APRICOT 2005 KYOTO

Real Object Oriented Technologies
ROOT INC.

Building Internet Infrastructure based on IEEE802.11 Wireless LAN Technologies

21 February 2005

ROOT INC. Hiroshi Mano

http://www.root-hq.com

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ROOT INC. Corporate Profile

Real Object Oriented Technologies
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- Corporate Policy
  - To contribute to society by providing technologies for problem solving.
  - To educate and train engineers as innovators .

- Profile (As of January 5, 2005)
  - Founded: 12 Apr, 1993
  - HQ: 1-17-8 Nishikata, Bunkyo-ku, Tokyo, Japan
  - Paid-up Capital: ¥274,750,000
  - Employees: 26

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Agenda

- Case study of Today’ Wireless LAN technology
  - Fixed Wireless Access:
    - Community Area Network
    - Wireless Internet access service
  - Security
    - WLAN in University with High secure policy operation
  - Mobility
    - Mobile communication, Telematics application
  - Industrial applications:
    - Monitoring
- New standards of Wireless LAN
  - 802.11x
  - 802.16
  - 802.20

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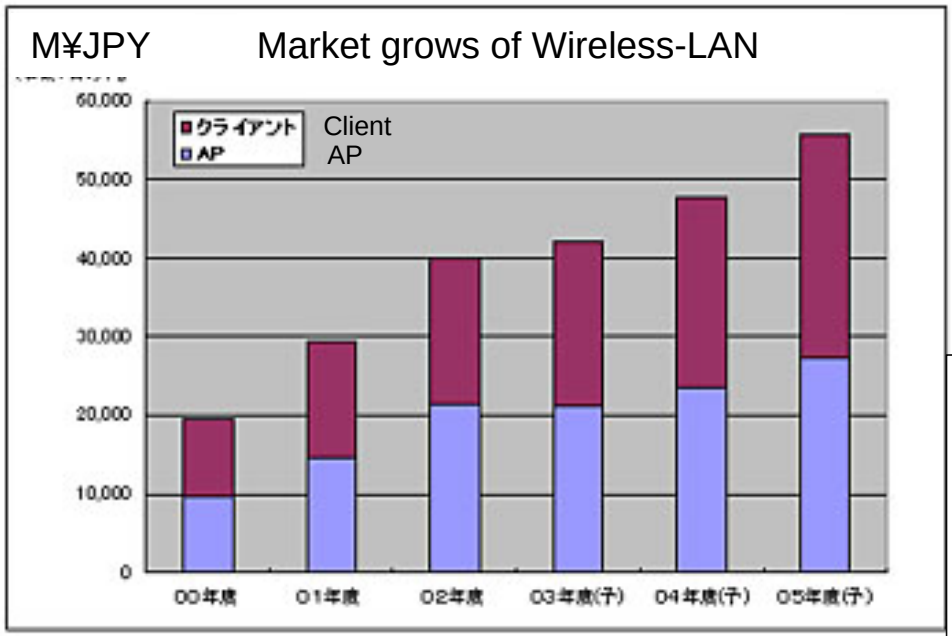
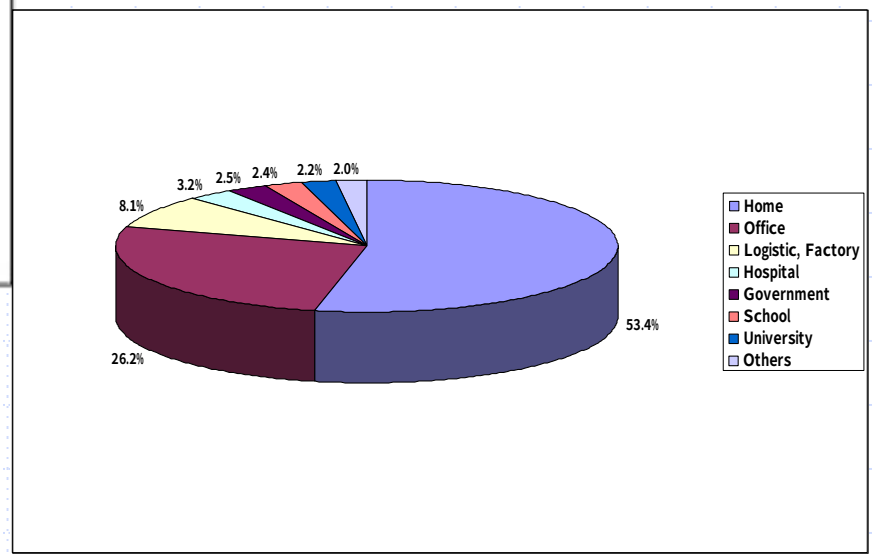
That market grows of Wireless LAN in Japan.

- That market grows rapidly and an application field expands day by day.



2003年10月　矢野経済研究所



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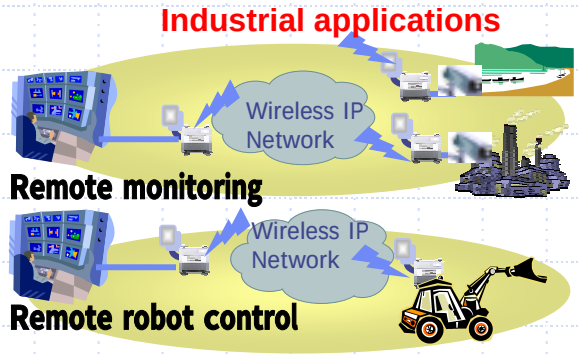
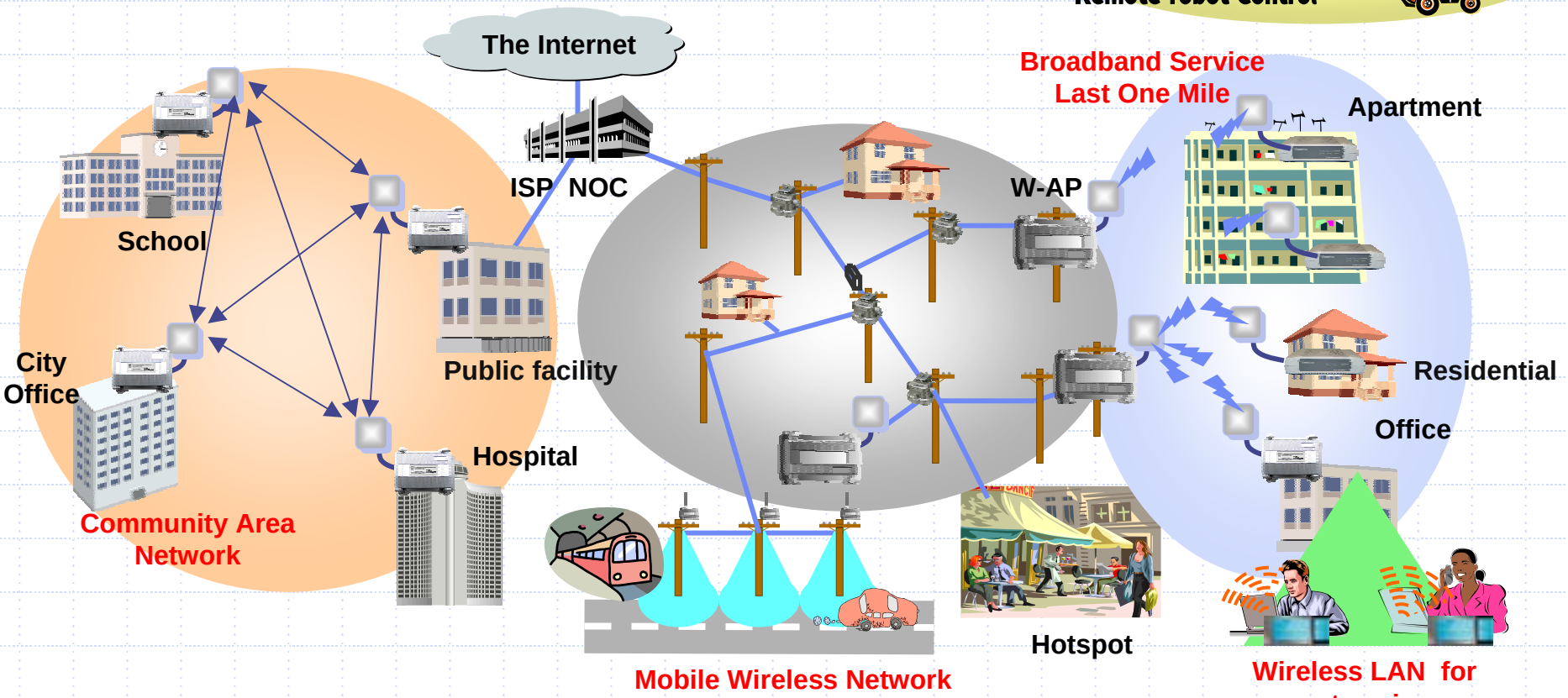
Marketability of Wireless LAN & Internet

- Fixed Wireless Access: Community Area Network
- Broadband Service Last One Mile: Wireless Internet access service
- Wireless LAN: WLAN in Enterprises
- Mobile Wireless Network: Mobile communication, Telematics
- Industrial applications: Monitoring , Robot control





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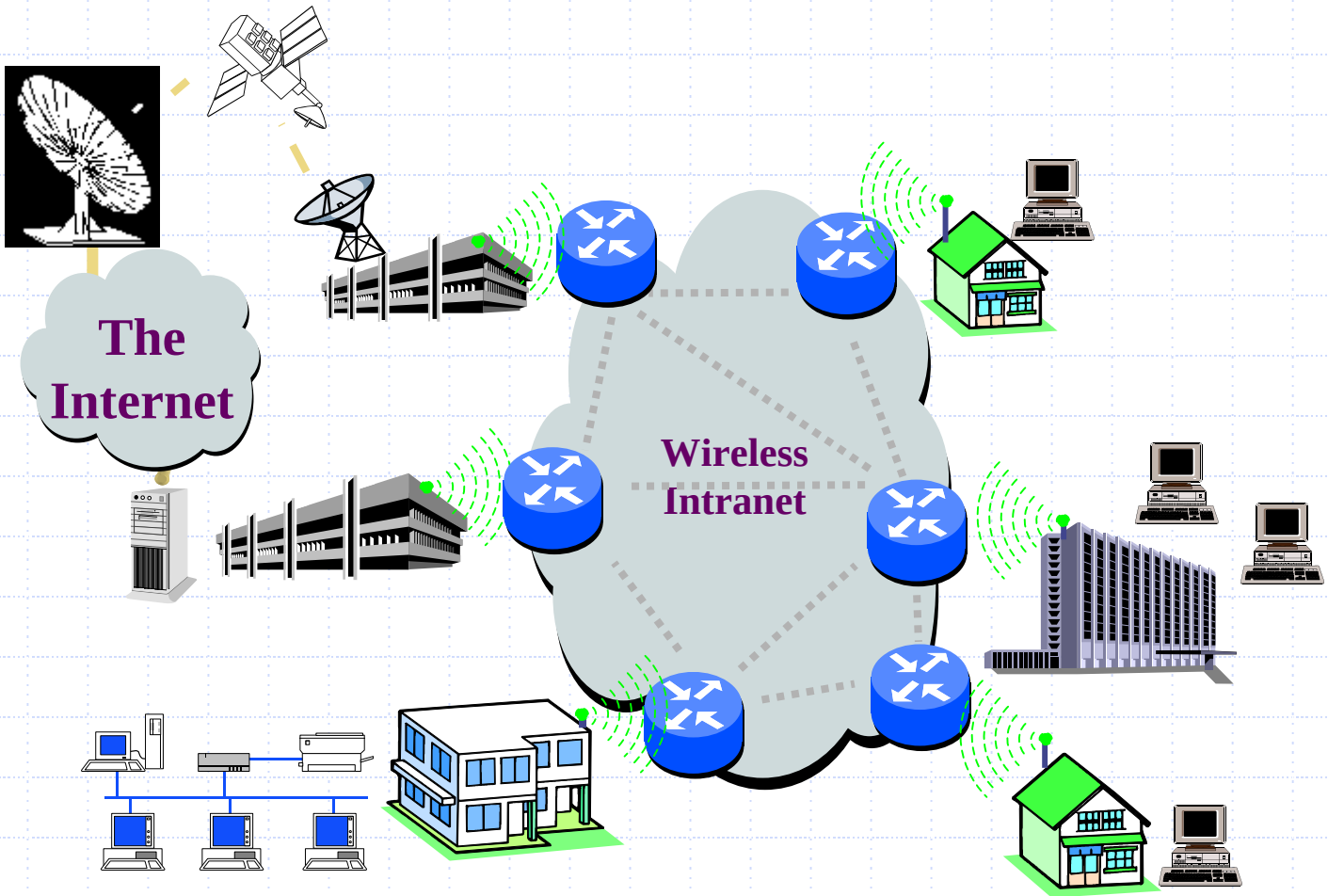
Fixed wireless access for Rural communications



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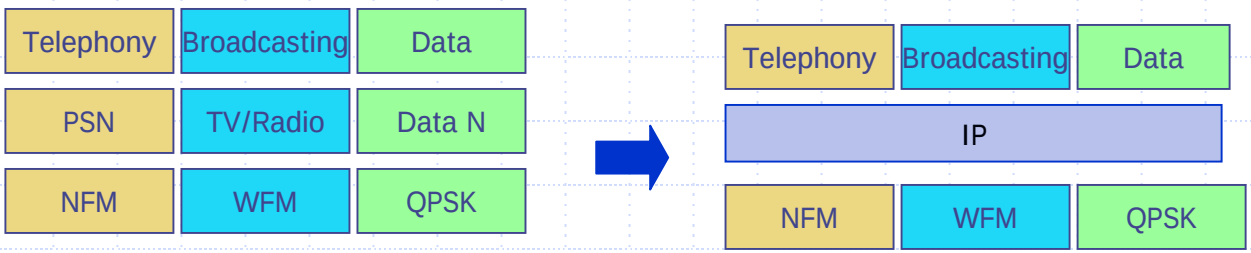
Advantage of Wireless IP Network

- Why IP ?
  - Multi Media applications such as VoIP, Tele Education, Telemedicine.
  - Sharing cost of infrastructure.
  - Interoperability to The Internet.
  - IP routing expands cover area.



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Wireless LAN and Wireless WAN

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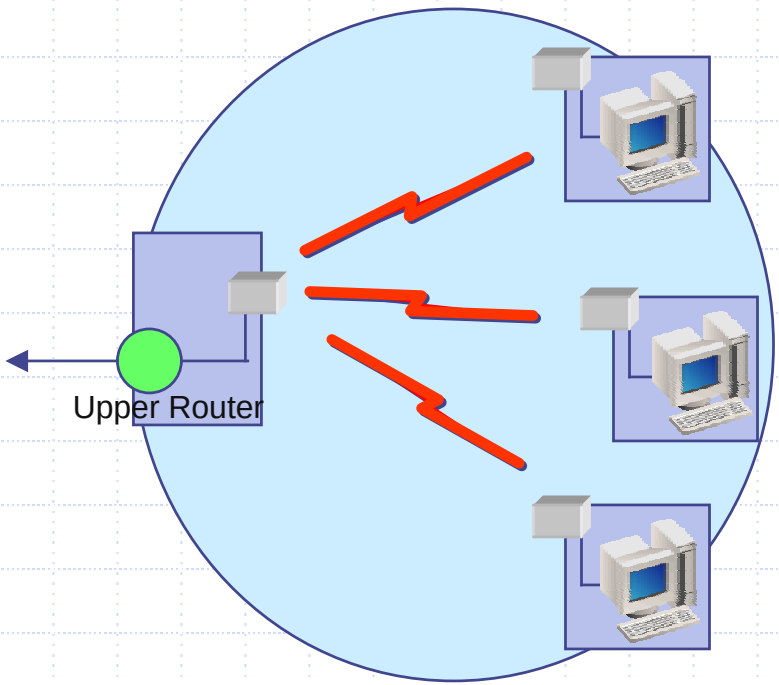
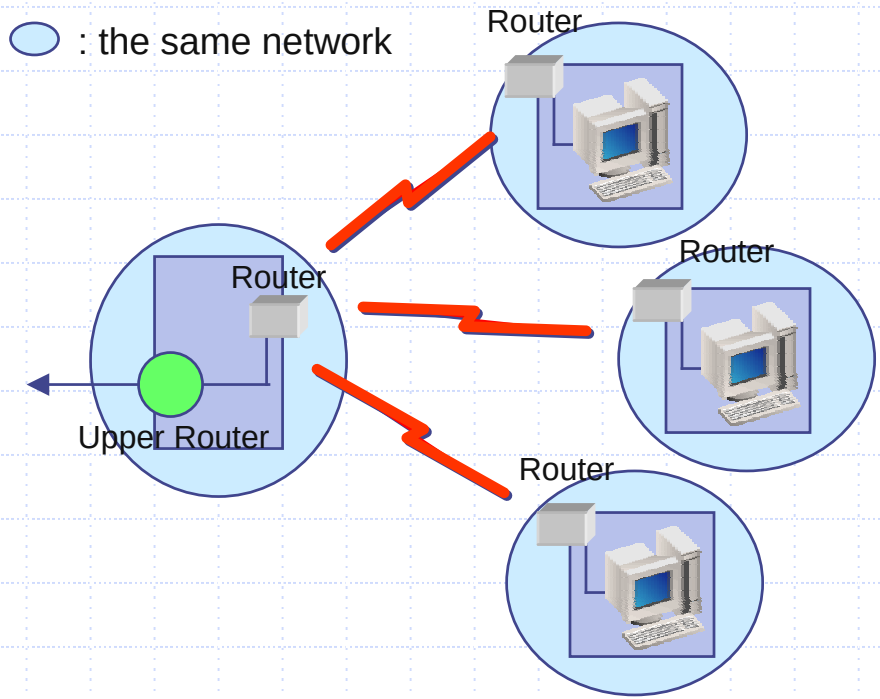
- Wireless LAN
  - Host to Network connection
  - Single Topology
  - Single operation policy
- Wireless WAN
  - Network to Network connection
  - Autonomous deployment network
  - Individual operation policy



Wireless LAN



Wireless WAN

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Actual case study of IEEE802.11b/g Equipment Wireless IP Router RGW5000 series

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- Realize transmission rate up to 54Mbps. Actual transmission rate up to 20Mbps.
- Realize long-distance transmission up to 22 km.
- Create well-managed and extensible system with built in NetBSD.
- Designed for outdoor use, 24 hours stable operation.
- No license is required for use
- Realize multi-point to multi-point wireless network, available for relying radio by single router.
- Variety of Antennas：Selectable by network topology and location.
  (Omni-directional, Directional or Long-distance)
- Designed as IP network equipments with high-reliability and supporting functions
- Variety of product lineup

Transmission rate up to 20 Mbps
Transmission range up to 22 km

Product Lineup	Image	Placement type	Interface
RGW5000/OD		Separate type for outdoor	10Base-T / 100Base-TX (4 ports)
RGW5000/ID		All-in-one type for Indoor	10Base-T / 100Base-TX
RGW5000/APF		All-in-one type for outdoor	100Base-FX （Single mode fiber）
RGW5000/APU		All-in-one type for outdoor	10Base-T / 100Base-TX

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For outdoor use, Separate type IEEE802.11b/g 2.4GHz Wireless IP Router RGW5000/OD

