simple interface

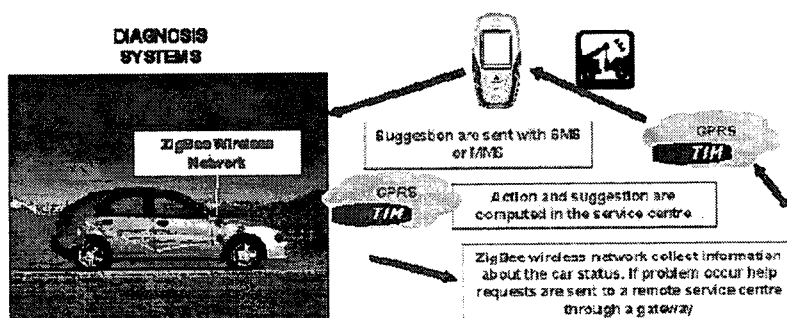
출처 : Telecomm

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2. ZigBee Applications

◆자동차 고장 진단

- Sensors with ZigBee interface placed in the car with a gateway to the mobile networks
- Information are gathered and if a problem occurs, a help request is sent to the service center
- Suggestion and performed actions are sent via SMS/MMS to the terminal of the user (e.g. car removal)
- If users have a ZigBee module integrated in the mobile phone, gateway functionalities can be performed by the phone-cell itself.



출처: Telecomm

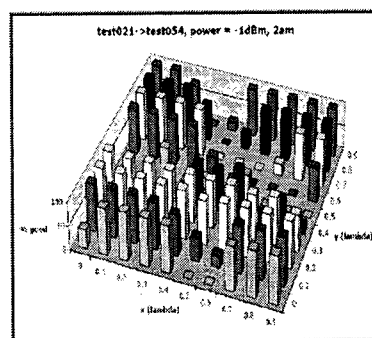
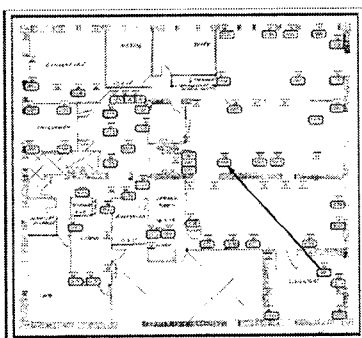
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삼성전기

3. 주요 기술 이슈 사항

◆Multipath Fading에 의한 통신 신뢰성 저하

- Multipath 효과는 거리에 따라 $\lambda/2$ 지점마다 급격한 신호 감소 발생시킴.



출처: Ember

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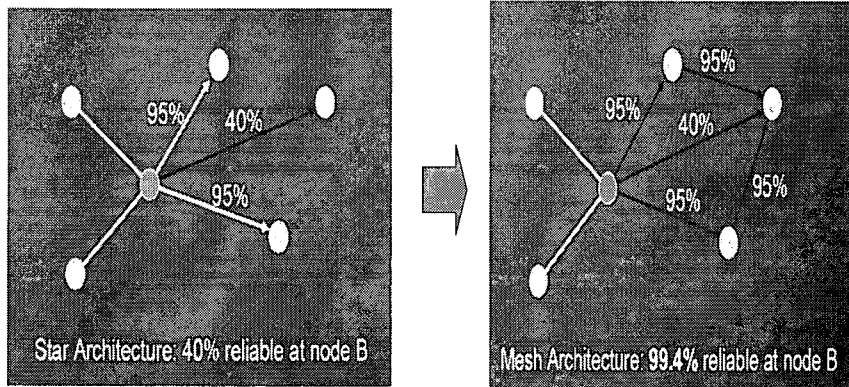
삼성전기

