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

Submission Title: [Use Cases and Market Potential of PAC Corresponding to Call for Presentation]
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Re: [.]

Abstract: [Representative use-cases for Peer Aware Communication (PAC) to support local and dynamic traffic service within hundreds of meters nearby a user and expected market potential]

Purpose: [To show use cases and market potential corresponding to CFP of PAC and to clarify the scope of PAR & 5C]
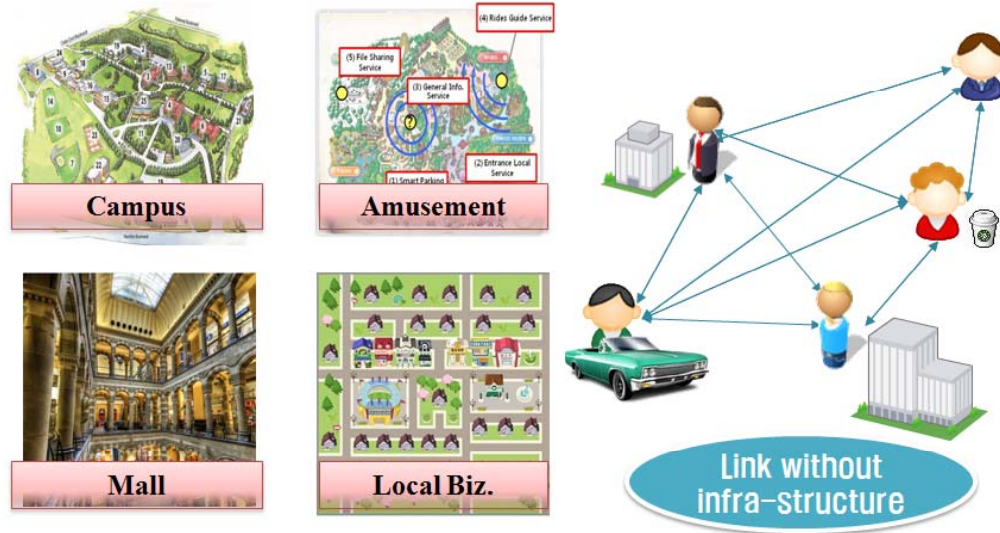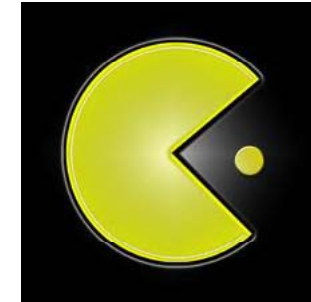
Opening

- Peer Aware Communication (PAC)
  - Discover information around me
  - Without infrastructure
  - Low power consumption
  - High performance

Service Trend at Local Vicinity

- Geo-social networking
  - Who's here

- Location-based Game
  - 'check-in' game: foursquare Gowalla
  - over 25 various games from Wikipedia

- Location-based Service
  - Google latitude

  - AroundMe

Around Me
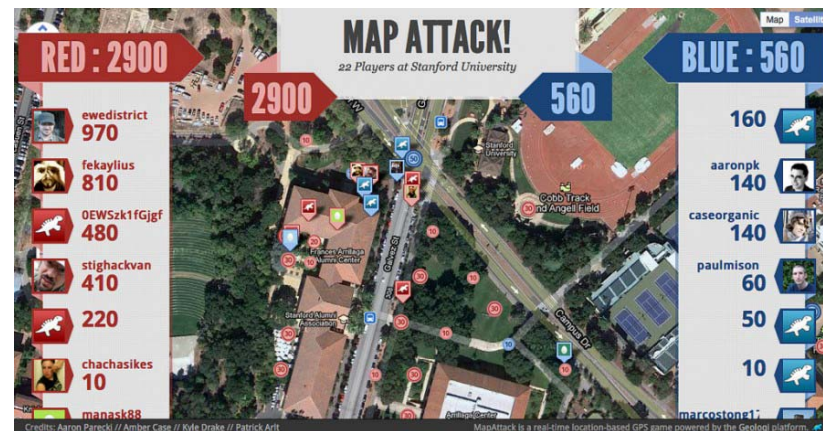
Map Attack

Service Trend at Local Vicinity

- ## Near-me Area Network (NAN)
  - A logical communication network built on top of existing physical network infrastructures that focuses on communication among wireless devices in close proximity