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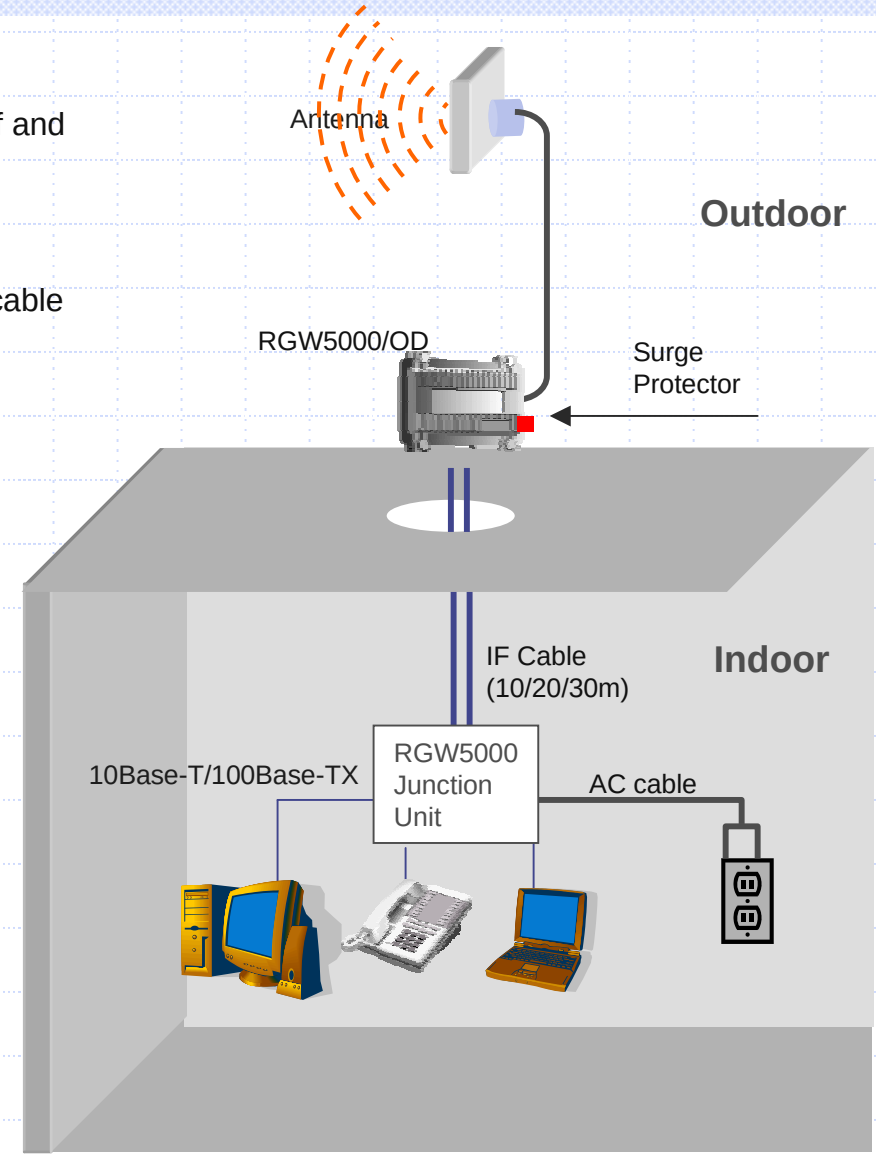
RGW5000/OD‥‥‥Open Price

- Designed for outdoor use, separate type, waterproof and dustproof unit.
- Enables long range transmission.
- Built –in 4 ports of SW-HUB within a junction unit.
- Variety of Antennas: Selectable from 10/20/30m of cable length.
- LED Display on the junction unit.
- Option: Surge protector

Upper left: RGW5000 Main unit
Under left: RGW5000 Junction unit
Center: AC cable for junction unit
Right: Interface cable



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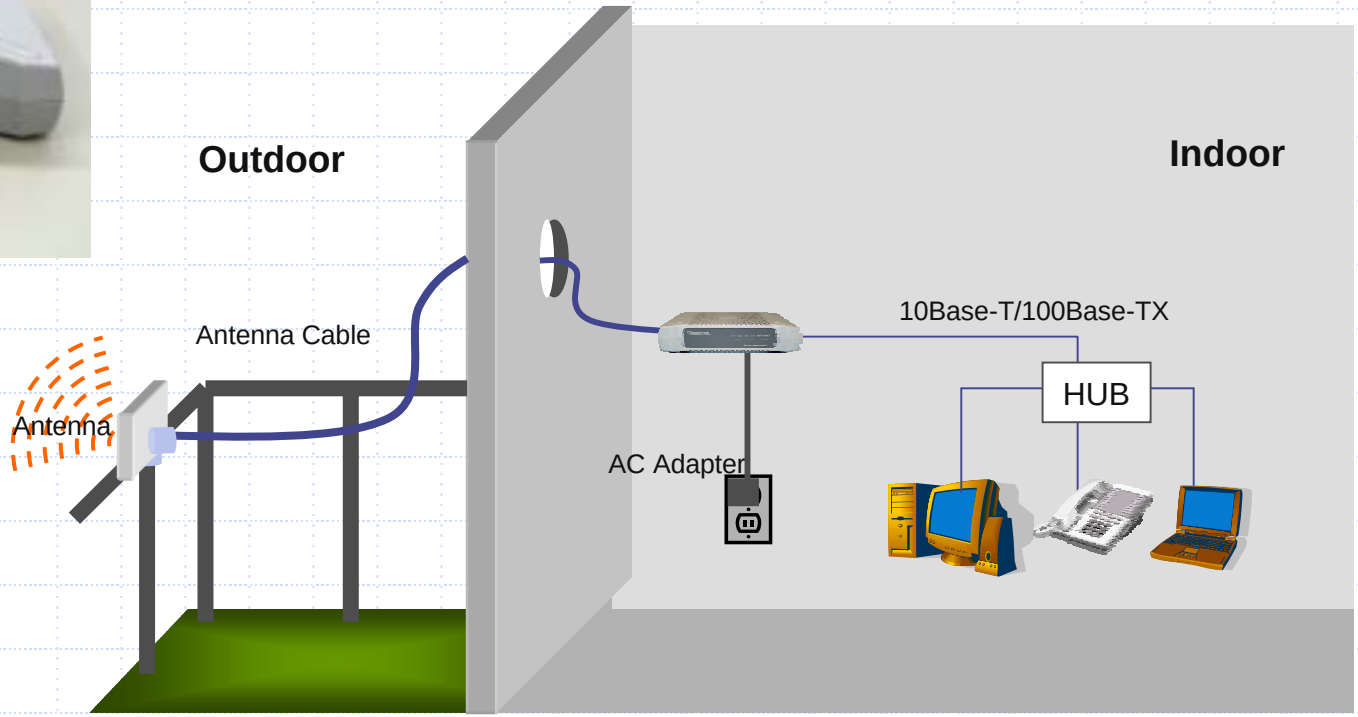
For indoor use, All-in-one type
IEEE802.11b/g　2.4GHzWireless IP Router RGW5000/ID

RGW5000/ID・・・・・・Open price

- Designed for Indoor use, all-in-one type
- LED display
- Enables hanging on the wall

RGW5000/ID Main unit



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IEEE802.11b/g
2.4GHz Wireless IP router RGW5000/APF, RGW5000/APU

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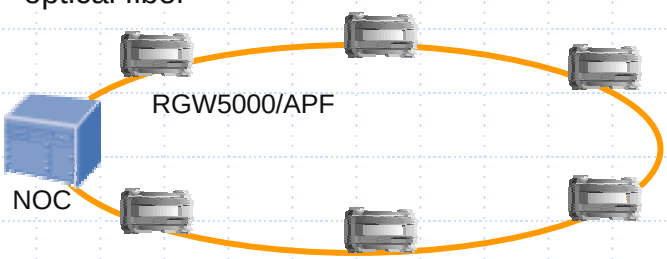
RGW5000/APF ・・・Open price

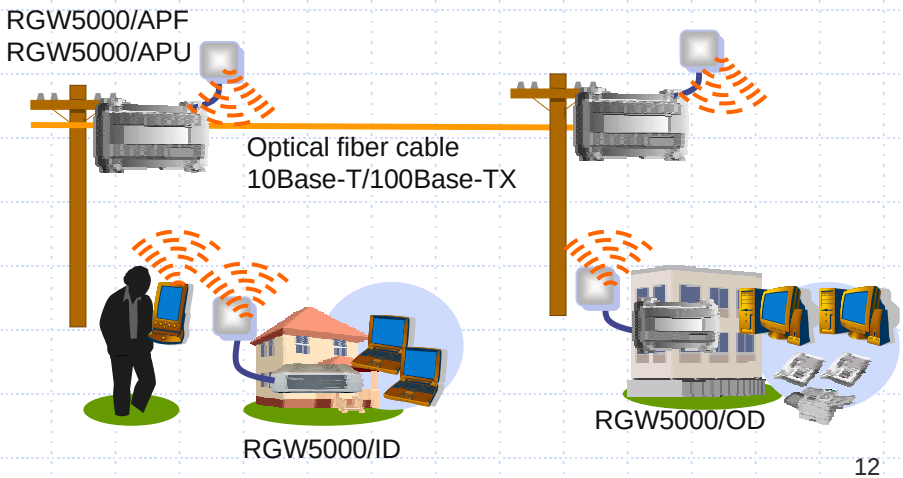
- Optical fiber Interface（Single mode fiber）
- Double-core multi-drop is available.
- Expensive HUB such as ATM is unnecessary.
- Enables doubling with loop system.
- Designed for outdoor use, waterproof and dustproof unit.
- LED display on the bottom of the main unit.

Realize multistage loop configuration with double-core optical fiber



RGW5000/APU・・・Open price

- 10Base-T/100Base-TX Interface
- Designed for outdoor use , waterproof, dustproof unit.
- LED display on the bottom of the main unit.



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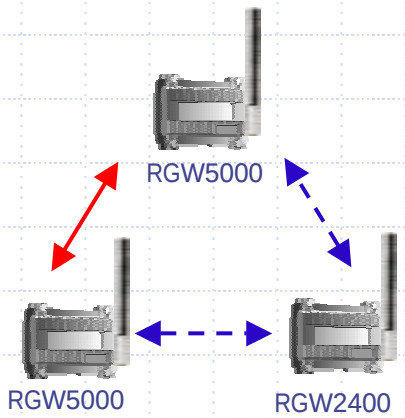
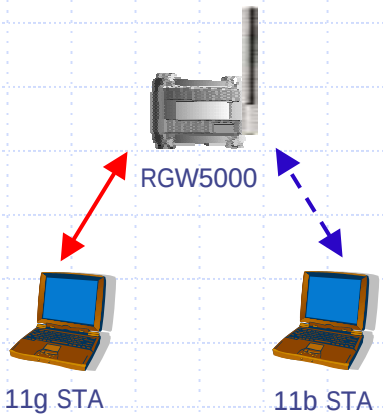
IEEE802.11b/g connection method

- Mode of IEEE802.11

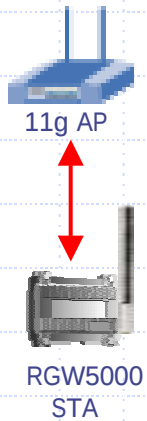
Pseudo-adhoc mode

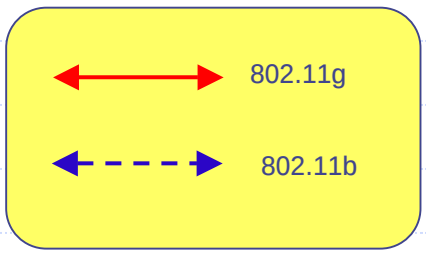


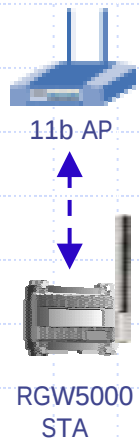
Infrastructure mode
Access Point



Infrastructure mode
Base Station







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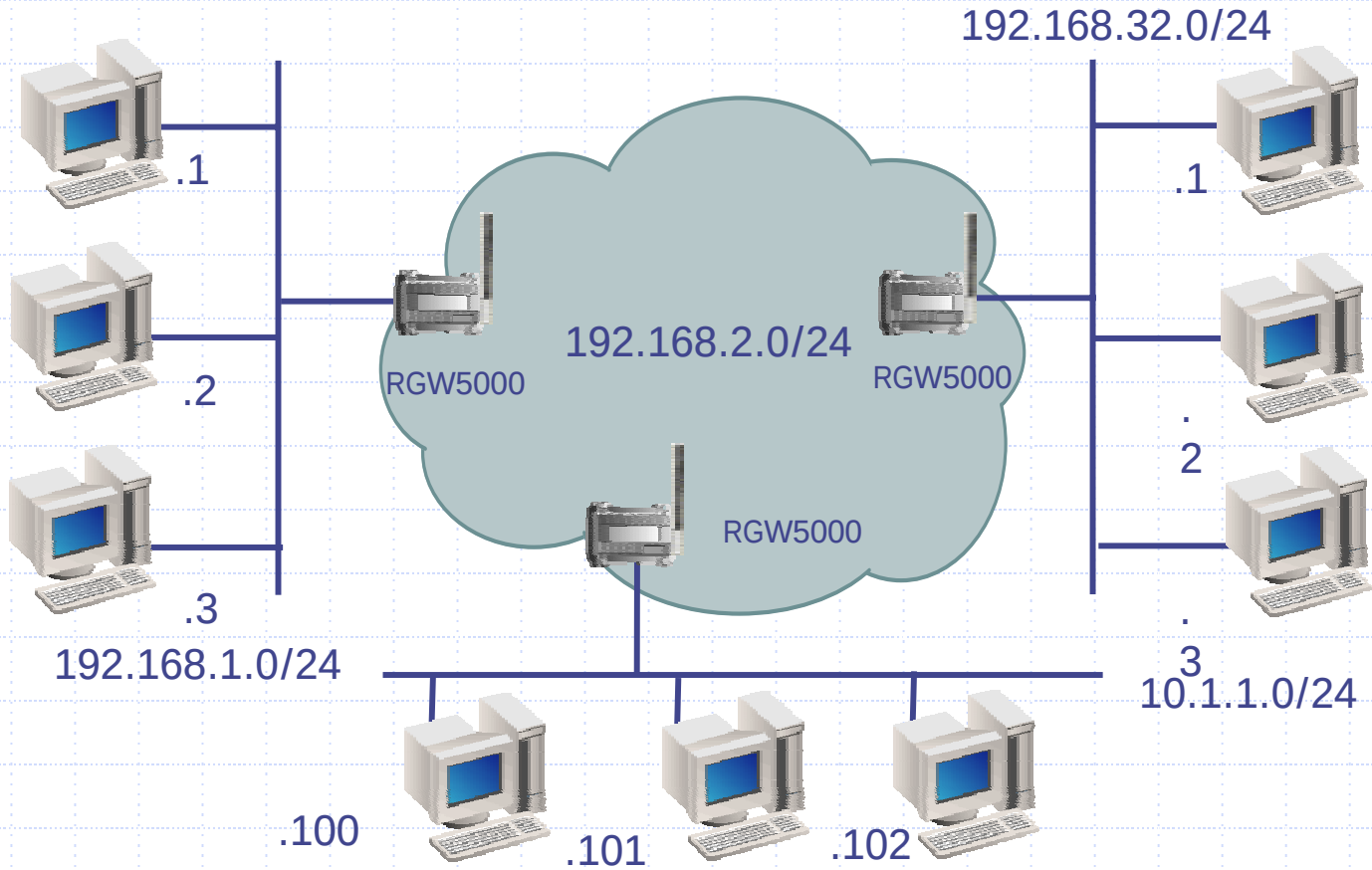
Router connection (Autonomous deployment)

- Connect with different networks
- Individual operation is available for connected networks
- MP to MP Free topologies



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IEEE802.11b,g AP
Bridge (AP-AP Communication) （1）

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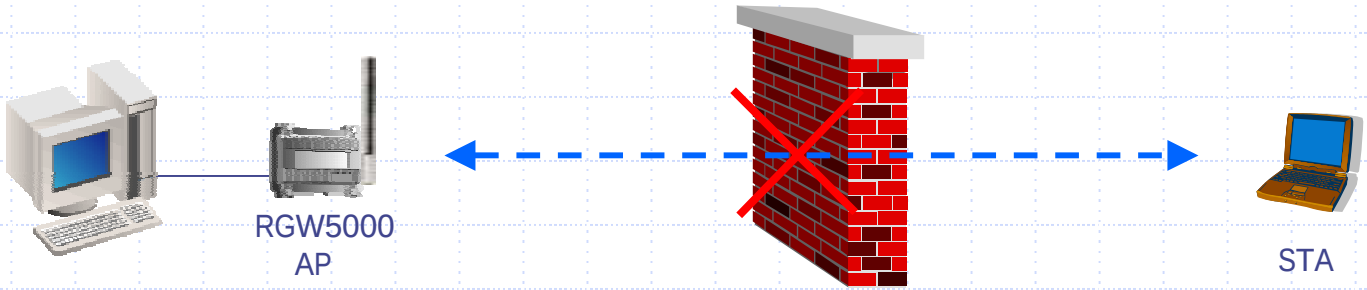
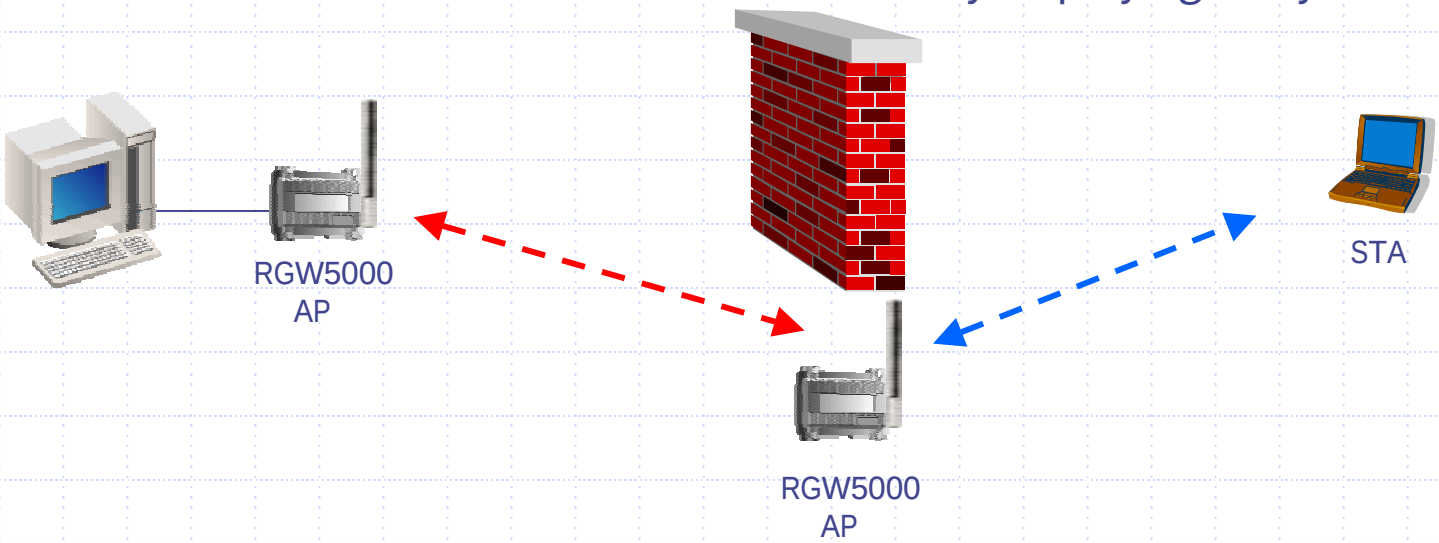
a. Impossible to connect as direct line



b. Possible to connect both sides of AP line by deploying relay router.