3. 주요 기술 이슈 사항



● Mesh Network 을 이용한 Multipath Fading 보상

- Fading에 의한 Packet 수신을 저하를 Mesh Network으로 방지

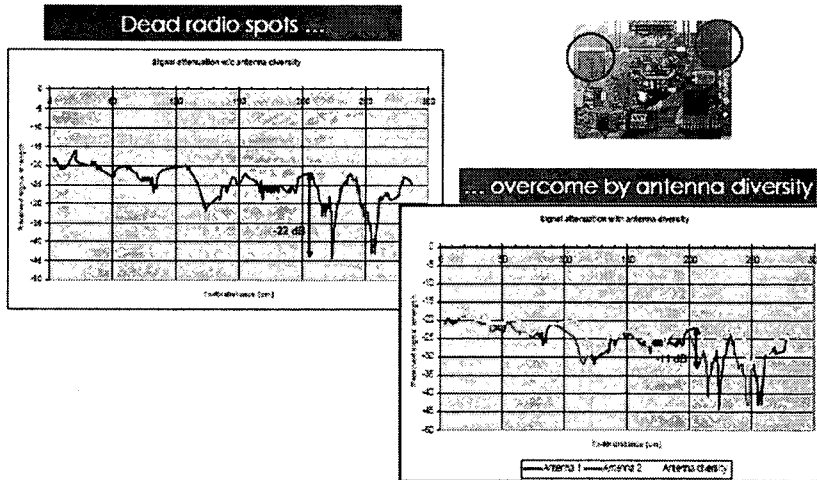


출처: Ember

3. 주요 기술 이슈 사항



● Antenna Diversity를 이용한 Multipath Fading 보상 방법



출처: Ubiwave Field Measurements

3. 주요 기술 이슈 사항



◆Interference 문제점

• Interference 발생원

- Bluetooth

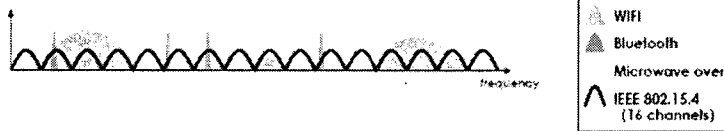
- 79개 1MHz Channels
- 대부분 Bluetooth Device Power < 1mW
- 중대한 발생원이 아님.

- WIFI

- 22MHz, 100mW
- 동일 지역에서 최대 3개 채널 사용

- Microwave oven

- Leaks energy < 100mW in 5MHz band at 50% DC
- 일반적으로 한정된 주파수 대역을 사용

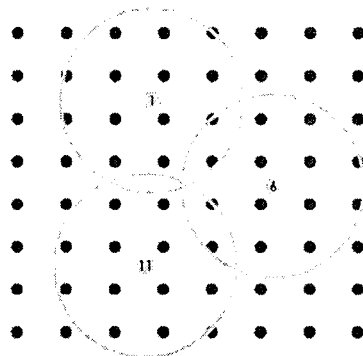


출처: Ubiwave

3. 주요 기술 이슈 사항




●실제적인 예 : ZigBee + WIFI



- 3개의 WIFI system이 동작함에도 ZigBee 16개 채널 중 7개는 간섭이 없음.
- 그러나, WIFI가 무작위로 동작할 수 있고, 채널이 바뀔 수 있음.
- 따라서, WIFI energy를 감지하여 적응적으로 간섭 채널을 피할 수 있는 방안이 필요함.

3. 주요 기술 이슈 사항




◆Power Saving 방법 (1)

• Energy = Time x Power
 $= (P_{\text{active}} \times T_{\text{active}}) + (P_{\text{sleep}} \times T_{\text{sleep}})$

=> 공급 전압, 동작 전류를 최소화

- 동작 시간을 줄여라
- 동작 전력을 줄여라



• 동작 시간을 최소화하는 기술


- Beaconless mode을 사용
- Beacon mode에서 beacon order 최대화, super frame order을 최소화
- frame/address 길이를 최소화
- 불필요한 메시지 최소화

• 동작 전력을 최소화하는 기술

- 출력 전력을 최소화 : 지능적인 전력 제어 필요
- 저전력 Wake-up Radio 사용

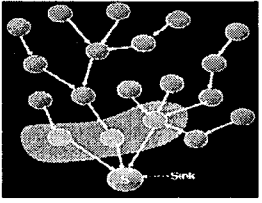
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삼성전기