Logically same to application

Wi-Fi AP

Cellular BS

different proprietary network infrastructures

Service Trend at Local Vicinity

- ## Near-me Area Network (NAN)
  - Some services are meaningful only to a group of people in close proximity
    - Ben is going to the ABC supermarket to buy three bottles of red wine. The supermarket offers a 30 percent discount on the purchase of six bottles, so he sends a message to other customers to see if they would like to buy the other three bottles of wine.
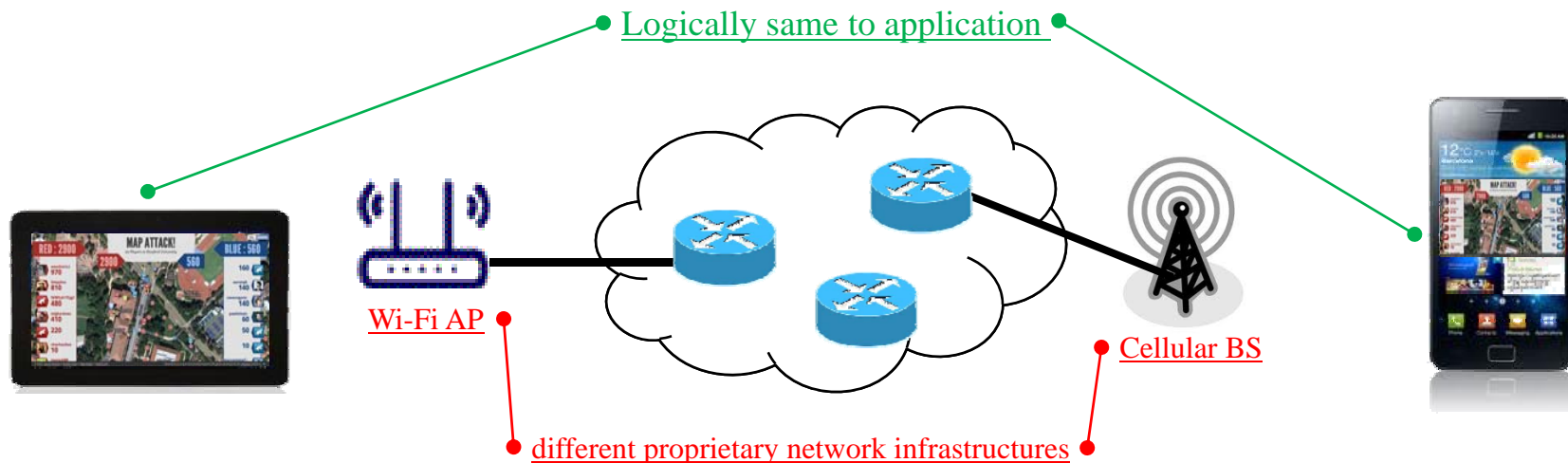   - Susan bought a movie ticket 15 minutes ago, but she now feels dizzy and can't watch the film. She sends out messages to people around the cinema to see if anyone will purchase her ticket at 50 percent off.
    - In a theme park, guests would like to know each ride's queue status to reduce their waiting time. So, they take a photo of the queue they're in and share it with other guests through a NAN application.
    - Ann works in Causeway Bay and would like to find someone to have lunch with. She checks her friend list to see who is closest to her at this moment and invites that friend to join her.
    - Carol just lost her son in the street, so she sends out his picture, which is stored in her mobile device, to passers-by to see if they can find him.