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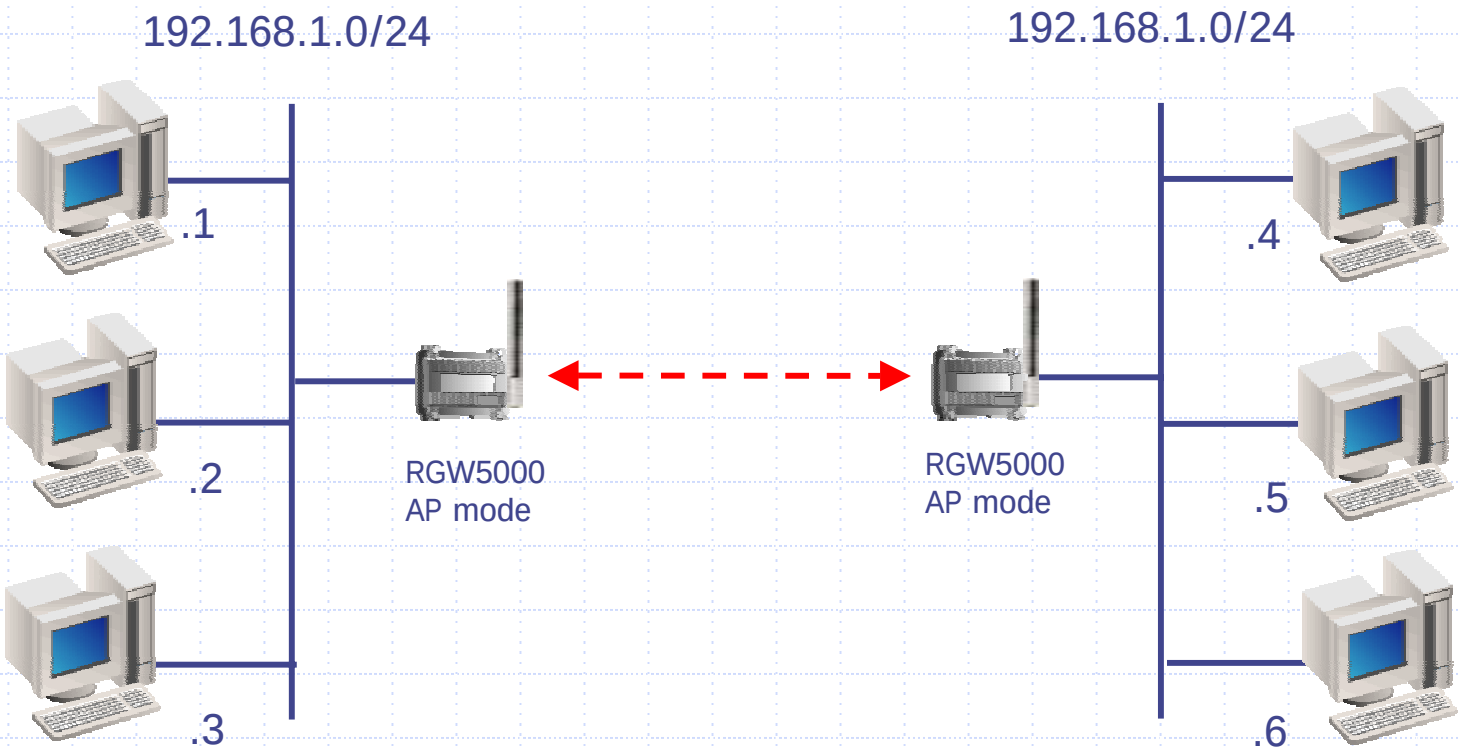
IEEE802.11b,g AP
Bridge（AP-AP Communication） （2）



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Antenna Lineup

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Omnidirectional

Octa-Step Co-Linear Antenna (CA-01)

Tri-Step Co-Linear Antenna (SA-00)

Directional

Patch Antenna For Outdoor (PA-03-01)

Semi-directional

Cardioid Antenna (KA-00)

For Relay Bidirectional

Yagi Antenna (YA-01)

For indoor

Patch Antenna For Indoor (LA-00)

For Long-range transmission

8-element Yagi Antenna (AT372)

27-element Yagi Antenna (YA2418RD)

Patch Array Antenna (WNA-202F)

Grid Parabolic Antenna (AT373)

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Introduction Procedure

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(1). Network Design

Design of network topologies
IP Address allocation
Routing
Service(DHCP, IP Filtering..)

(2). Surveillance of Sight Environment

Line of sight
P-P propagation (according to need)
Noise test

(3). Equipment Configuration

Configure the network parameters

(4). Installation

Construction
Installation

(5). P-P Propagation Test

Ping(short / Long packet)Throughput
Signal strength

(6))Network Test

Local communication test
Access to the internet
Functions check

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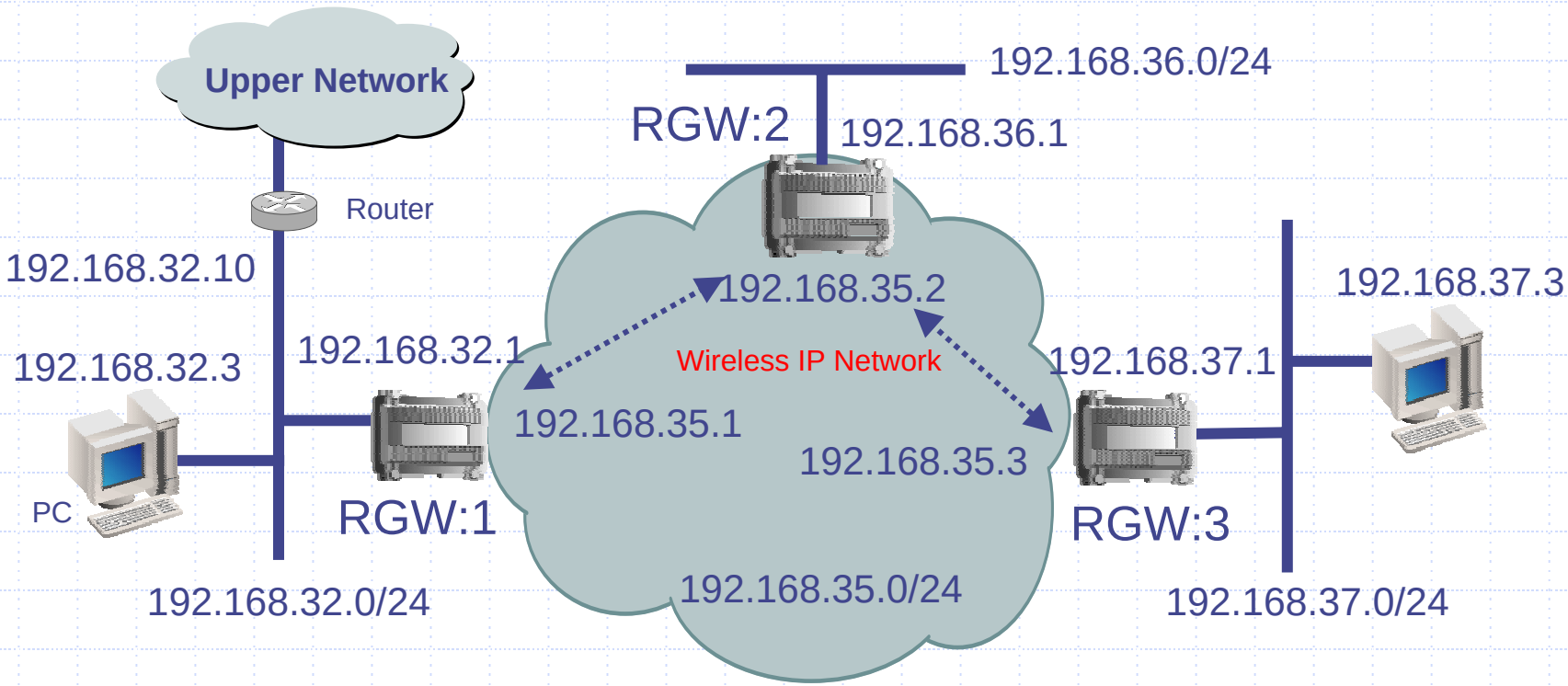
Network Design

- Design of Network topologies
- IP Address allocation
- Routing(Routing for upper network)
- Service(DHCP、IP Filtering…)



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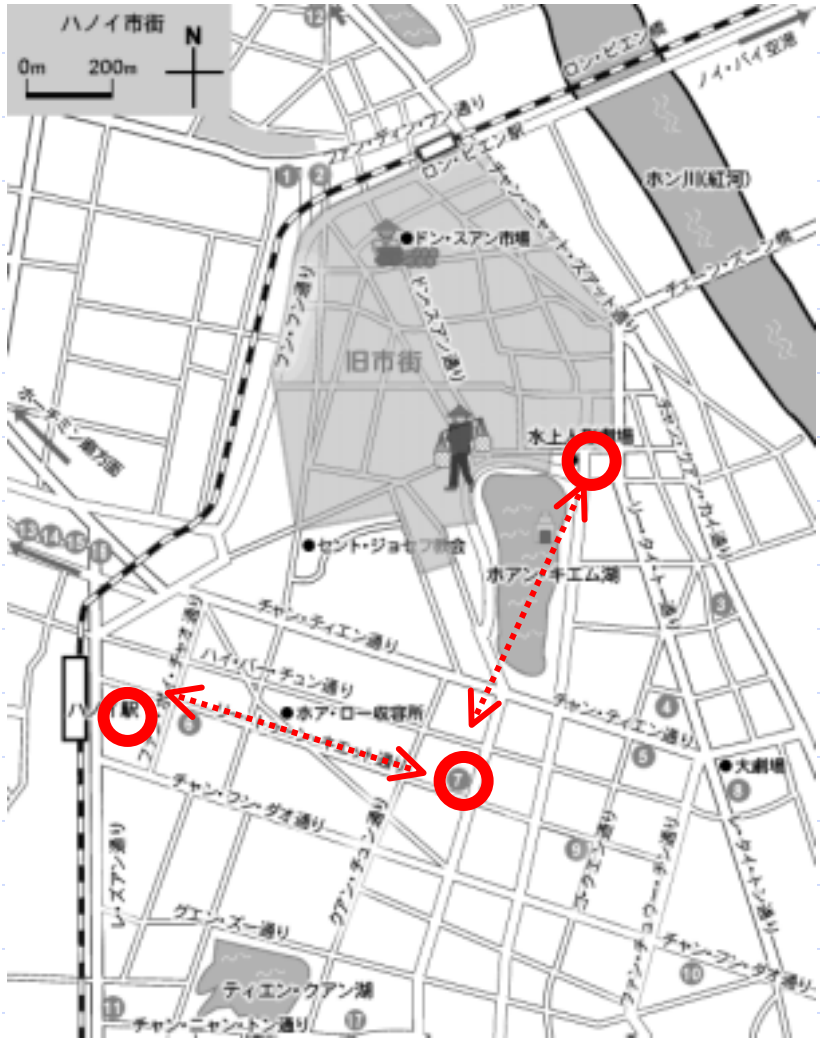
Surveillance of sight environment

- The Wireless link should be checked on map first.
  - Distance
  - Line of sight
  - Multipass
  - Relay point
- Network topologies
  - Point to point
  - Point to Multi points
  - Relay operations
- Construction
  - Indoor or Outdoor



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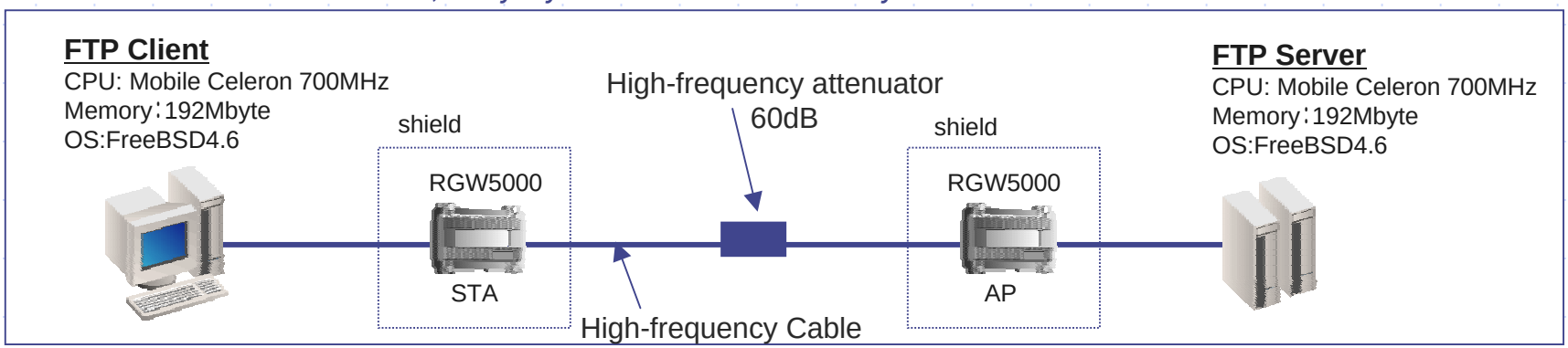
Reference of Transmission Range and Transmission Rate

Reference of Transmission Range and Transmission Rate

Transmission Mode		Effective Transmission Rate	Transmission Range * When used with 6dBi antenna on both sides ：PA-03-01、CA-01、KA-00	Transmission Range * When used with 16dBi antenna on both sides ：AT373
IEEE802.11b	11Mbps	4~5Mbps	2.0km	14km
IEEE802.11g	6Mbps	4~5Mbps	3.0km	22km
IEEE802.11g	12Mbps	7~8Mbps	2.5km	18km
IEEE802.11g	24Mbps	13~14Mbps	1.7km	12km
IEEE802.11g	36Mbps	16~17Mbps	1.2km	8.8km
IEEE802.11g	54Mbps	19~20Mbps	0.5km	3.0km

Method for measuring reference

＊Differ from locations, Vary by the law of the country.



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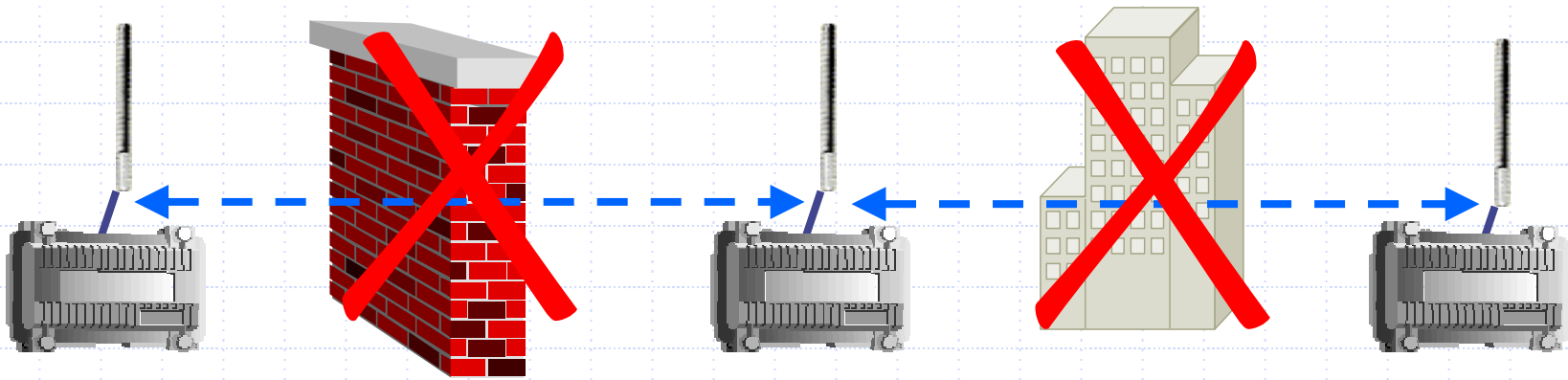
Keep line of sight

- Line of sight is required
- Check the availability of electric power etc.,



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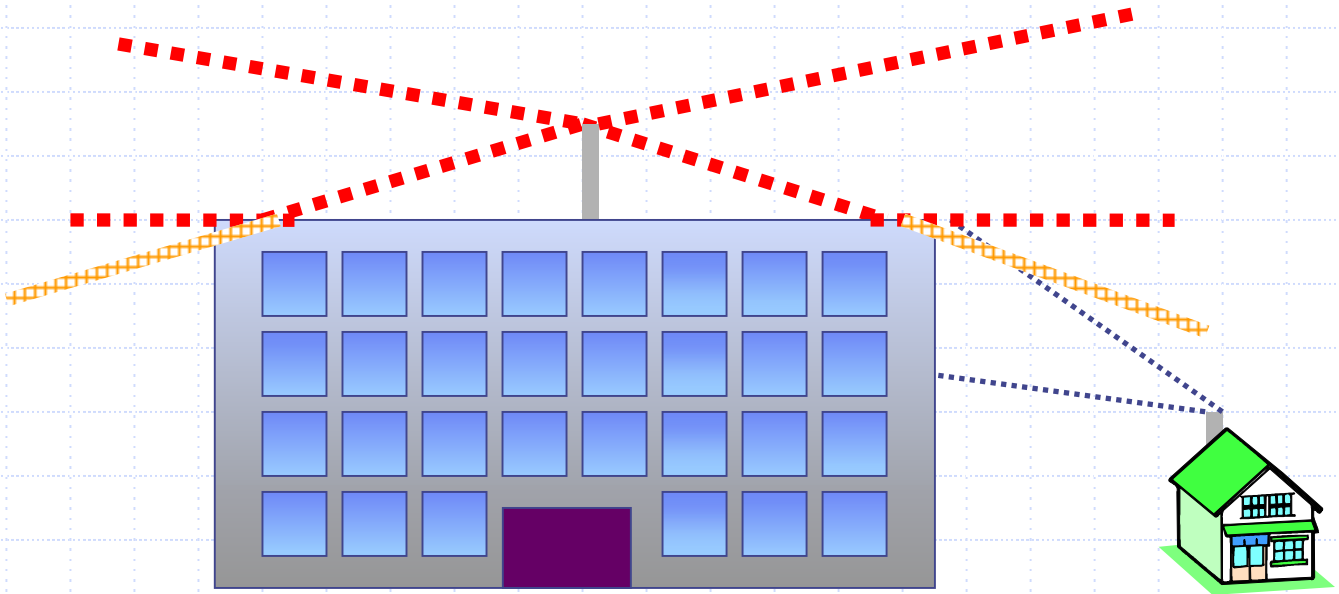
P-P propagation

- Line of sight between antenna and antenna is required. (not building and building)
- Omni directional antenna do not have omni directional for vertical.