3. 주요 기술 이슈 사항



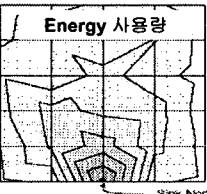
◆Power Saving 방법 (2)

<비효율적인 Network 구성>



↓

Energy 사용량



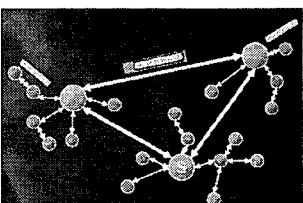
- 350-400
- ▣ 300-350
- ▢ 250-300
- ▤ 200-250
- ▥ 150-200
- ▦ 100-150
- ▧ 50-100
- ▨ 0-50 x 100μJ

Sink Node

• Network Lifetime이 Sink Node 근처에 있는 Node들에 의해 결정

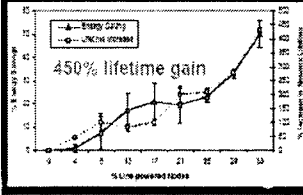
출처: Intel

<효율적인 Network 구성>



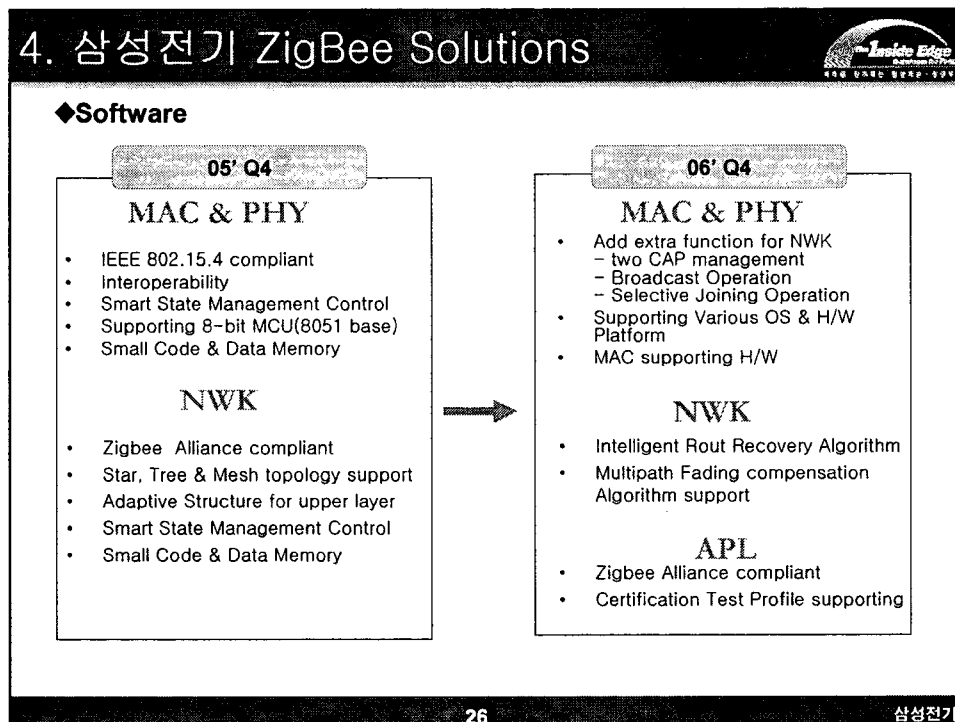
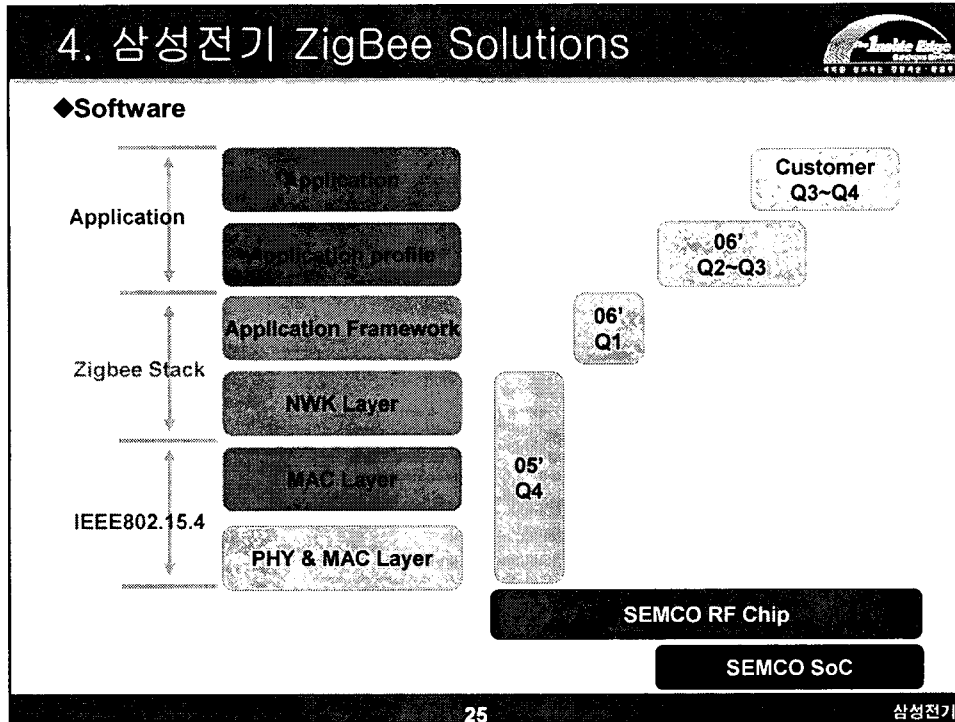
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Testbed results from 6x8 Mica grid