Limitation of Existing Approaches for Near-me Area Network

- ## Virtue
  - NAN provides common discovery platform to Apps

- ## Limitation
  - high control overhead
    - due to periodic report from Apps and updates from server
      - Sending geo-location information or discovery request from nodes
      - Finding matched near-by nodes and informing result/request to them from server
    - 10s of protocol steps for connection setup
  - long latency
    - the communication path between devices is long even though two devices are geographically close in the same segment

Peer-awareness
by direct communication in close proximity

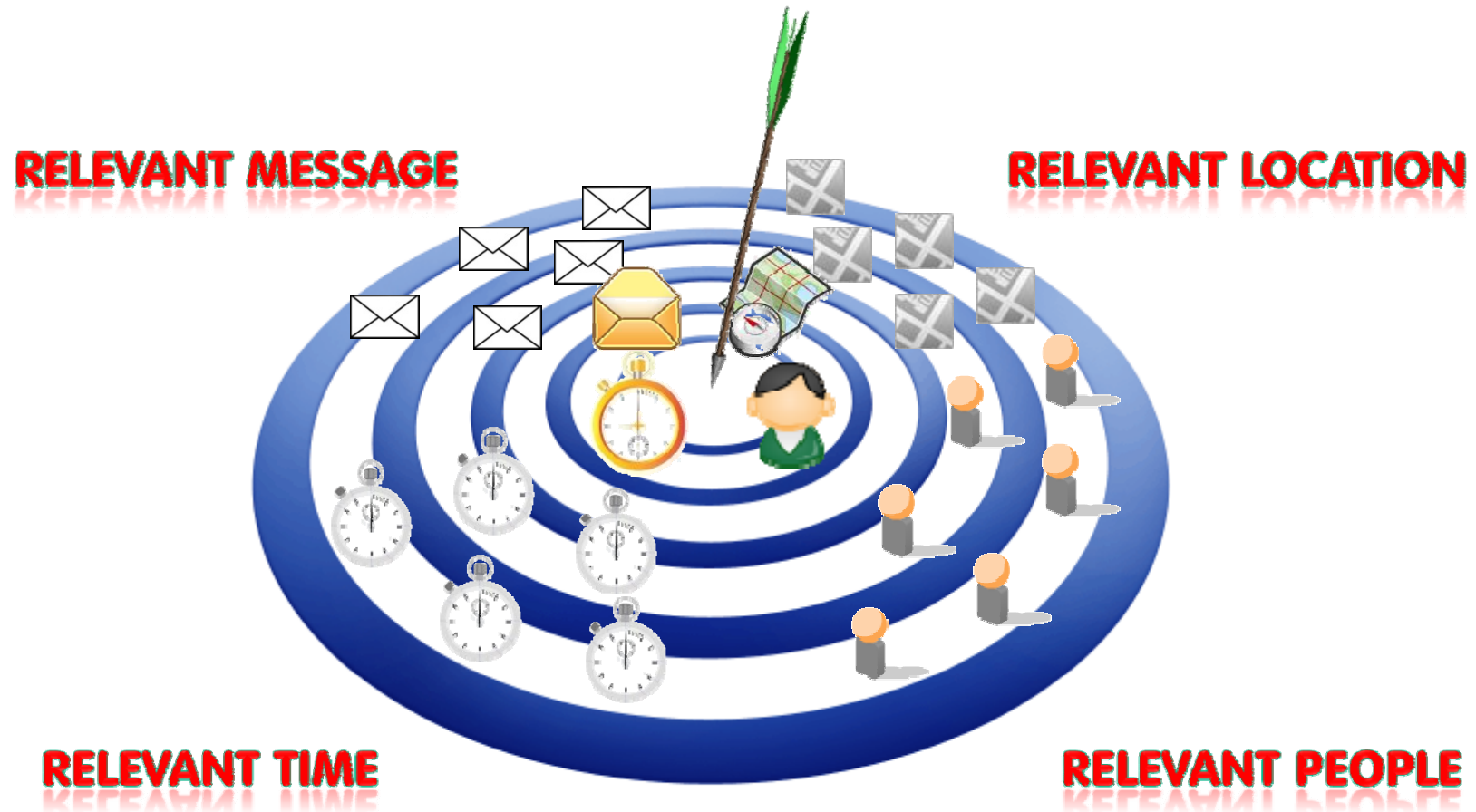# Peer Awareness

Who's Nearby, Not Who You Know

- **Proximity-awareness**
  - local people /event or location information
- **Service-awareness**
  - match interests for shopping, gaming, or etc
  - monitor the nearby service locators
- **Interface-awareness**
  - notify communication interfaces