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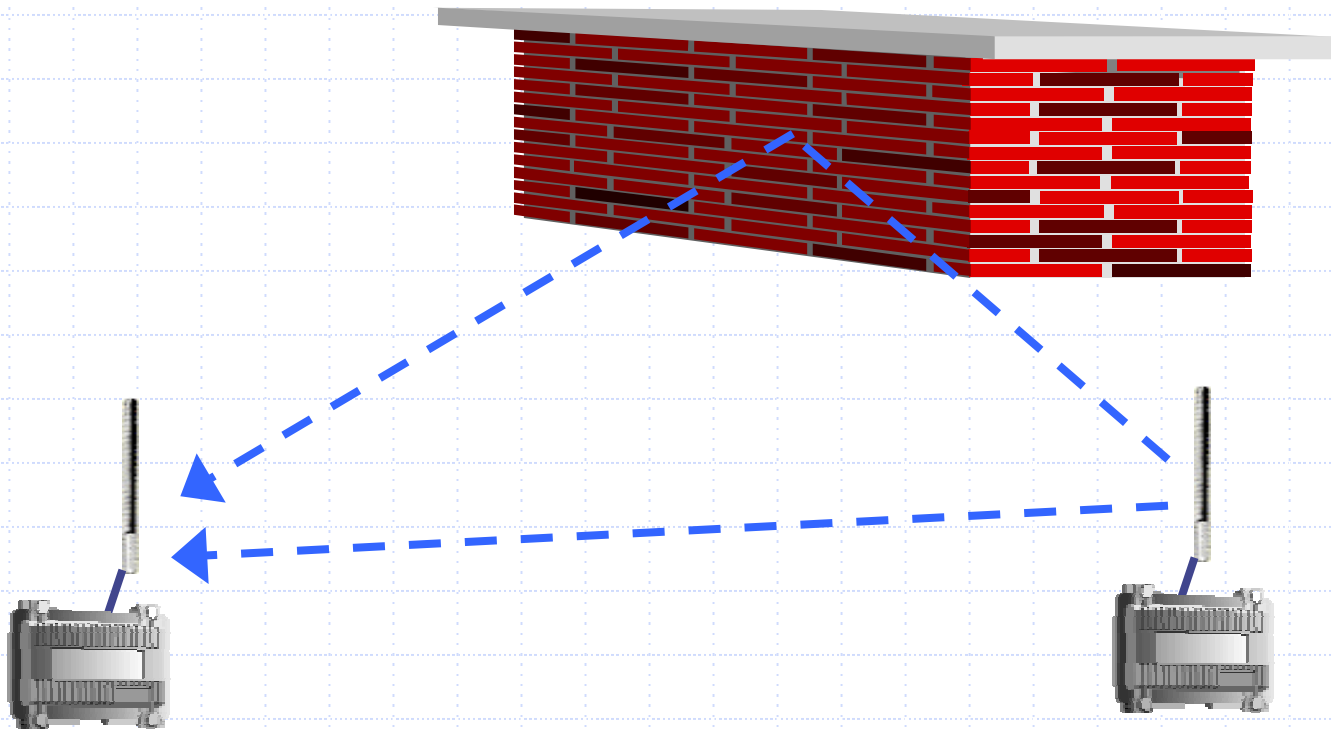
Multi path

- Need to reduce the multi path reflections
- Keep free space around antenna



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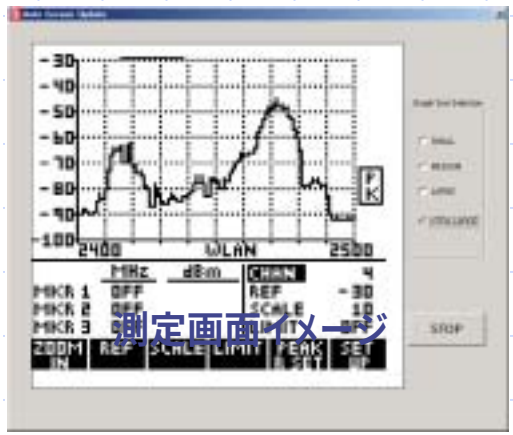
Noise Test

- Check the undesired signal from
  - Another wireless LAN
  - Medical equipment
  - Micro oven
  - Blue tooth

- Measurement by using Spectrum Analyzer



測定画面イメージ

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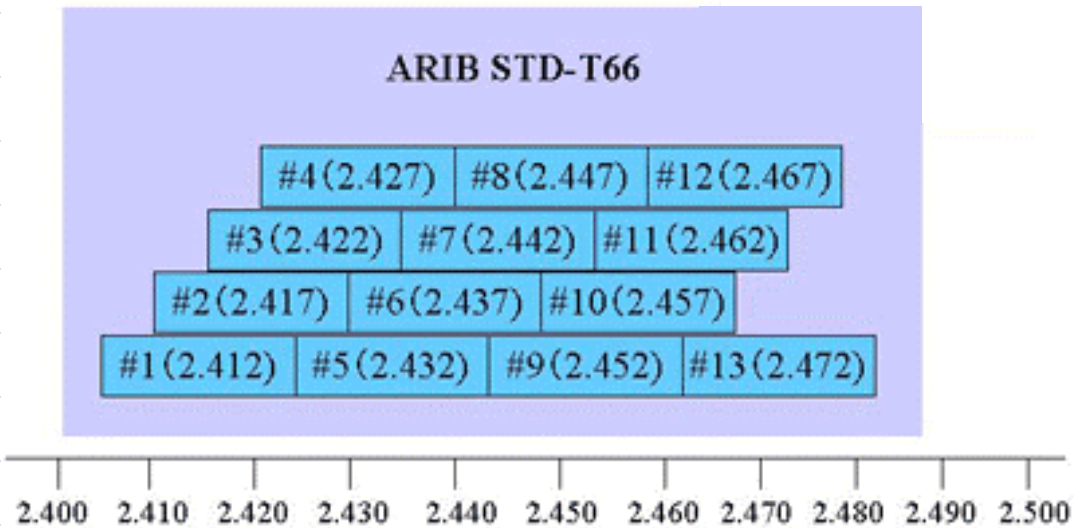
Frequency Allocation and Channel of Wireless LAN

- 4ch spacing is required in theory.
  - 100% occupied band width = 22MHz
  - 99% occupied band width = 16MHz (11b)
- Desired / Undesired ratio is required.



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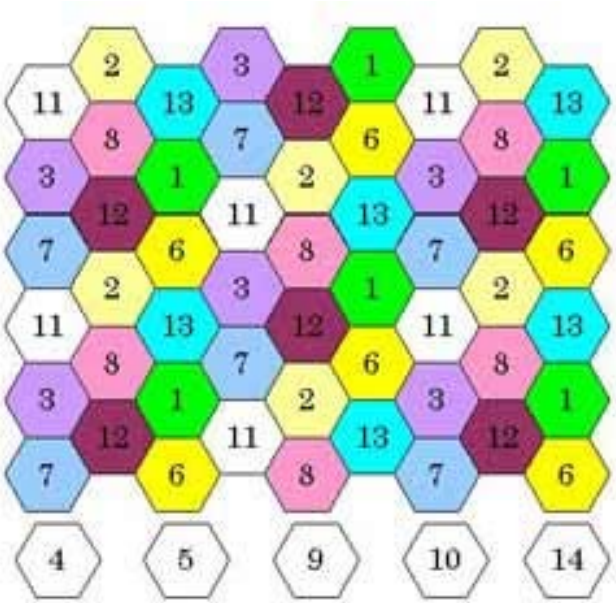
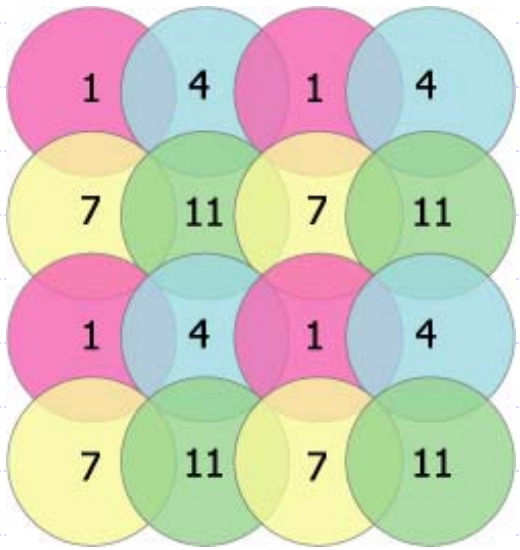
Cell deployment for using 9ch

- All base stations are deployed in free space and same environment.



- Incase of practical field, 4ch patterning is enough.



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Equipment Installation

- Enables hanging on the wall or deploying on the pole
- P-P Propagation Test again after installation

【Reference】






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Case Study of Installation of Wireless IP Router

- Actually, Installed in over 10,000 stations in Japan.
- Actually, Installed in over 150 Local Government units.

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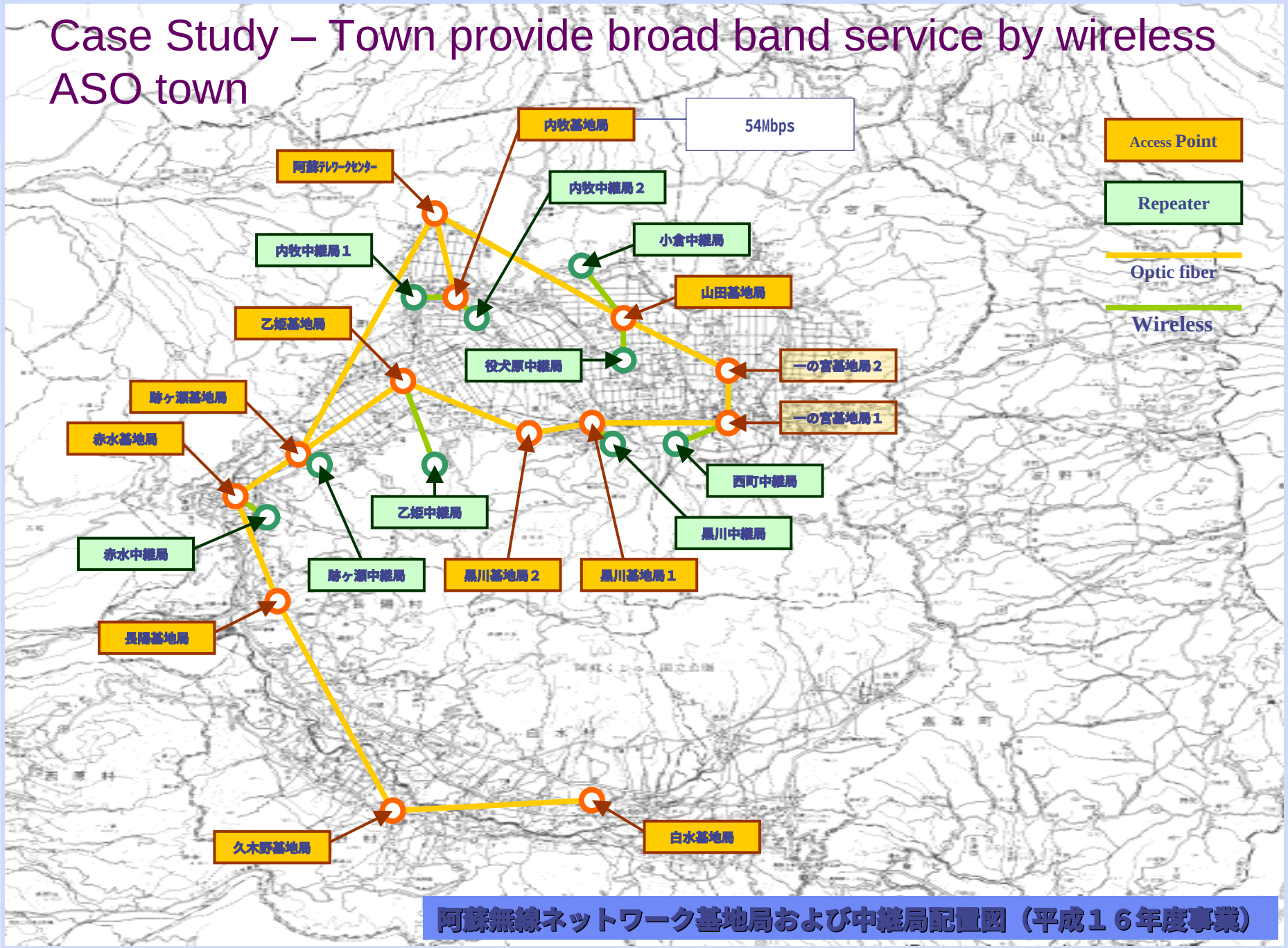
Case Study – Town provide broad band service by wireless ASO town



阿蘇無線ネットワーク基地局および中継局配置図（平成１６年度事業）

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Case Study – Town provide broad band service by wireless ASO town

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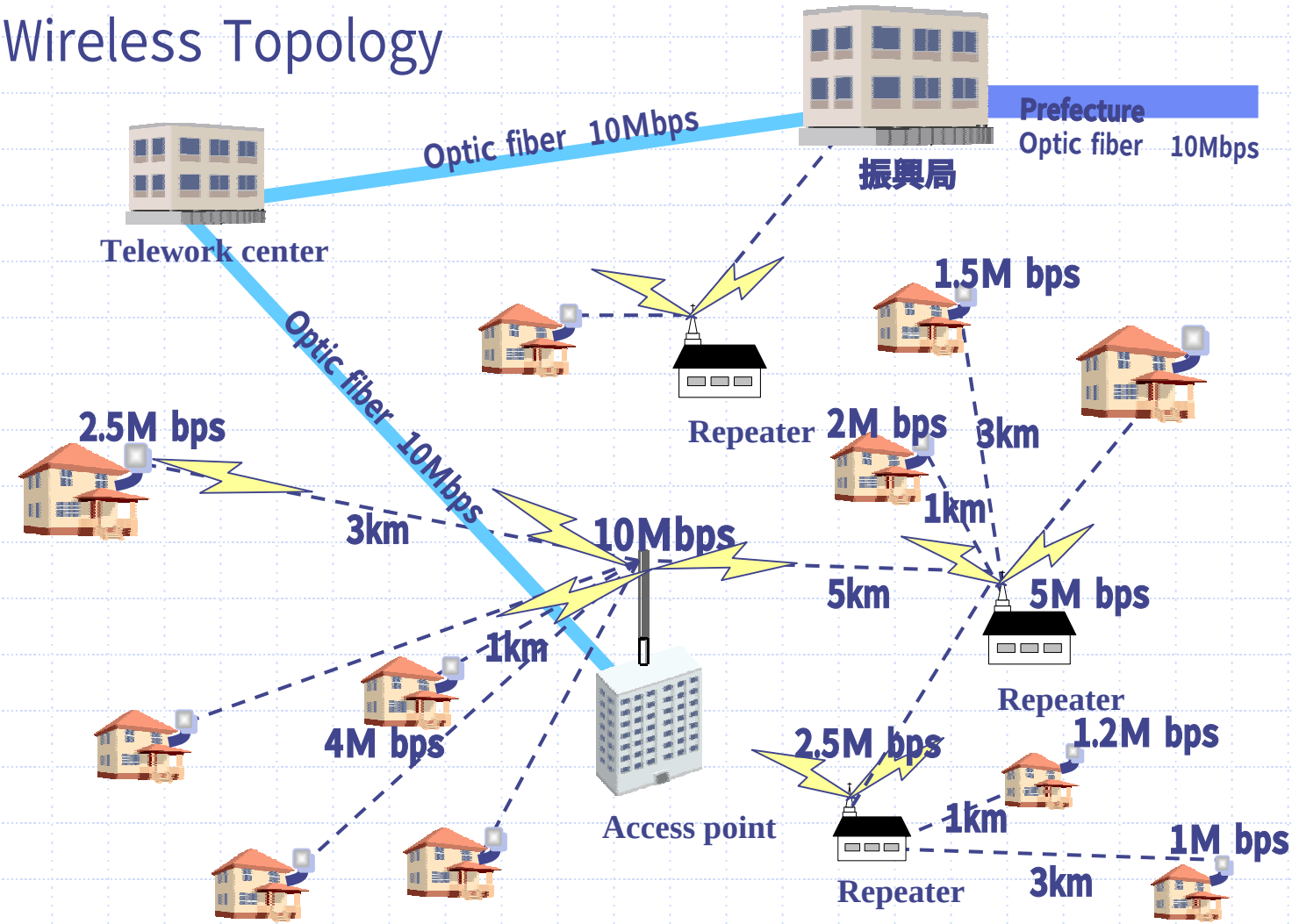
Wireless Topology



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Case Study – Town provide broad band service by wireless ASO town

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＊Telework center ⇔ Access point 「Optic fiber」 10Mbps

＊Access point → Repeater1 「wireless」 10Mbps
→ Residential 「wireless」 3～4Mbps

＊Repeater1 → Repeater2 「wireless」 5Mbps
→ Residential 「wireless」 1～2Mbps

＊Repeater2 → Repeater3 「wireless」 2．5Mbps
→ Residential 「wireless」 1～1．5Mbps

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Case Study – Town provide broad band service by wireless ASO town

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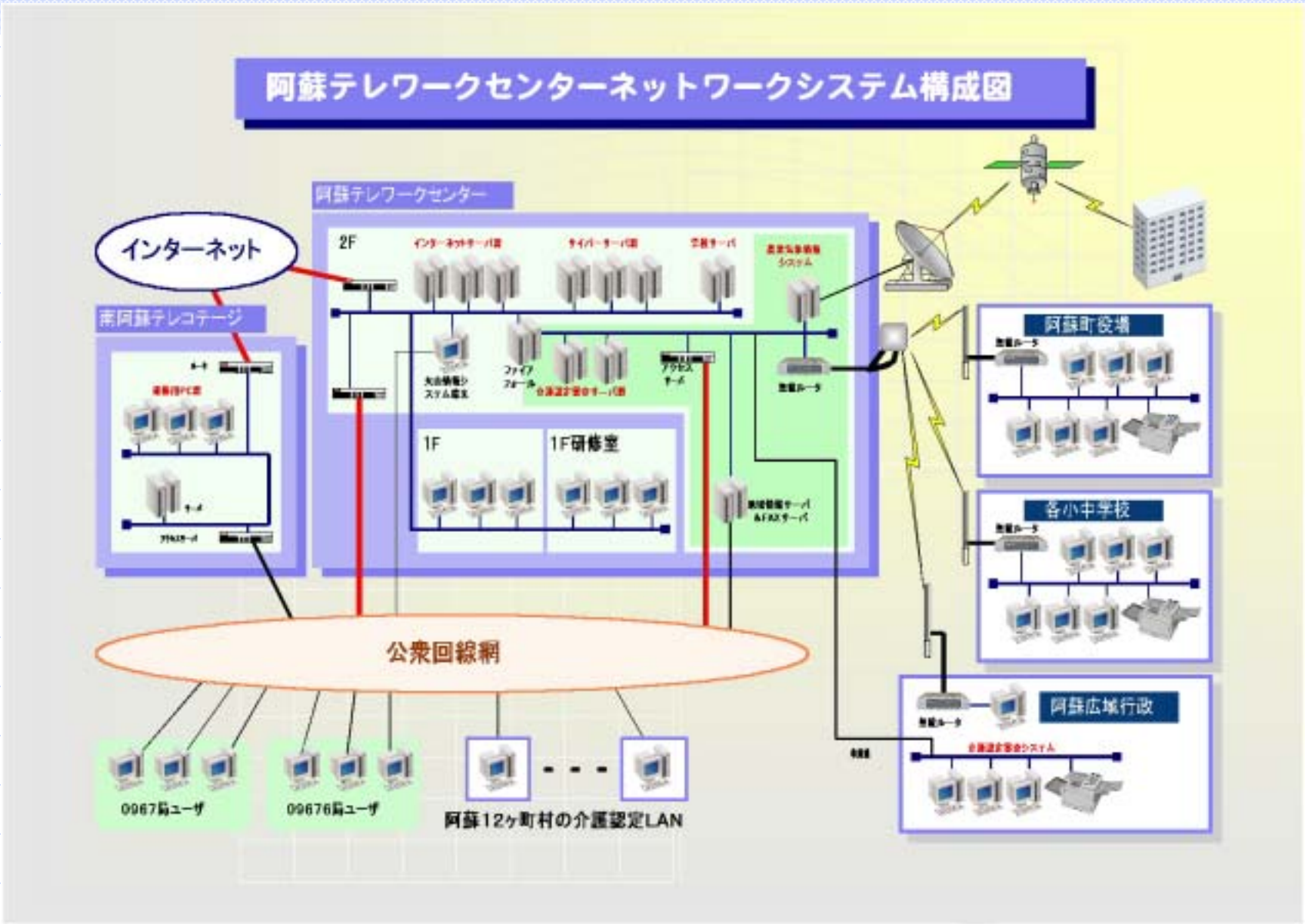

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Case Study – Wireless ISP
Kita net club (http://www.knc.ne.jp/) (1/2)

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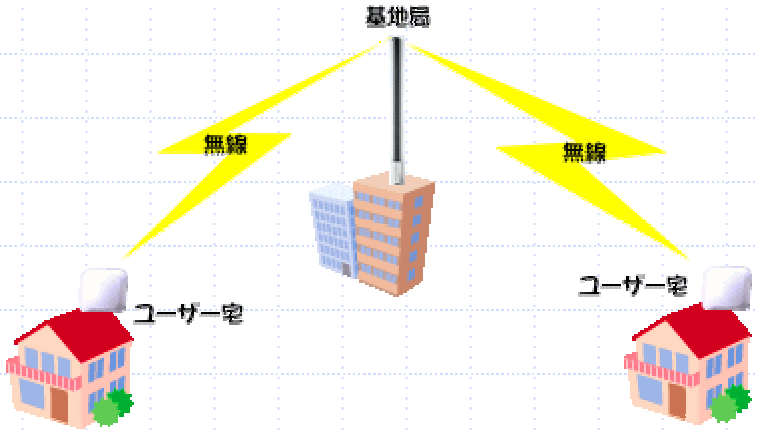
Topology



他サービスとの比較

	無線インターネット	フレッツADSL	Bフレッツ
Setup charge 初期費用	25,000円	27,930円	28.455円～38,010円
Monthly charge 維持費	4,050円～31,350円	5,093円～15,645円	7,959円～155,505円
Bandwidth 最大回線速度	下り：2Mbps～11Mbps 上り：2Mbps～11Mbps	下り：1.5Mbps～12Mbps 上り：512Kbps～1Mbps	下り：10Mbps～100Mbps 上り：10Mbps～100Mbps
Actual throughput 実効転送速度	下り：300Kbps～1.2Mbps 上り：300Kbps～1.2Mbps	下り：300Kbps～1.2Mbps 上り：128Kbps～256Kbps	下り：2Mbps～5Mbps 上り：2Mbps～5Mbps
Distance limitation 距離による速度低下	無し	有り	無し
Stability 安定度	中	低	高
Service area サービスエリア	10件以上の需要でサービス開始可能。	NTT東日本のサービスエリアのみ。	NTT東日本のサービスエリアのみ。
Link method 接続方法	常時接続	PPPoE	PPPoE
Setup schedule 開通期間	1週間～1ヶ月	2週間～1ヶ月	1ヶ月～3ヶ月
※実効転送速度は実測データの中央値です。			

Wireless　　ADSL　　FTTH

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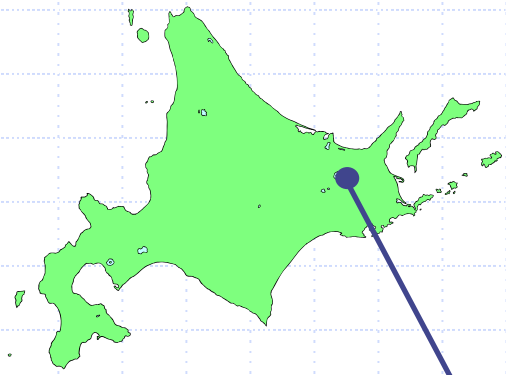
Case Study – Wireless ISP
Kita net club (http://www.knc.ne.jp/) (2/2)

Real Object Oriented Technologies
ROOT INC.