450% lifetime gain

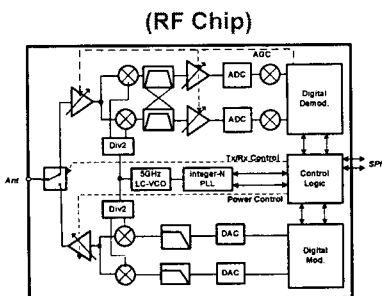
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삼성전기



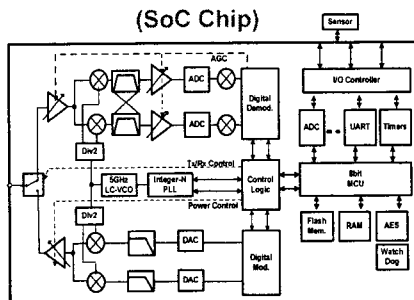
4. 삼성전기 ZigBee Solutions



◆Chip



- 5x5 PKG
- 송/수신 동작 전류 < 20mA
- Sensitivity ~ -95dBm
- 전원 : 2.1 ~ 3.6V
- PHY + MAC HW 내장
- SPL : 2006. Q1



- 7x7 PKG
- 송/수신 동작 전류 < 25mA
- 채널 모니터링 전류 < 3mA
- Sensitivity ~ -95dBm
- 전원 : 2.1 ~ 3.6V
- PHY + MAC HW + 8bit MCU + ADC 내장
- SPL : 2006. Q4

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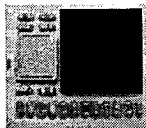
삼성전기

4. 삼성전기 ZigBee Solutions



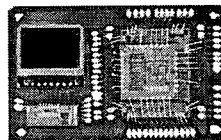
◆Module

(ZigBee Module)



- 소형 모듈
- Embedded PCB & LTCC Technologies
- SPL : 2006. Q1

(ZigBee 복합 Module)



- 복합 모듈
- (ZigBee+Sensor, ZigBee+WLAN, ..)
- Embedded PCB & LTCC Technologies
- SPL : 2006. Q4

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삼성전기

4. 삼성전기 ZigBee Solutions

◆Total Solution

Module Solutions
Module, Antenna, Filter, Crystal, MLCC, ..

Software Solutions
MAC, NWK, OS, Applications, ..

Chip Solutions
Transceiver, SoC, Sensor, ..

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감사합니다.

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that shapes the **Future**

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