[Tech Crunch]

Peer Awareness

RELEVANT MESSAGE

RELEVANT LOCATION

RELEVANT TIME

RELEVANT PEOPLE

Peer Awareness
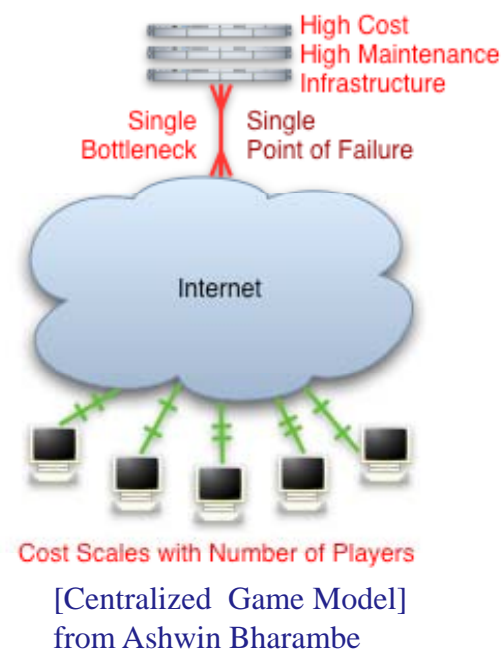
- ## Peer Discovery
  - Broadcasting only prior to connection setup
  - Autonomous awareness

- ## Peer Discovery Information (PDI)
  - Identification
  - Customer information : membership, wish list
  - Service/Resource locator: URL*, SIP call-ID
  - Local advertisements: coupon, deal, flash-mob
  - Alarm, emergency message

*URL (Uniform Resource Locator), **SIP (Session Initiation Protocol)

Infrastructure-less Architecture

- No BS, no AP
  - No cost for deployment or maintenance
  - No network control overhead
  - Low power consumption compared to using BS/AP with GPS
  - Fulfill both massive and riche market
  - Useful for crowded and even isolated places which is not reached by infra as well

- No LBS server
  - Low cost to implement local search
  - Encourage developing applications from contents providers
  - Avoid tracking and storing personal geo-location
  - No single point of hazard from cracking

High Cost
High Maintenance
Infrastructure

Single
Bottleneck

Single
Point of Failure

Internet

Cost Scales with Number of Players

[Centralized Game Model]
from Ashwin Bharambe

Peer-to-Peer Communication

- ## No coordinator node
  - Border-less network
  - Scalable networks to cover 100s of devices
- ## Long range to cover large site
  - Enhance service/market potential
- ## Direct link
  - Low latency
  - Efficient resource usage
  - Low power consumption
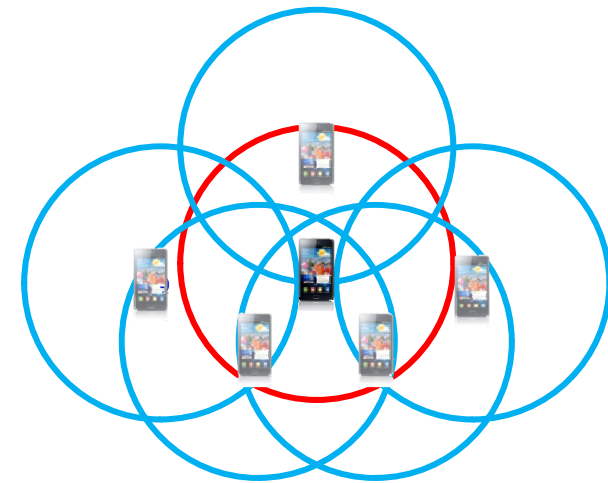
Fully Distributed Coordination