- High-speed Internet service area



Reference: Kitami city

北見市
北見市三輪３６－１　屋上
北見市美山町４５－１０５　電柱
北見市とん田西町２９６－１　屋上
北見市常盤町２丁目１－６５　屋上
北見市大通西２丁目１番地　屋上
北見市青葉町１６番２３号　屋上
北見市田端町９８　電柱
北見市川東７０番地の１７　電柱
北見市高栄西町８丁目８－７　鉄塔
北見市東相内町１６　屋上
北見市北進町３０番地４　屋上
北見市豊地１４－１６　屋上
北見市小泉３８６－４　屋上
北見市常盤町６丁目７番地　屋上
北見市美山町６９番地の８　電柱
北見市卸町１丁目７－１　屋上
北見市北光２６８番地　屋上
北見市東陵町７０番地　屋上
北見市相内町１３８－１３　鉄塔
北見市上ところ３０－８　鉄塔

常呂町
常呂町字常呂６１７番地　鉄塔
常呂町南町　屋上
常呂町岐阜　鉄塔
常呂町富丘　鉄塔
常呂町豊川　電柱
常呂町栄浦　屋上

小清水町
小清水町８区　電柱
小清水町字浜小清水３０４　屋上
小清水町旭３４１　屋上

網走市
網走市新町１　屋上
網走市駒場南７－５－１　電柱
網走市潮見２１６番地４８　電柱
網走市潮見１０丁目６－３　鉄塔
網走市南２条西３丁目７番地　屋上
端野町
端野町字二区４８８番地１　屋上

斜里町
斜里町光陽町５２番地　鉄塔
斜里町ウトロ東１７２番地　屋上
斜里町ウトロ香川３０６　屋上
斜里町ウトロ香川３７番地

浜中町
浜中町茶内橋北東５３　電柱
浜中町茶内旭３丁目　電柱
留辺蘂町
温根湯
美幌町
福住
生田原町
生田原町生田原中区　鉄塔
生田原町安国５５　鉄塔
遠軽町
遠軽町瀬戸瀬西町８５番地　電柱
白滝村
白滝村南区　鉄塔
白滝村字白滝６８４番地　屋上

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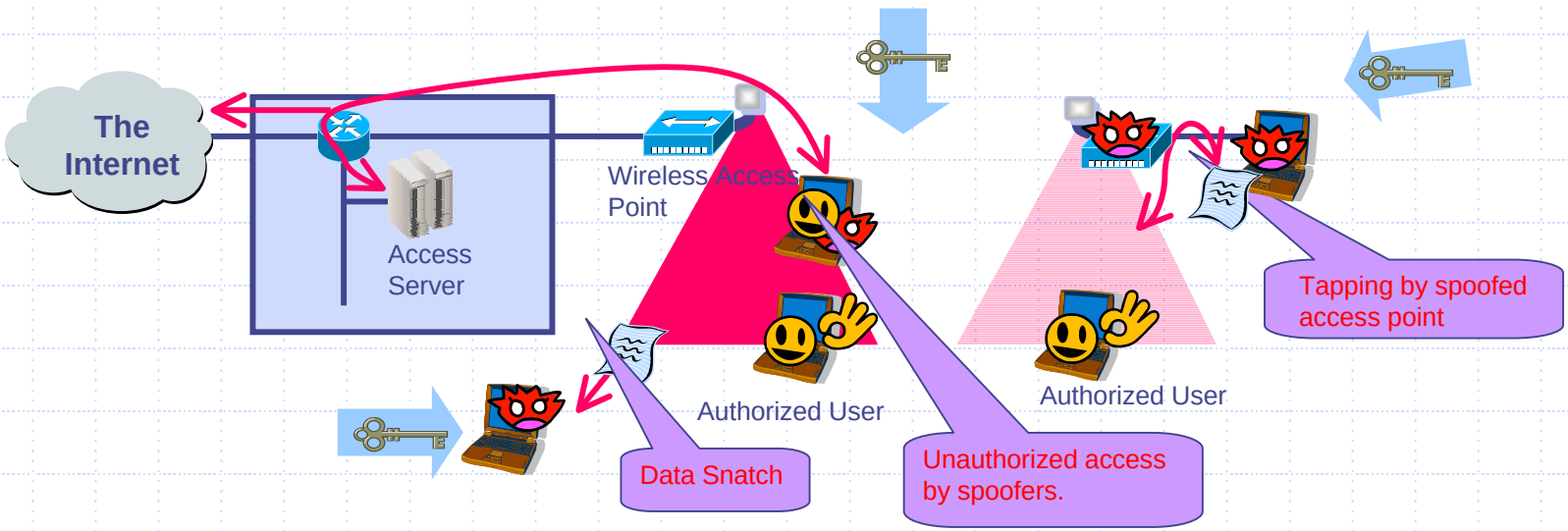
Security Policy

- The property which should be protected is
  - Protect networks and all of the properties which are connected to them.
  - Protect information transmitted through networks from snatches.
- Issues of Security Protection
  - Spoofing
  - Tapping
  - Data snatch by spoofed access points



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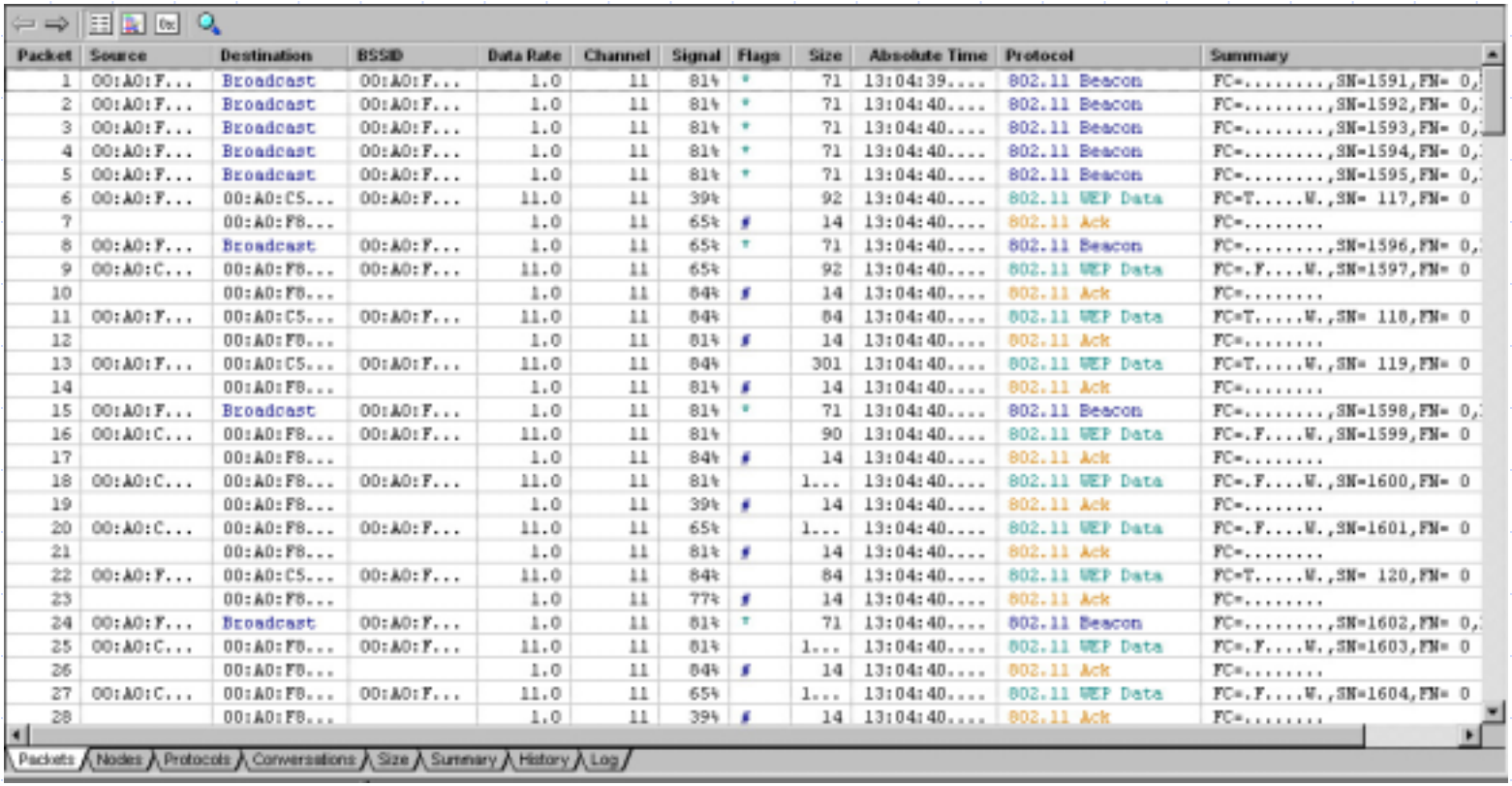
Issue of security in Wireless LAN…

- Personal information such as ID or radio channels can be detected by using free downloads or off-the-shelf analysis tools.



Packet	Source	Destination	BSSID	Data Rate	Channel	Signal	Flags	Size	Absolute Time	Protocol	Summary
1	00:A0:F...	Broadcast	00:A0:F...	1.0	11	81%	*	71	13:04:39....	802.11 Beacon	FC=.....,SN=1591,FN= 0,
2	00:A0:F...	Broadcast	00:A0:F...	1.0	11	81%	*	71	13:04:40....	802.11 Beacon	FC=.....,SN=1592,FN= 0,
3	00:A0:F...	Broadcast	00:A0:F...	1.0	11	81%	*	71	13:04:40....	802.11 Beacon	FC=.....,SN=1593,FN= 0,
4	00:A0:F...	Broadcast	00:A0:F...	1.0	11	81%	*	71	13:04:40....	802.11 Beacon	FC=.....,SN=1594,FN= 0,
5	00:A0:F...	Broadcast	00:A0:F...	1.0	11	81%	*	71	13:04:40....	802.11 Beacon	FC=.....,SN=1595,FN= 0,
6	00:A0:F...	00:A0:C5...	00:A0:F...	11.0	11	39%		92	13:04:40....	802.11 WEP Data	FC=T.....W.,SN= 117,FN= 0
7		00:A0:F8...		1.0	11	65%	#	14	13:04:40....	802.11 Ack	FC=.....
8	00:A0:F...	Broadcast	00:A0:F...	1.0	11	65%	*	71	13:04:40....	802.11 Beacon	FC=.....,SN=1596,FN= 0,
9	00:A0:C...	00:A0:F8...	00:A0:F...	11.0	11	65%		92	13:04:40....	802.11 WEP Data	FC=.F....W.,SN=1597,FN= 0
10		00:A0:F8...		1.0	11	84%	#	14	13:04:40....	802.11 Ack	FC=.....
11	00:A0:F...	00:A0:C5...	00:A0:F...	11.0	11	84%		84	13:04:40....	802.11 WEP Data	FC=T.....W.,SN= 118,FN= 0
12		00:A0:F8...		1.0	11	81%	#	14	13:04:40....	802.11 Ack	FC=.....
13	00:A0:F...	00:A0:C5...	00:A0:F...	11.0	11	84%		301	13:04:40....	802.11 WEP Data	FC=T.....W.,SN= 119,FN= 0
14		00:A0:F8...		1.0	11	81%	#	14	13:04:40....	802.11 Ack	FC=.....
15	00:A0:F...	Broadcast	00:A0:F...	1.0	11	81%	*	71	13:04:40....	802.11 Beacon	FC=.....,SN=1598,FN= 0,
16	00:A0:C...	00:A0:F8...	00:A0:F...	11.0	11	81%		90	13:04:40....	802.11 WEP Data	FC=.F....W.,SN=1599,FN= 0
17		00:A0:F8...		1.0	11	84%	#	14	13:04:40....	802.11 Ack	FC=.....
18	00:A0:C...	00:A0:F8...	00:A0:F...	11.0	11	81%		1...	13:04:40....	802.11 WEP Data	FC=.F....W.,SN=1600,FN= 0
19		00:A0:F8...		1.0	11	39%	#	14	13:04:40....	802.11 Ack	FC=.....
20	00:A0:C...	00:A0:F8...	00:A0:F...	11.0	11	65%		1...	13:04:40....	802.11 WEP Data	FC=.F....W.,SN=1601,FN= 0
21		00:A0:F8...		1.0	11	81%	#	14	13:04:40....	802.11 Ack	FC=.....
22	00:A0:F...	00:A0:C5...	00:A0:F...	11.0	11	84%		84	13:04:40....	802.11 WEP Data	FC=T.....W.,SN= 120,FN= 0
23		00:A0:F8...		1.0	11	77%	#	14	13:04:40....	802.11 Ack	FC=.....
24	00:A0:F...	Broadcast	00:A0:F...	1.0	11	81%	*	71	13:04:40....	802.11 Beacon	FC=.....,SN=1602,FN= 0,
25	00:A0:C...	00:A0:F8...	00:A0:F...	11.0	11	81%		1...	13:04:40....	802.11 WEP Data	FC=.F....W.,SN=1603,FN= 0
26		00:A0:F8...		1.0	11	84%	#	14	13:04:40....	802.11 Ack	FC=.....
27	00:A0:C...	00:A0:F8...	00:A0:F...	11.0	11	65%		1...	13:04:40....	802.11 WEP Data	FC=.F....W.,SN=1604,FN= 0
28		00:A0:F8...		1.0	11	39%	#	14	13:04:40....	802.11 Ack	FC=.....

Packets | Nodes | Protocols | Conversations | Size | Summary | History | Log

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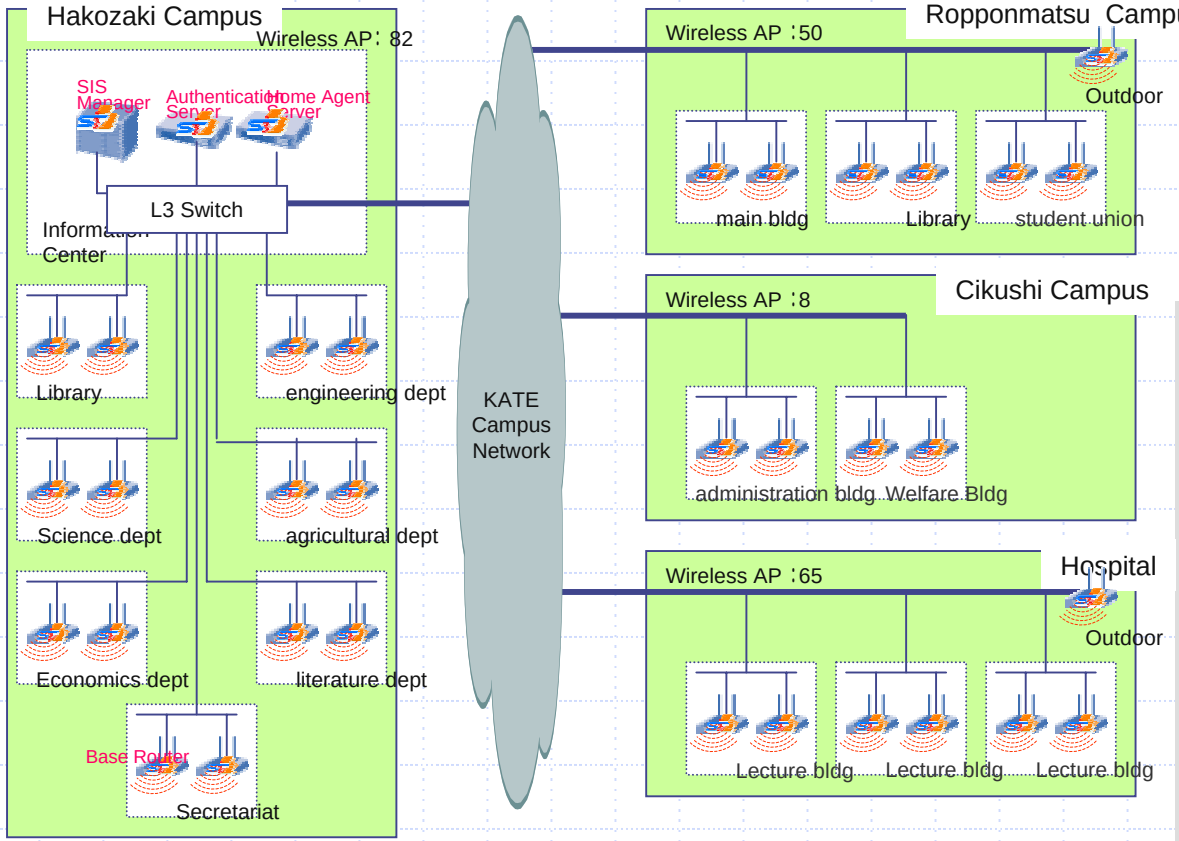
Case Study
High secure network with Wireless LAN Kyusyu university Network Image

Real Object Oriented Technologies
ROOT INC.



Secure IP Solution Installation Image

Secure IP Solution Server

Wireless base station for outdoor
(Access Controller－W)

Wireless base station for indoor
(Access Controller－W)

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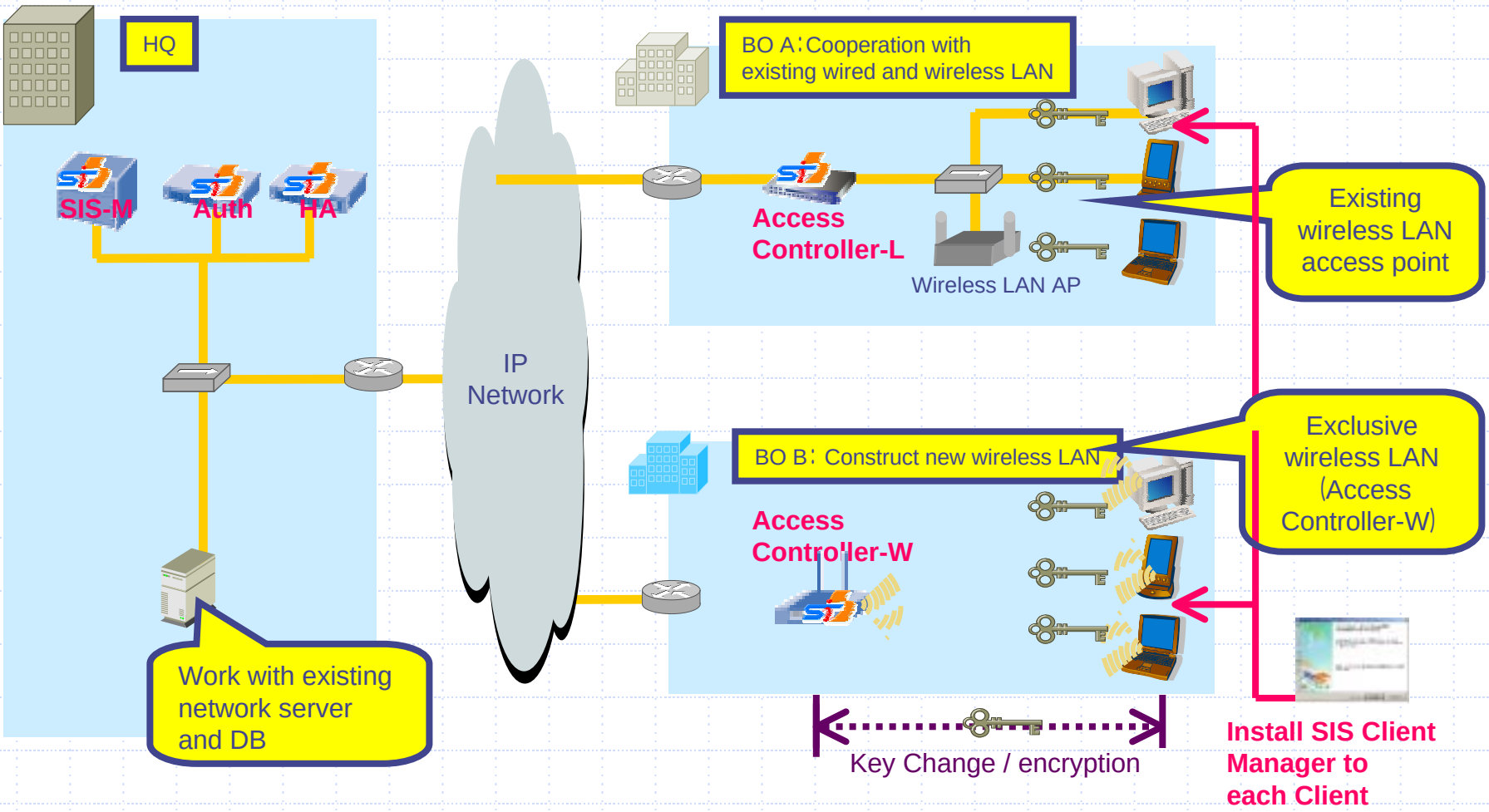
Network Image



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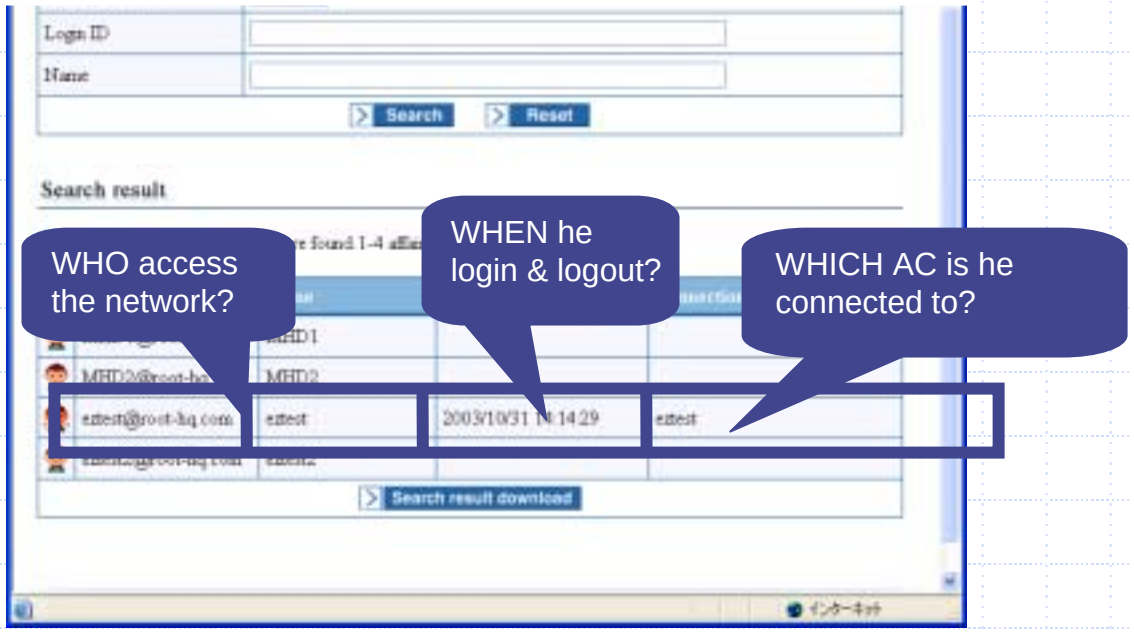
Network Access Management

- Administrator can see “WHO” access the network “WHEN” from “WHERE”.



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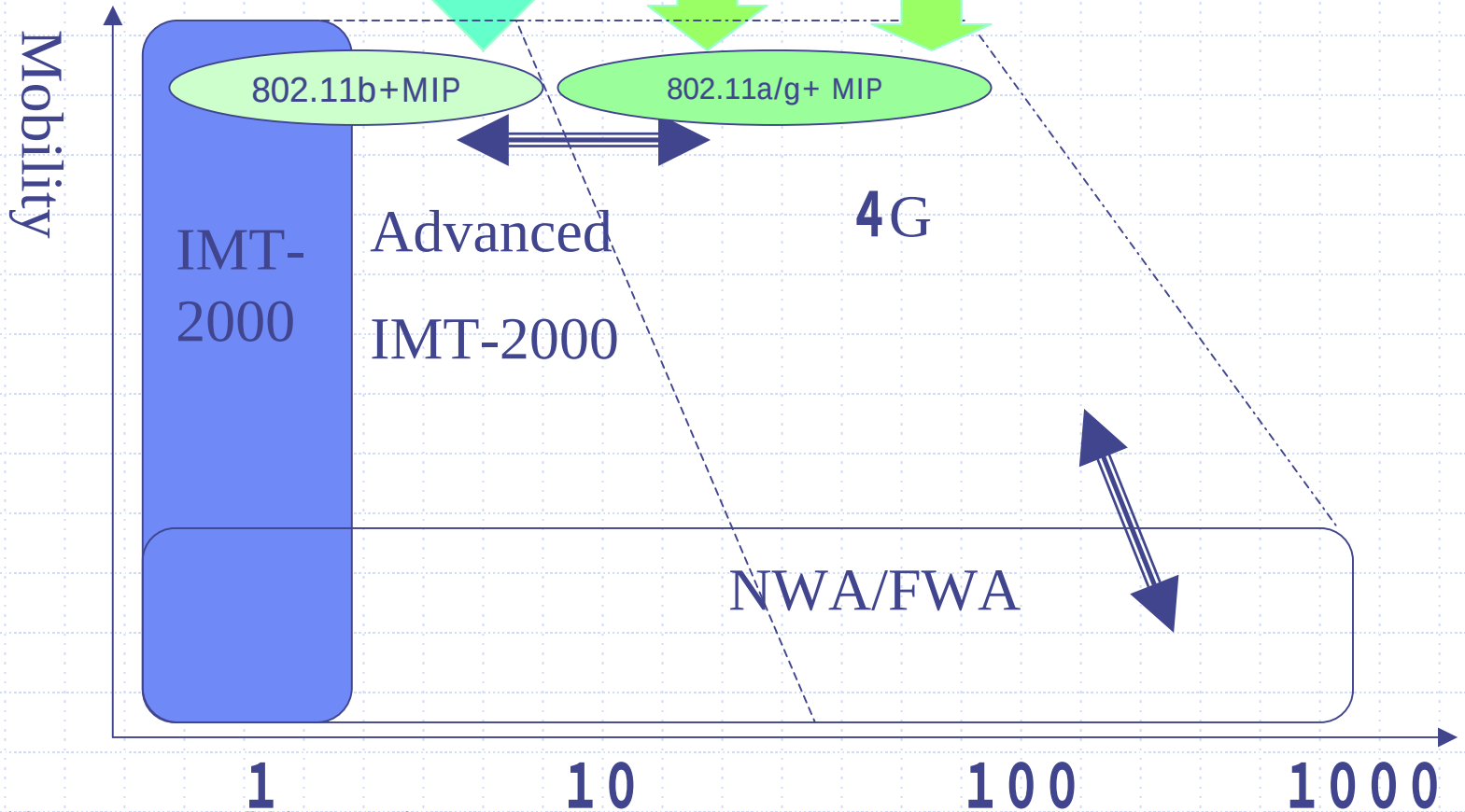
Today's Wireless Technology mapping

- 802.11b + MIP → 11Mbps Mobile
- 802.11g/a + MIP → 54Mbps Mobile
- 802.11g/a + MIP + MIMO/Turbo → 108Mbps Mobile



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Outline of Wireless LAN and Mobile IP system

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- System
  - Using wireless LAN Technology for access between vehicle and infrastructure side.
- Mobility
  - Mobile IP provide mobility.
  - Network mobility is supported.
  - High speed hand over is available.
- Authentication and Security
  - Authentication and security is supported by MBA protocol.
- Target Market
  - ITS (Road-to-Vehicle Communications)
  - From Moving Vehicle
  - Plants, Container Yards, Bus Terminals and etc.
  - Telematics

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Road to Vehicle Communication System

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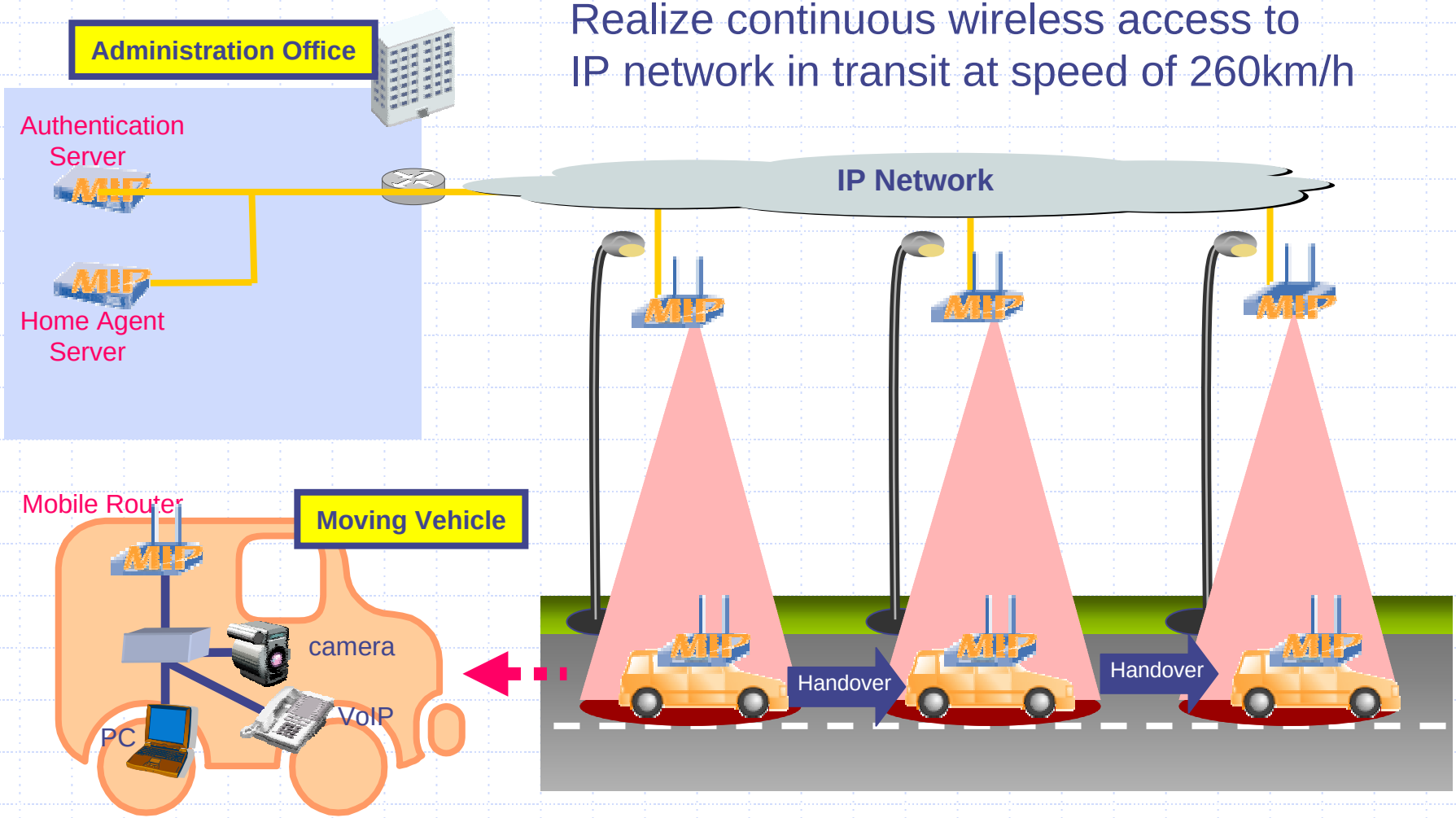
Realize continuous wireless access to
IP network in transit at speed of 260km/h



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Mobile IP system with Hand-over technology with WLAN

Real Object Oriented Technologies
ROOT INC.

- Mobile node carrier sense radio wave(beacon) from base station.
- Mobile node require network access to base station.
- Base station confirm authentication server whether mobile node is registered or not.
- If mobile node is permitted to access, base station provi des CoA(Care of Address) to mobile node
- At the same time, of 4, mobile nodes apply its own CoA(Care of Address) to home agent server.
- Home agent server start managing location of mobile node. And, if mobil e node transit to another network segment, home agent server forward data packet to new location.

- *Do 1-6 over again whenever mobile node transit

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Mobile IP Solution
System Configuration and Products Lineup

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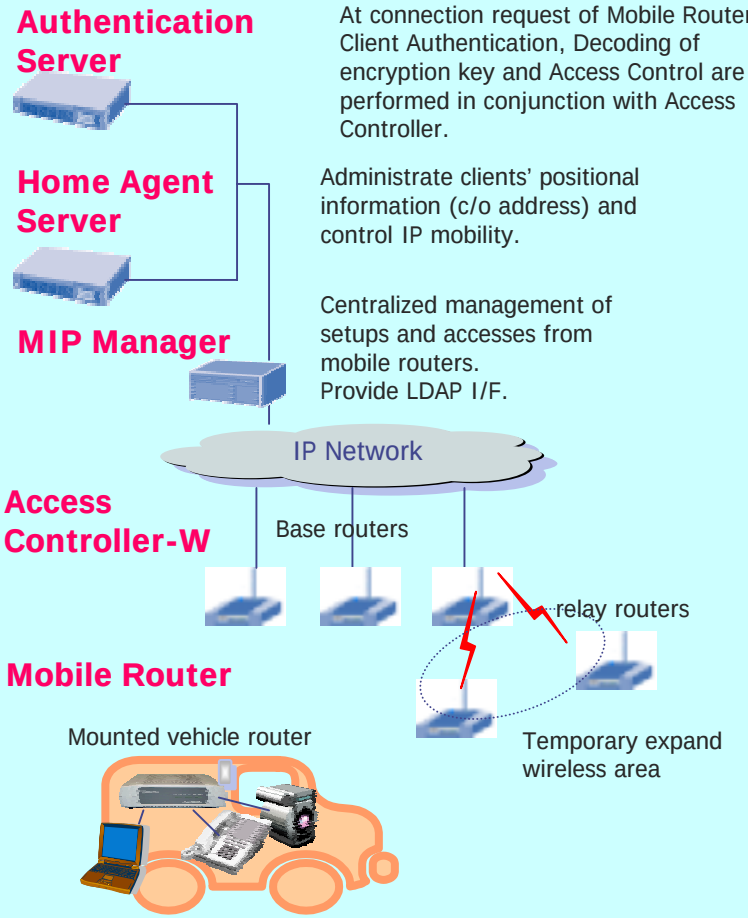
System Configuration



Products Lineup

Specialized for high-speed mobile communication use

2.4GHz IEEE802.11b
Base Router
RBR2400/APF, RBR2400/APU

- High-end CPU (Celeron 400MHz)

2.4GHz IEEE802.11b
Relay Router
RRR2400

- Constructs ad-hoc network at the area where radio doesn't reach.
- Use for relaying communication between wireless base station and Mobile router.

2.4GHz IEEE802.11b
Mobile Router
RMR2400

- Specialized in-vehicle unit (with anti-vibration and heatproof)
- High-end CPU (Celeron 400MHz)

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Archive of Wireless IP Mobile Communication System





- Installed at 17 National road office
- Installed at 2 High-way
- Actually, Installed in over 1,000 stations in the road, under installing in over 500 stations

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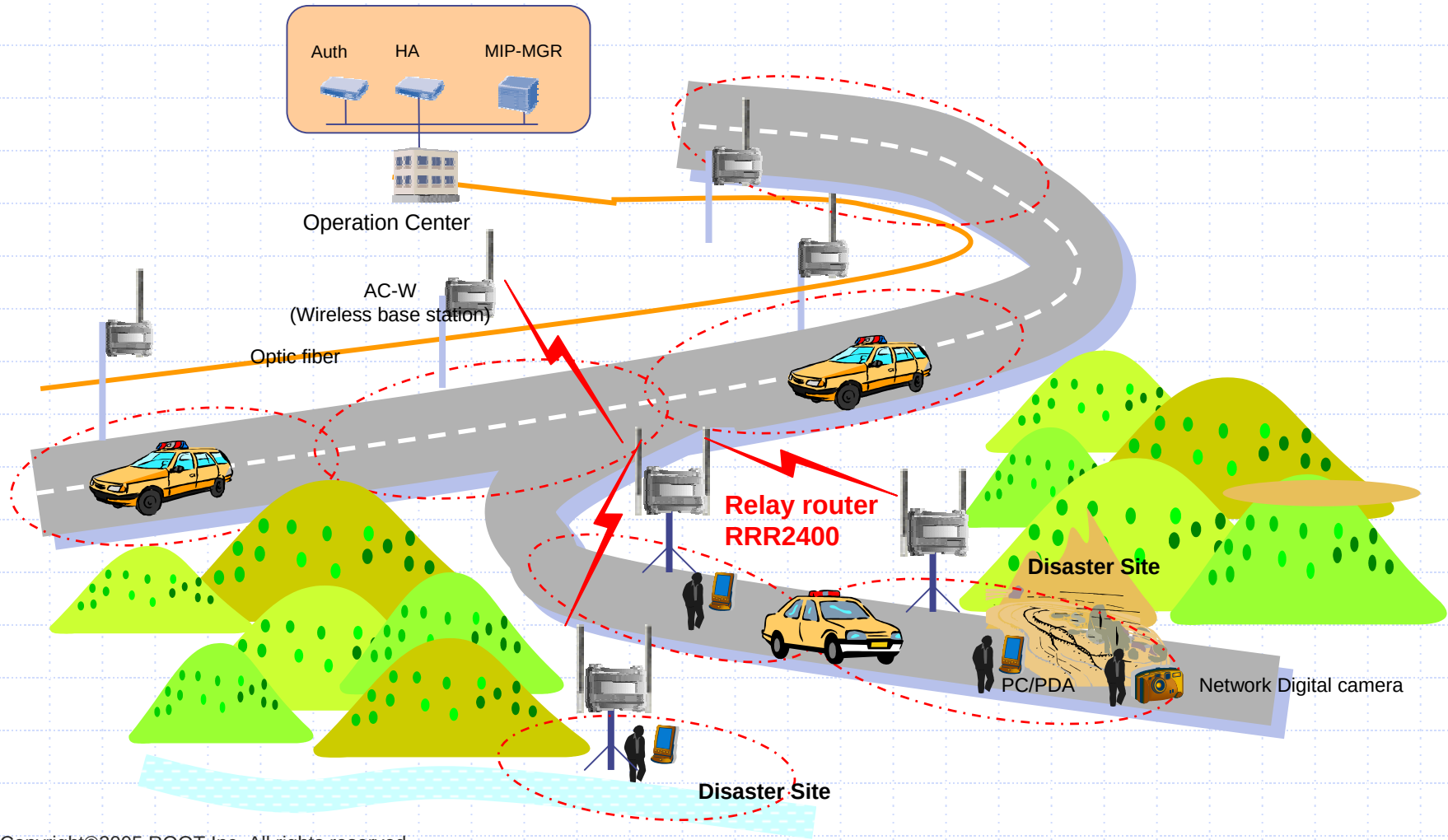
Relay Router RRR2400

- Constructs ad-hoc network at the area where radio doesn't reach.