- ■ **Distributed protocol**
  - • to achieve the same objectives as centralized coordination by peer node's joining mutually with distributed manner
  - – Synchronization
    - • enables low duty cycling for discovery
    - • enables efficient signaling and transmission mechanism
  - – Resource management
    - • distributed multiple access
    - • distributed scheduling
    - • distributed interference management
- ■ **Benefit**
  - – Simple & Scalable
  - – Proper to device-centric operation

PAC Characteristics

- **Scalability**
  - 1s to 100s of meters of range
  - High discovering capacity up to couple of 1000s of PDIs

- **Simplicity**
  - Minimal system/protocol overhead
  - Physical layer support for higher layer functionalities

- **Efficiency**
  - Days operation with low power consumption
  - Distributed protocol with high efficiency
  - Spatial reuse by interference management

PAC Biz. Model

Near-me Area Peer Aware Services

Ad service

Ad statistics

Ad Agency

Ad Clients

App Store
Server

AAA Server

Management
Server

SNS

Game

Contents Provider

PAC Service Provider

•Authenticating
•Authorization
•Discovery management
•Security

User
Device

User
Device

Connected

User
Device

User
Device

PAC PDI
Broadcasting

Retailer Device

<PAC Eco System>
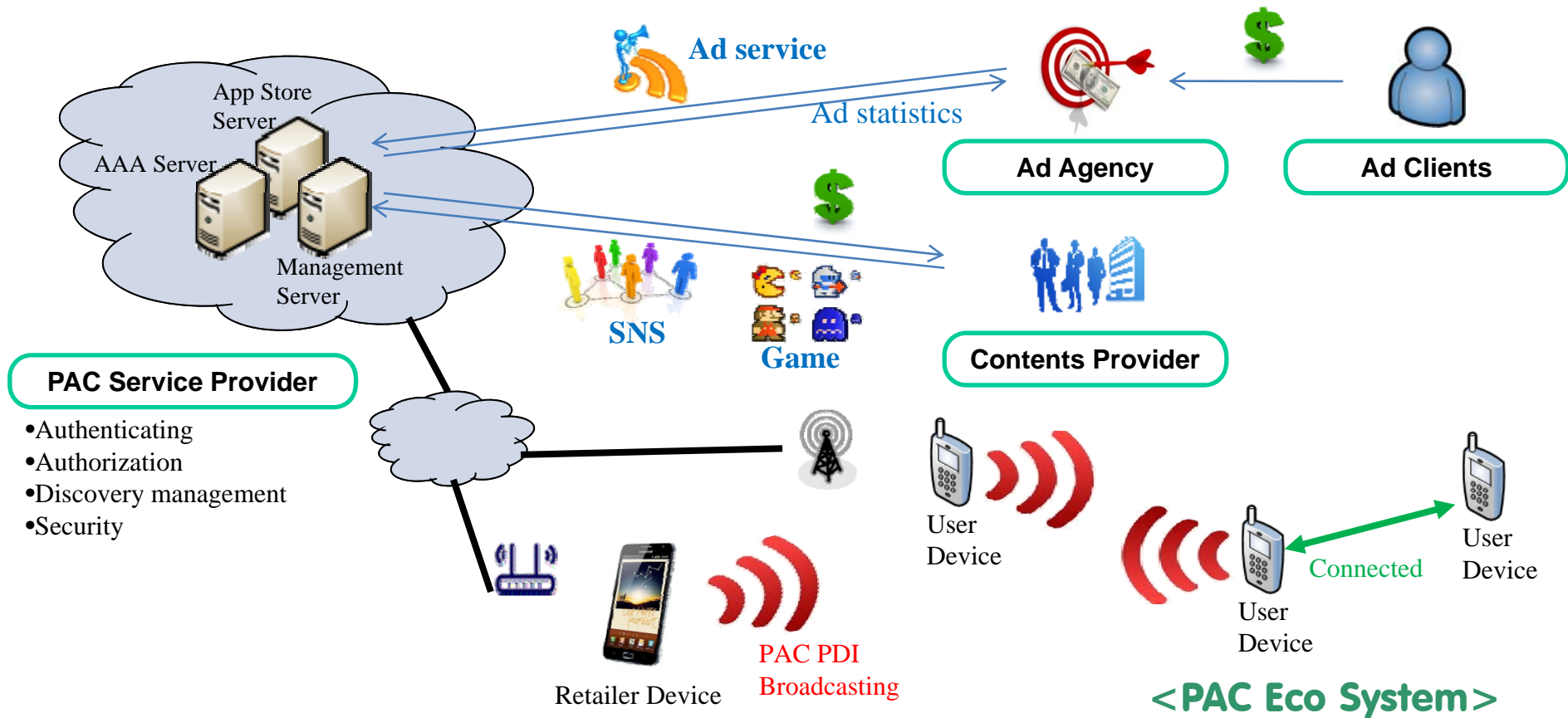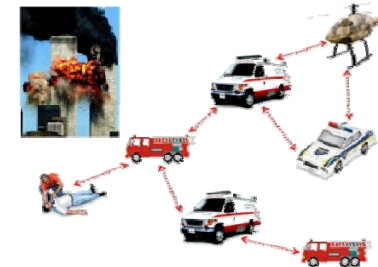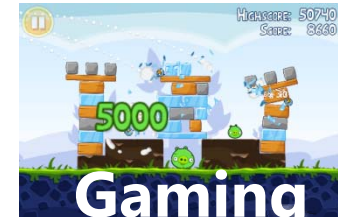
PAC Use-cases