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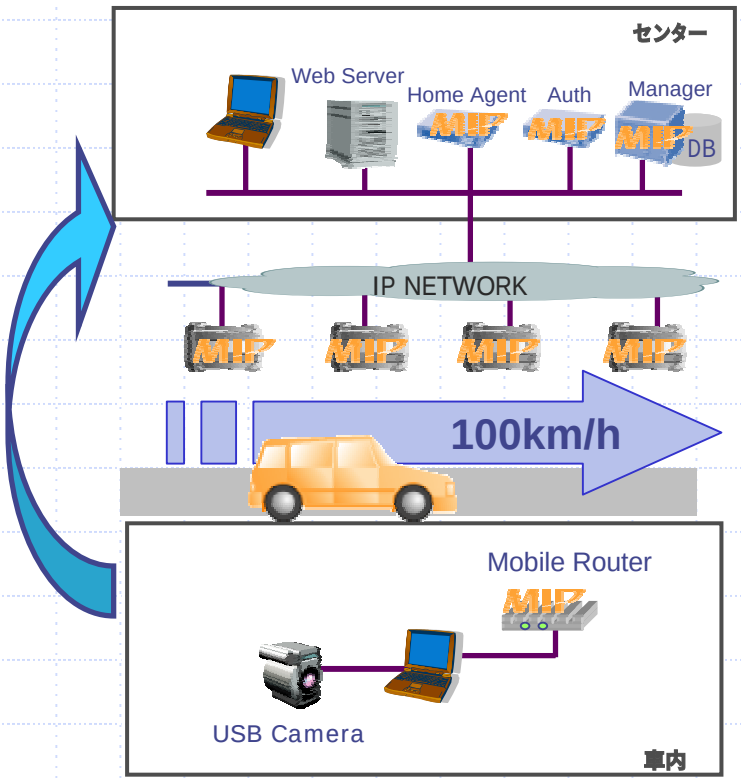
Reference of **Road &Vehicle Communication System (路車間通信事例)**
Streaming video from the moving vehicle

Real Object Oriented Technologies
ROOT INC.

- The screen image was recorded at the control center.
- Transmit video continuously from the MPEG2 encoder mounted moving vehicle to the control center.



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Reference

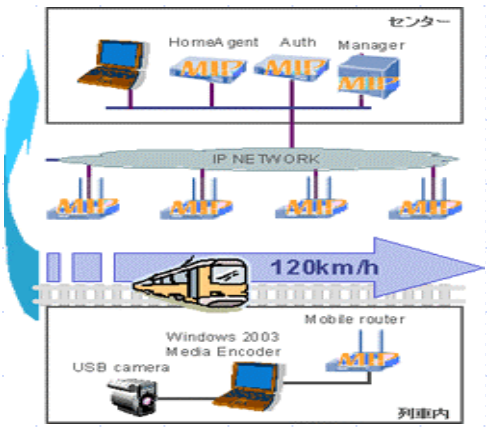
Real Object Oriented Technologies
ROOT INC.

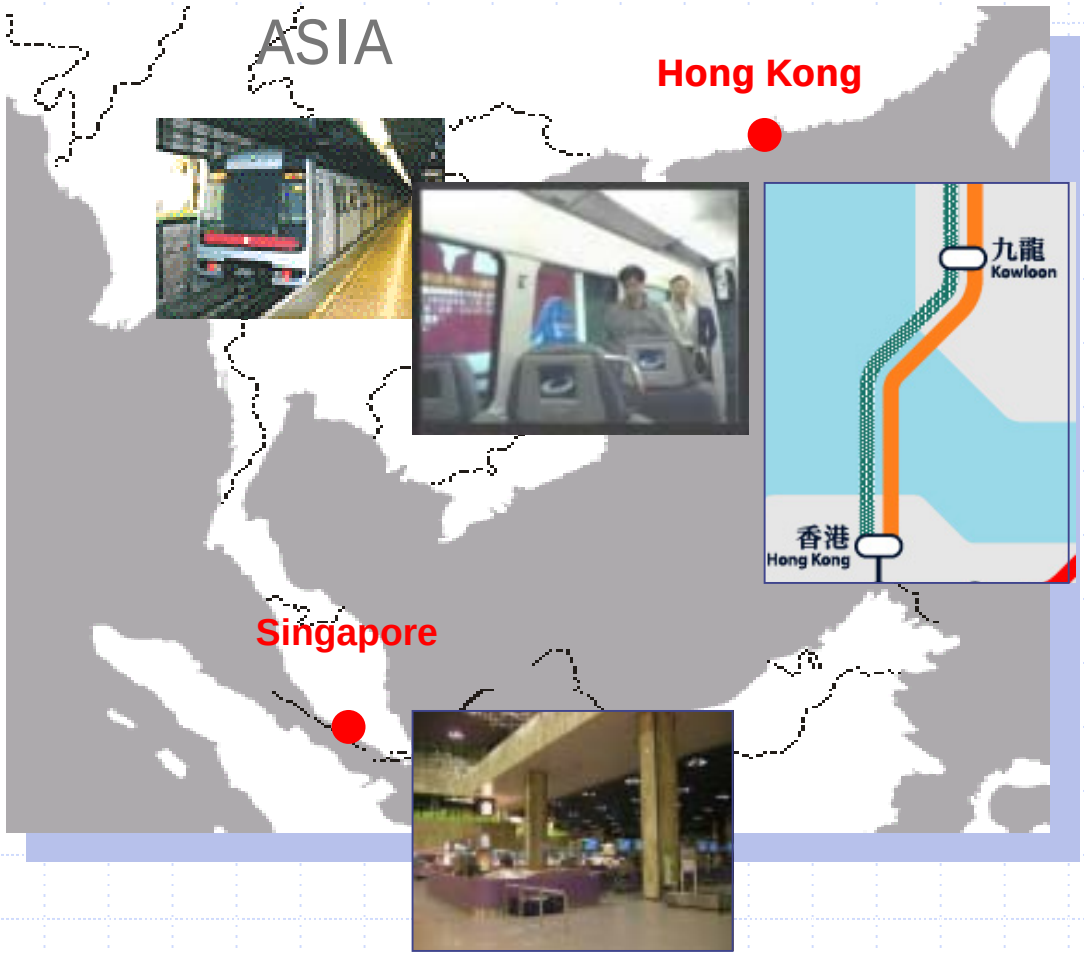
⟪Overseas⟫

《 High-speed mobile communication / Wireless access 》

・Hong Kong Subway
Pilot of Broadband Network over Train

http://www.root-hq.com/case/mis_hongkong.html





・Others;

Singapore Changi Airport Skytrain,
Malaysia, Vietnam, China, Egypt,
Afghanistan, Germany, Italy etc...

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Trial Experience at Hong Kong Subway

Kowloon Station NOC

Test client PC

Web Server

Home Agent

Auth

Manager

DB

Hong Kong Station

Total 2.5km distance

Kowloon Station

Optic fiber

100BASET-FX

(2)Net Meeting

2.4GHz
Wireless AP1

2.4GHz
Wireless AP2

2.4GHz
WirelessAP10

(1)Media streaming

(3)Web Access

120km/h Max speed

Mobile router

Windows2003
Media Encored /Server

IEEE802.11a,g,b
Wireless AP

USB camera

Windows PC

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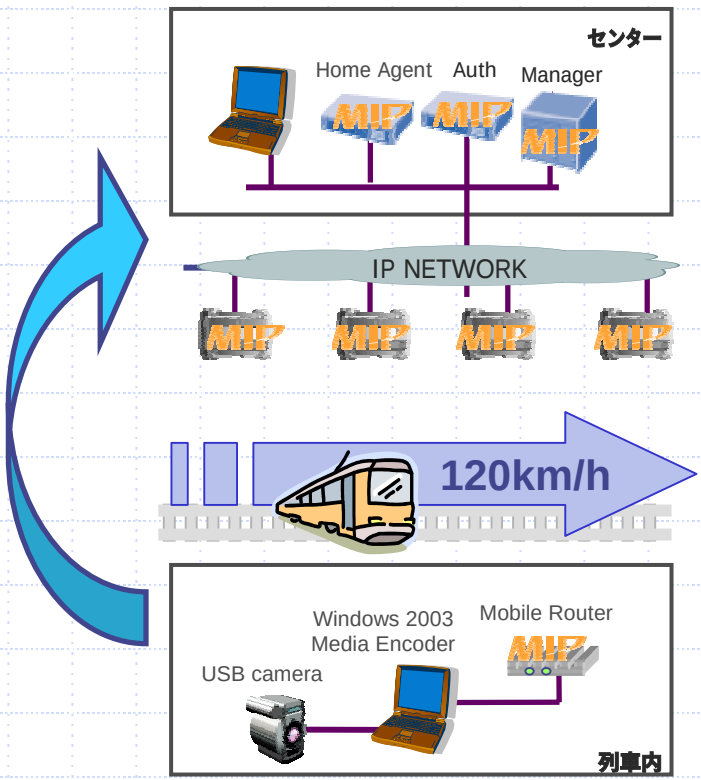
Pilot - Result #1 (Streaming Video)

- Monitoring train compartment by streaming video
  - 30 frames / sec



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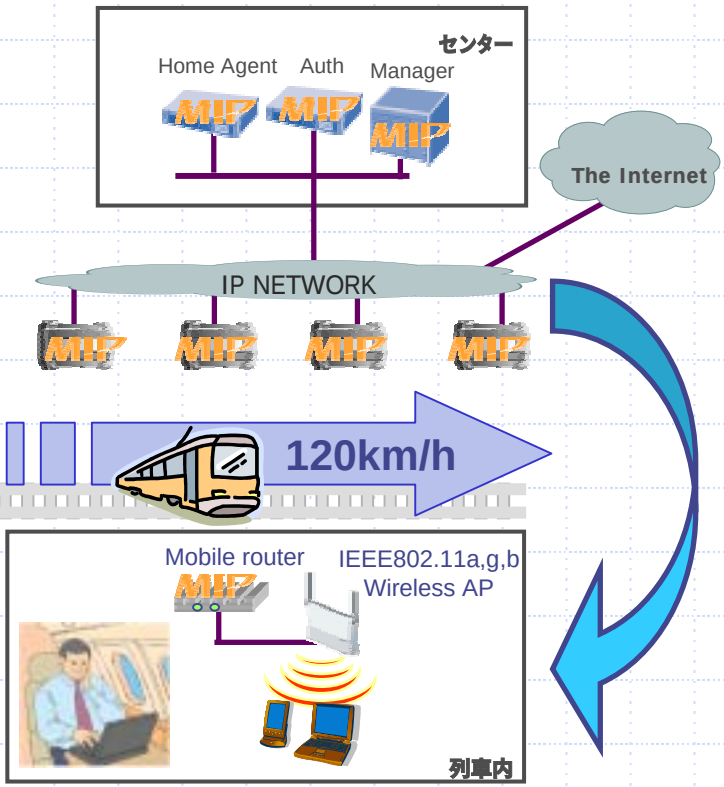
Pilot - Result #2 (Web Access)

- Providing web browsing for passenger using notebook computer and PDA(iPAQ) through IEEE802.11b/g/a AP



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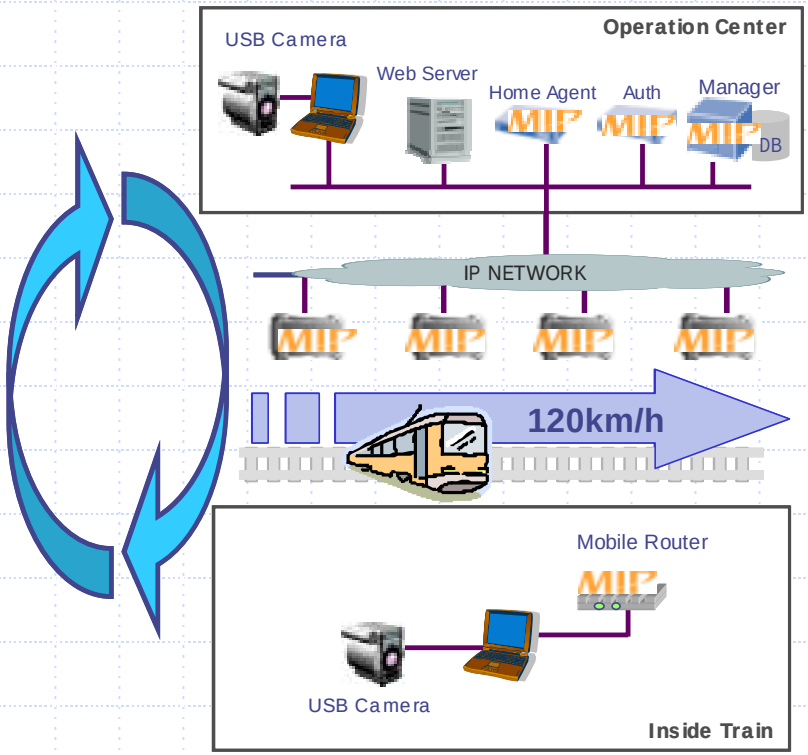
Pilot – Result #3 (Net meeting)

- Net meeting between train passenger and NOC staff at station side.



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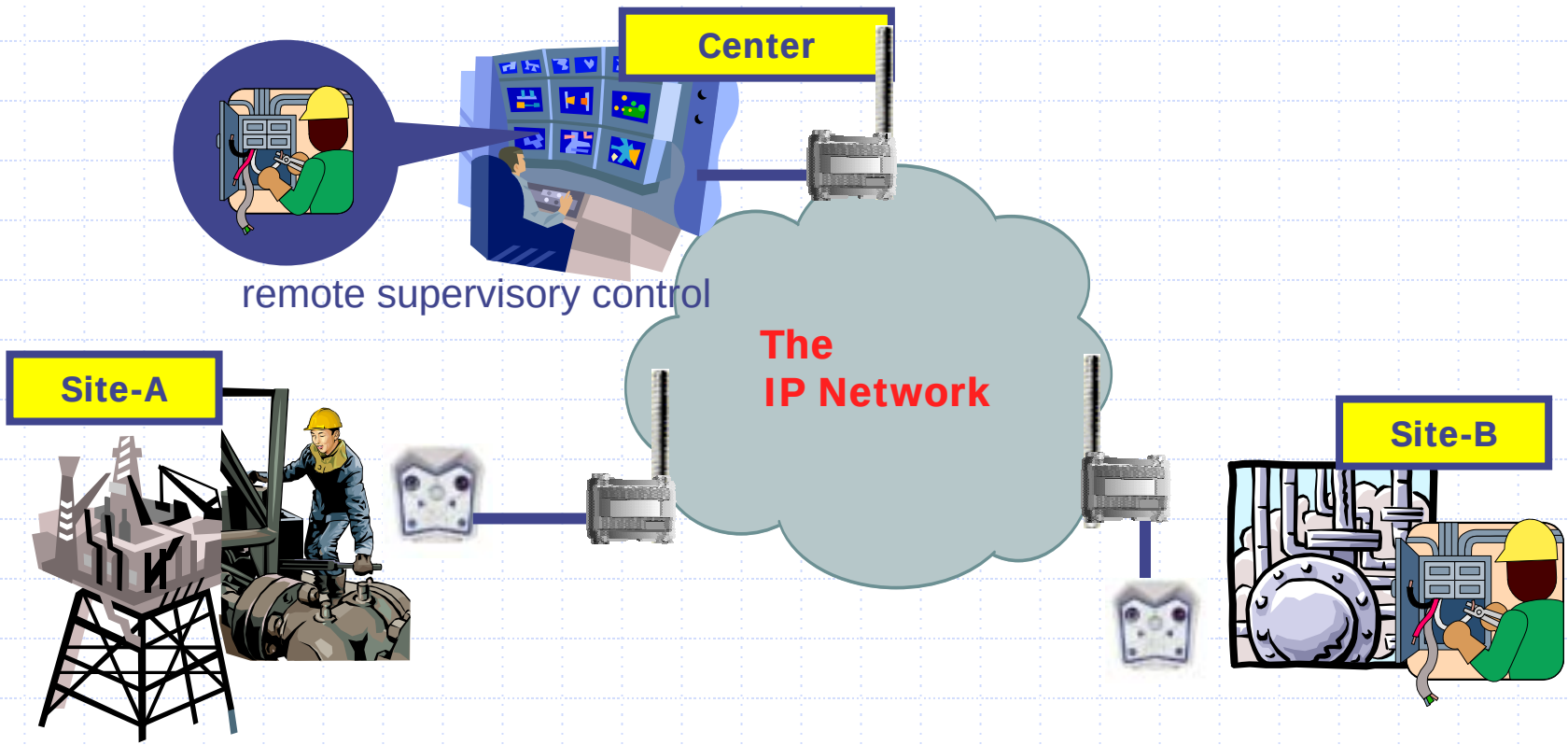
Remote Monitoring of Factories/Plants

Real Object Oriented Technologies
ROOT INC.

- Security Surveillance at factories or construction sites
- Anticrime Measures (Block intrusion by suspicious individuals).



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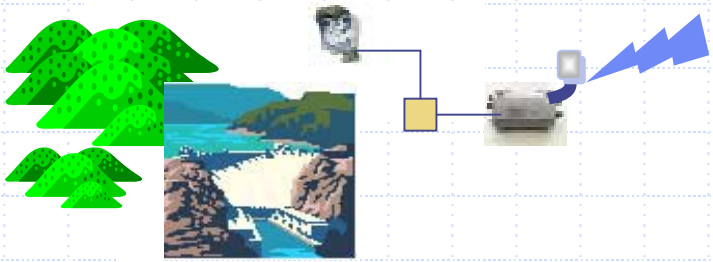
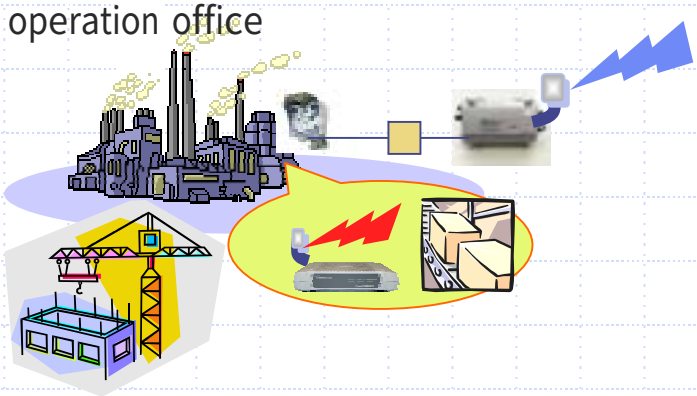
Remote surveillance with wireless LAN and the Internet

Real Object Oriented Technologies
ROOT INC.

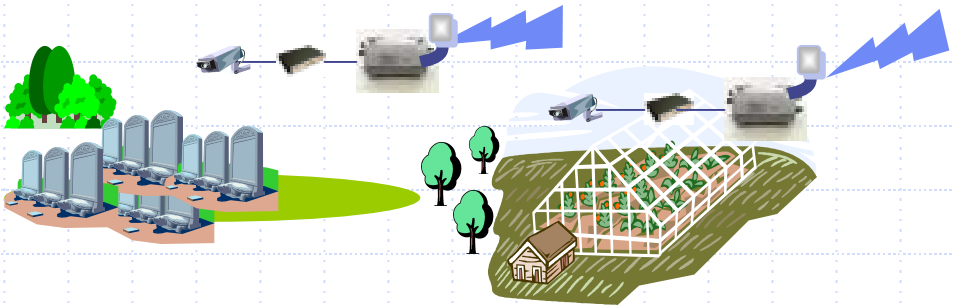
● Remote monitoring for dam, river or



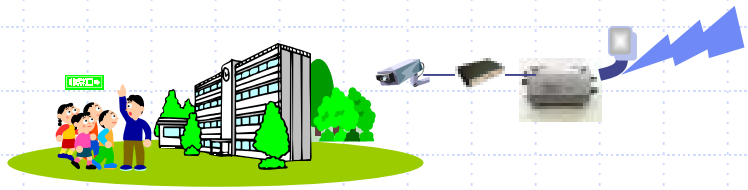
● Streaming transfer from plant or field site to operation office



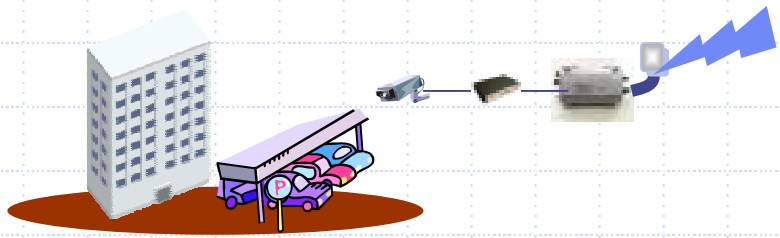
● Remote monitoring for field or



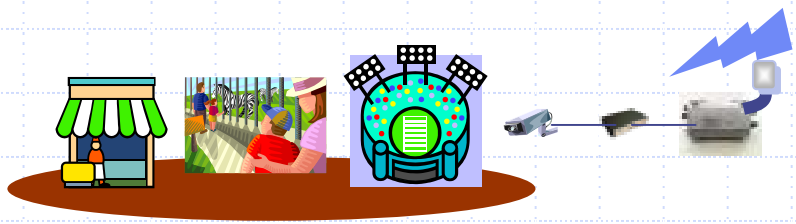
●Remote monitoring for education facilities



●Remote monitoring for office building or parking



●Remote monitoring for stores or shopping moles



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Case study of remote station with Wind and Solar Power Operation

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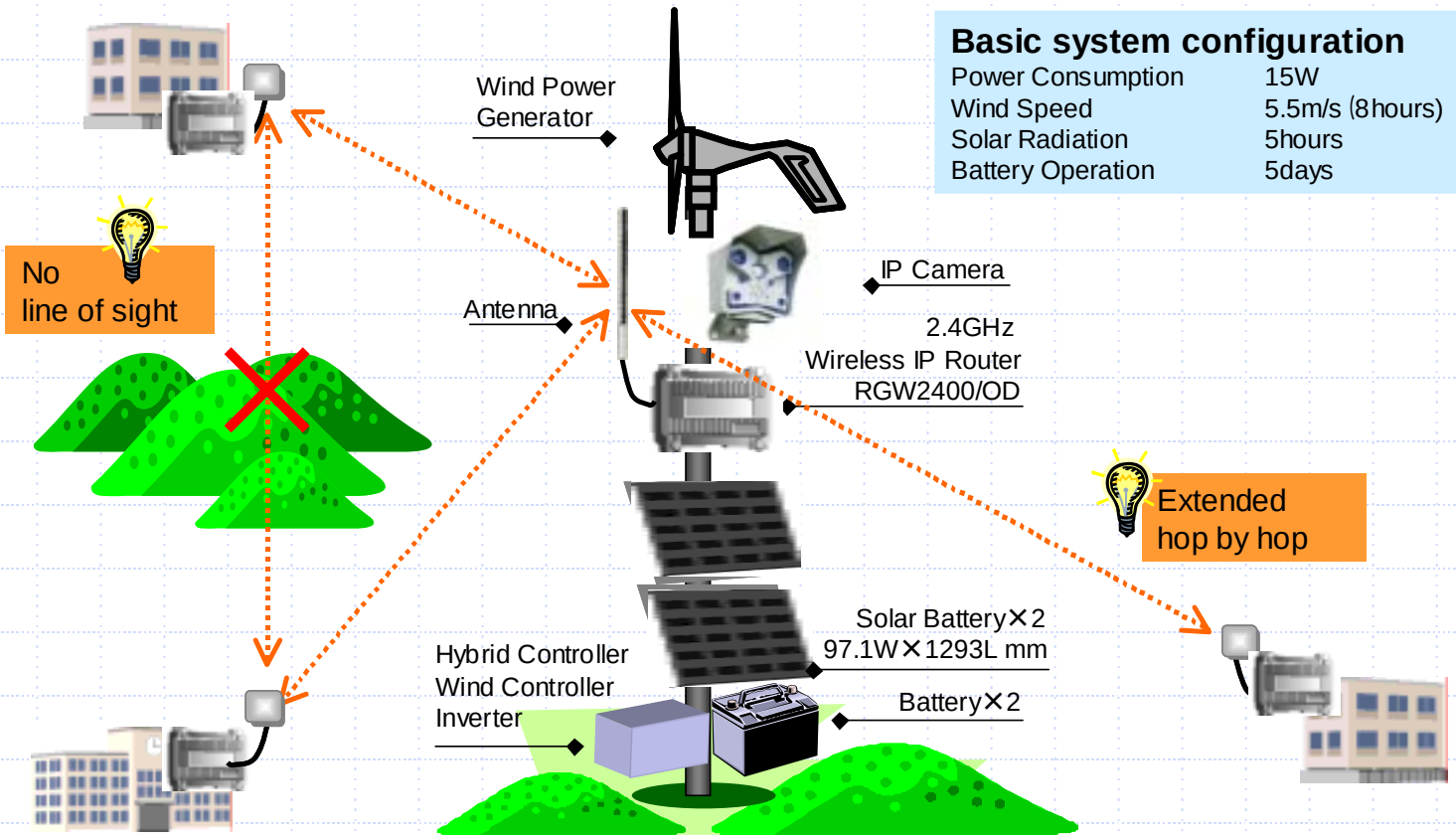
- Wind Power and Solar Panel Operation available for Wireless IP Network.
- Combination with solar battery and Wind power.
- Effective in the area without power supply.



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IEEE802.11x

- 802.11a: 5 GHz, 54 Mbps
- 802.11b: 2.4 GHz, 11 Mbps
- 802.11e: Quality of Service (QoS)
- 802.11g: 2.4 GHz, 54 Mbps
- 802.11i: Security
- 802.11j: Japan 5 GHz Channels (4.9-5.1 GHz)
- 802.11n: High-Speed

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Another Wireless LAN

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- UWB
  - 802.15 WPAN(Wireless Personal Area Network)
  - 110-480Mbps〜Gbps??
- Wi-MAX
  - 802.16 WMAN
    - 75Mbps long distance,
  - 802.16e Mobile WMAN
    - 30Mbps mobility
- IEEE802.20
  - High speed IP mobile
  - Down link 3Mbps、Up Link 900Kbps
- IEEE802.21
  - Media hand over between 3GPP-Wireless LAN
- IEEE802.22
  - Cognitive radio
  - Sharing frequency with digital broadcasting

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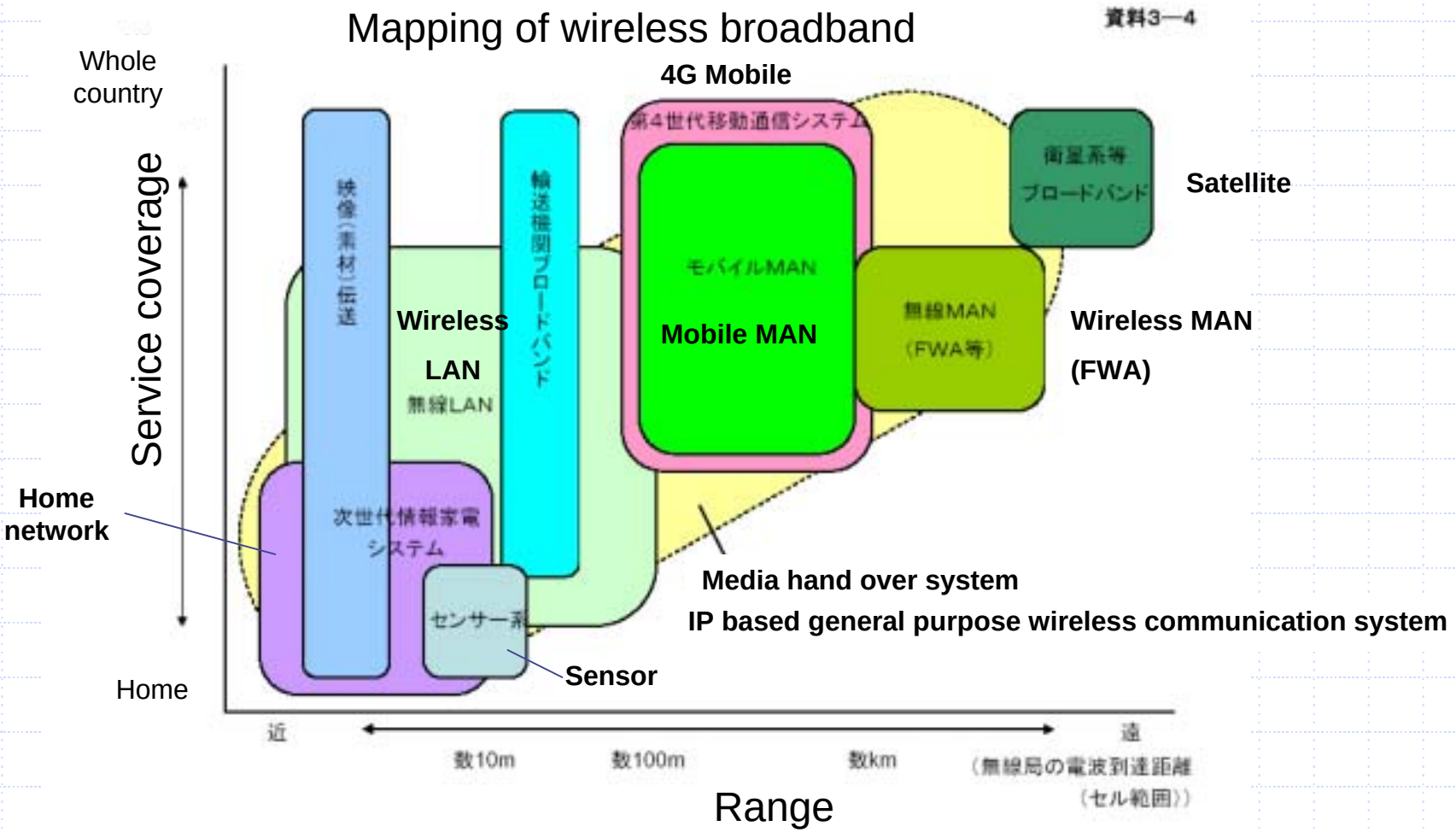
Future of Wireless broad band

- Ministry of Internal Affairs and Communications (MIC)
- Set up Study Group for Wireless Broadband Promotion



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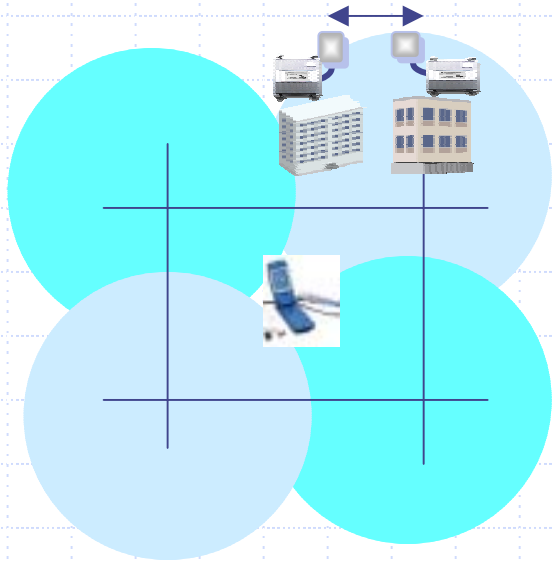
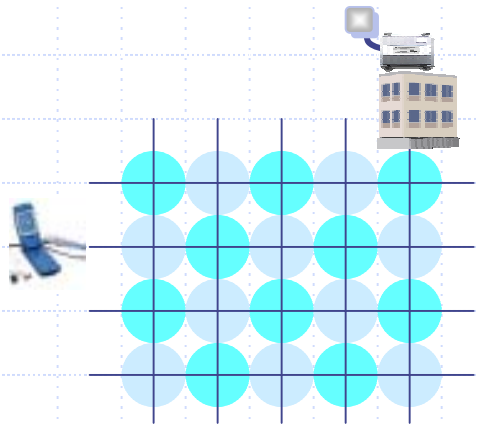
A change in the role of the radio communication

- Before the Internet
  - Low density of network
    - Long distance for fixed wireless access
    - Large cell for mobile
      - Base stations are connected by expense network
  - Limited application
    - Narrow band applications.
    - Application specific communication



- After the internet
  - High density of network
    - Fixed access are covered by FTTH,xDSL,CATV
    - Small cell for mobile
      - Connect mobile terminal to neighbor network
      - Base stations are connected by inexpensive network
  - Un limited application
    - Wide band application
    - General purpose communication



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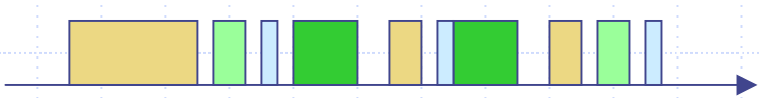
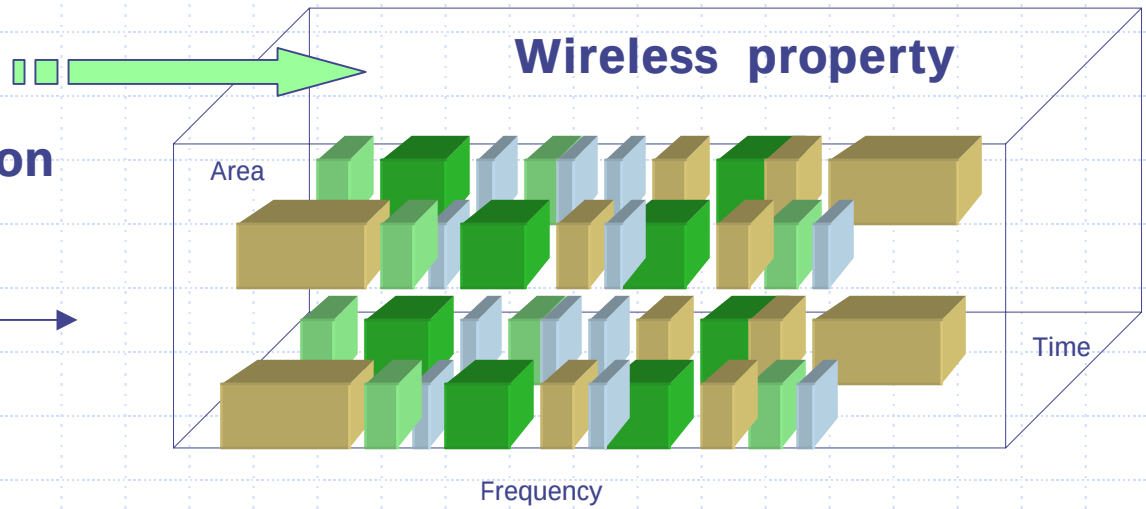
A change of wireless property

- Before
  - Development speed > Consumption speed
  - Narrow band application (Voice)
  - Enough clear band on frequency based allocation
- Now
  - Development speed < Consumption speed
  - Wide band application
  - Frequency, Space, Time based allocation

Frequency resource

Frequency based allocation





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Change of the technology

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- Before the Internet
  - Analog communication
  - Digital communication
  - Continuous communication
    - Error = Information Lost
    - 99.999999.....% BER is required
    - Liner feed back
  - Circuit switch
    - Connection best effort
      - Limited capacity for connection
    - Guaranteed band width
      - After connection established

Good for telephone

- After the Internet
  - Digital packet communication
  - Store & Forward
    - Error ≠ Information Lost
    - Retry can recover the information lost.
    - Delay and quality are trade-off.
    - Packet base feed back
  - Packet exchange
    - Guaranteed connection
    - Best effort for band width

Good for general purpose

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New wireless topics in last 10years

- Spread spectrum
  - Low spreading, no process gain
- Bluetooth
  - Low speed
- V-OFDM
  - No advantage to ADSL
- Wi-MAX
  - No line of site required
  - High speed,
  - Long distance
- UWB
  - Data rate > process gain
  - Dedicated frequency is required **?**
- SFDR
  - General coverage
    -> Limited coverage

- Technical advantage / condition
  - Robustness for noise
    - If enough process gain is high…
  - Very low cost
    - Huge mass-produces…
  - Non line of site
    - If the link margin is enough…
  - High speed
    - If the band width is enough…
  - Long distance
    - If the power is enough
  - No need clear band
  - If enough band width is allocated…
  - 1chip solution cover everything
    - If huge dynamic range is given…

Nobody can exceed the principle

$$C = W \cdot \log_2(1 + S/N)$$

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SIMPLE

- Smart Internet Mobile Project with Layered Effect -

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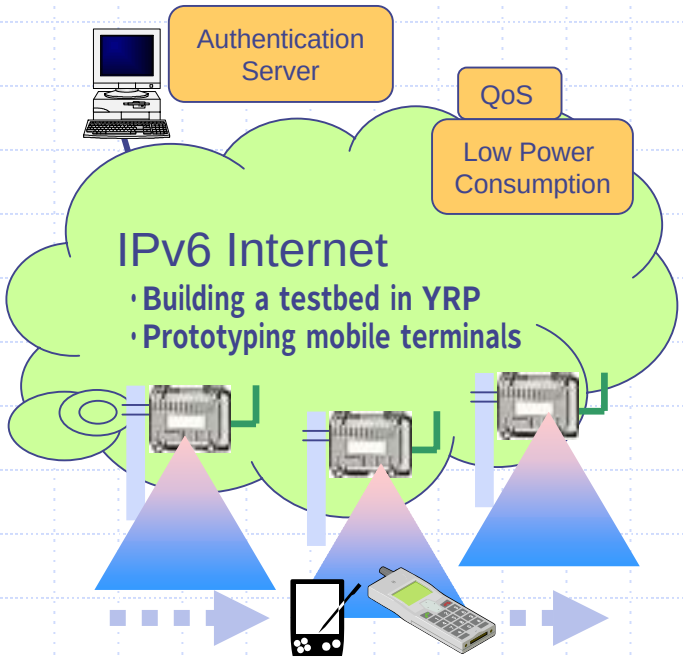

We are designing novel layered architecture, developing flexible mobile communication system, building a testbed, and standardizing our proposal.

Joint work with Internet Arch. Group of NICT, Keio Univ., Univ. of Tokyo, Tokyo Inst. of Tech., Kyoto Univ., ASTEM, ISIT,and Root Inc.

Operation

Objective: cost reduction of maintenance of networks

・IP-based redundant architecture → ・Pure Isnternet

Transport Layer

Objective: efficient end-to-end communication

・Fast recoverable TCP from packet losses caused by handover and unstable wireless links

Network Layer

Objective: seamless mobility at network layer

・Mobility and multi-homing support by separation of identifier and locator
・Fast handover with event notifications from link layer

Link Layer

Objective: simple and flexible link layer

・Handover without collaboration with upper layers → ・Collaboration with upper layers
・Upper layers-led handover

Physical Layer

Objective: effective utilization of spectrum

・Fixed frequency allocation → ・Flexible frequency relocation and reallocation

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