- ## Urban/Crowded
  - SNS, Advertisements, Gaming,
  - Broadcasting/Multicasting
  - Service/Connectivity discovery

- ## Rural/Isolated
  - SNS, Advertisements

- ## Public safety
  - Back-up network at emergency

Social Networking

Gaming

Public Safety

Use-case 1:
Peer Aware Social Networking

Food Truck

Friends

Company

Neighbors
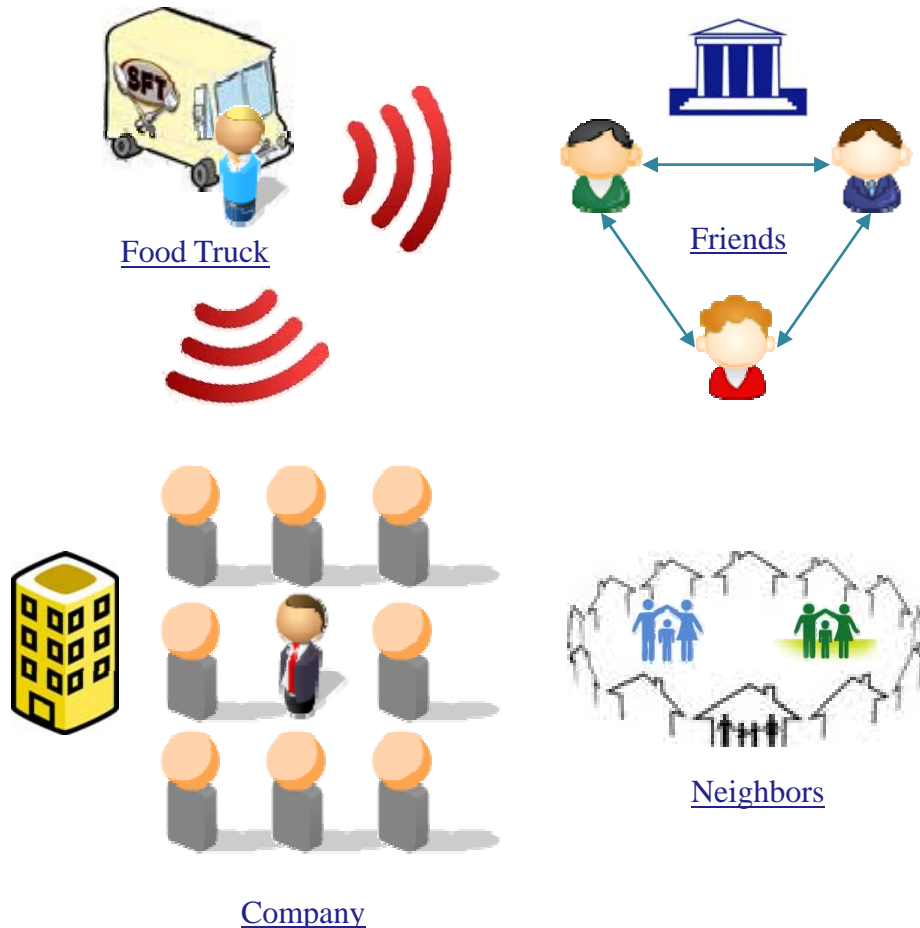
- Geo-social networking
  - Relevant to situation/context
- Proximal filtering
  - Avoid too many messages from social network
- Proximal search
  - Suitable for dynamically changing proximal info.
  - Proximal answering engine
  - Proximal profile matching
- Augmented society
  - Complementing real world
- Advertising platform
  - By relevant information

Use-case 2:
Distributed Service Platform

PAC link PAC link

Distributed Game Model

① Broadcast Ad for McDonald's Hamburger

Retailer

② Receive Ad from near-by shop when hitting the score

John
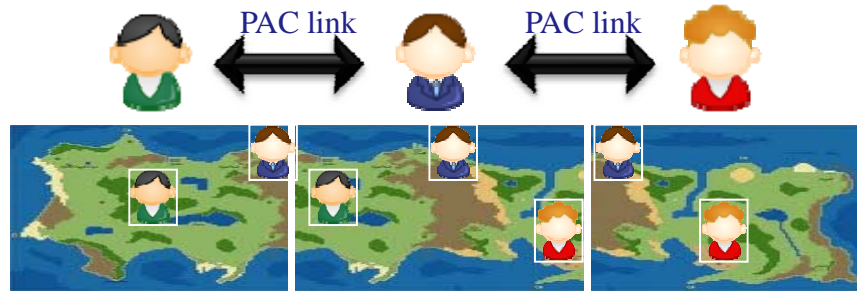
Ads in Game

- Distributed platform
  - For collaborative applications that is scalable and efficient
  - Gaming, streaming, file sharing, productivity, education

- Advertising platform
  - By user interaction/context
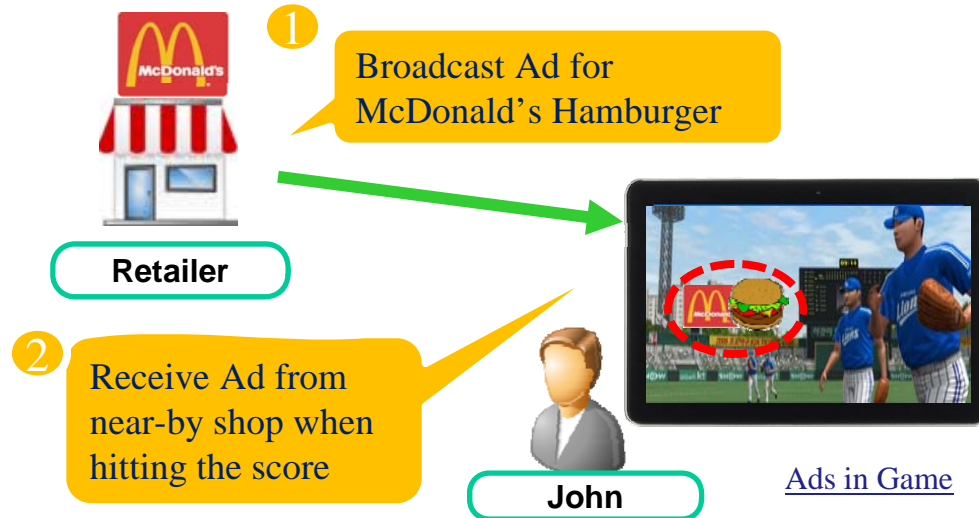
Personal DJ

Use-case 3:
Alarm & Emergency Service

Car Accident Alarm
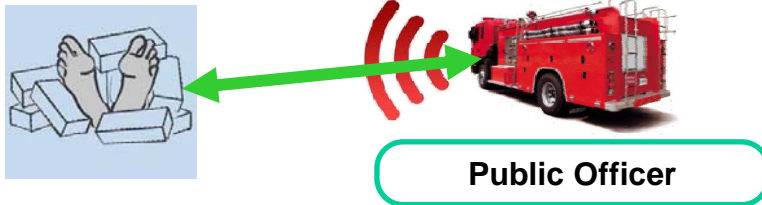
Public Officer
Finding people

Connecting people

- Accident alarm
  - Fast notification in near-by area
  - E.g. car accident alarm

- Emergency platform
  - Robust link to infrastructure or public officer, or among distant peoples
  - Coverage enhancement
  - E.g. finding a injury

- Hazard sensing
  - Monitoring hazard syndrome and inform to people in the area
  - E.g. chemical effusion, air pollution, water contamination

Main Features
according to use-cases

Use-cases	Features
Peer-aware Social Networking	▪ Low duty cycling for discovery ▪ High discovering capacity: up to 1000s of PDIs ▪ Long range : up to 1 km ▪ Data rate : up to 1 Mbps ▪ Mobility support : Pedestrian, Slow vehicle (30km/h)
Distributed Service Platform	▪ Low duty cycling for discovery ▪ Long range : up to 1 km ▪ High data rate : up to 10 Mbps ▪ High spatial reuse for transmission : typically [x5~x10] ▪ Mobility support : Pedestrian, Nomadic
Alarm & Emergency Service	▪ Low duty cycling for discovery & transmission ▪ Robustness ▪ Low latency for alarm : < 30 ms ▪ Mobility support : Pedestrian, Vehicle (60km/h)

Potential Spectrum Bands

- Unlicensed
  - No need for licensees, fast adoptions

- Licensed
  - Easier to find Biz model (compared to unlicensed)

- Potential spectrum bands
  - Unlicensed : TV White Space, WLAN(2.4GHz, 5GHz), local license-exempt band
  - Licensed: under utilized existing bands (e.g. TDD band)

BACKUP

Technical Comparison

	Wi-Fi (802.11n)	Bluetooth v2.0+EDR	ZigBee	UWB (WiMedia)	802.15 PAC
Data Rate	240 Mbps	2.1 Mbps	250 kbps	300 Mbps	20 Mbps
Coverage	< 100 m	< 10 m	< 30 m	< 3 m	< 1 km
PWR Efficiency (Mbps/mW)	0.24	0.07	0.00625	0.5	-
PWR consumption (Tx)	1000 mW	30 mW	40 mW	600 mW	-
Spectrum	2.4 GHz (5 GHz)	2.4 GHz	2.4 GHz (825/918 MHz)	3.1 to 10.6 GHz	-
Multiple Access	CSMA/CA	Polling	CAP* (option: GTS**)	PCA†, DRP††	TDMA with spatial reuse
BW (MHz)	20 (40)	1	2	500	5 (10)
Application	Best for wall-powered, indoor networking	Best for P2P audio streaming	Best for home/building automation, networking	Best for mobile, battery-powered video, connectivity	Best for mobile, battery-powered indoor/outdoor networking
Topology	Star	Star	Star, Mesh	P2P (w/o coordinator)	Mesh (w/o coordinator)
# of steps (time) to discovery	~ 20 (0.2~1.6 s)	~ 6 (min. 10 s)	~ 10	~ 10	~ 3

*CAP(Contention Access Period)   **GTS(Guaranteed Time Slot)   †PCA (Prioritized Contention Access)   † † DRP (Distributed Reservation Protocol)

Representative Use-cases

	Wi-Fi (802.11n)	Bluetooth v2.0+EDR	ZigBee	UWB (WiMedia)	802.15 PAC
Web browsing	O				
File download	O				
File sharing	O	O		O	O
Large file sharing	O			O	
Audio streaming	O	O		O	O
Video streaming	O			O	O
HD streaming	O			O	
Navigator (LBS)	O				O
Chatting	O	O			O
Collaboration	O				O
Turn-based game	O	O			O
Real-time game	O				O
Advertisement	O				O
Remote control			O		O
Automation			O		O
Monitoring			O		O
Healthcare			O		
Emergency Alarm			O		O