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國立臺北大學 資訊工程學系
NTPU, Department of Computer Science and Information Engineering

Wireless and Mobile Networks
Syllabus

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課程內容大綱

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- Chapter 2: **Power Saving in IEEE 802.11**
- Chapter 3: **Basic Routing Protocols for Ad Hoc Mobile Wireless Networks (MANETs)**
- Chapter 4: **The Broadcast Storm Problem in MANETs**
- Chapter 5: **Relay-Based Multi-Rate MAC Protocol in MANETs**
- Chapter 6: **Energy Conservation for Broadcast Routing in MANETs**
- Chapter 7: **Directional and Smart Antennas**
- Chapter 8: **An On-Demand, Link-State, Multi-Path QoS Routing in a MANET**

Cont.

- Chapter 9: **SOM: Spiral-Fat-Tree-Based On-Demand Multicast Protocol in a Wireless Ad-Hoc Network**
- Chapter 10: **Spiral-Multi-Path QoS Routing Protocol in Wireless Mobile Ad-Hoc Networks**
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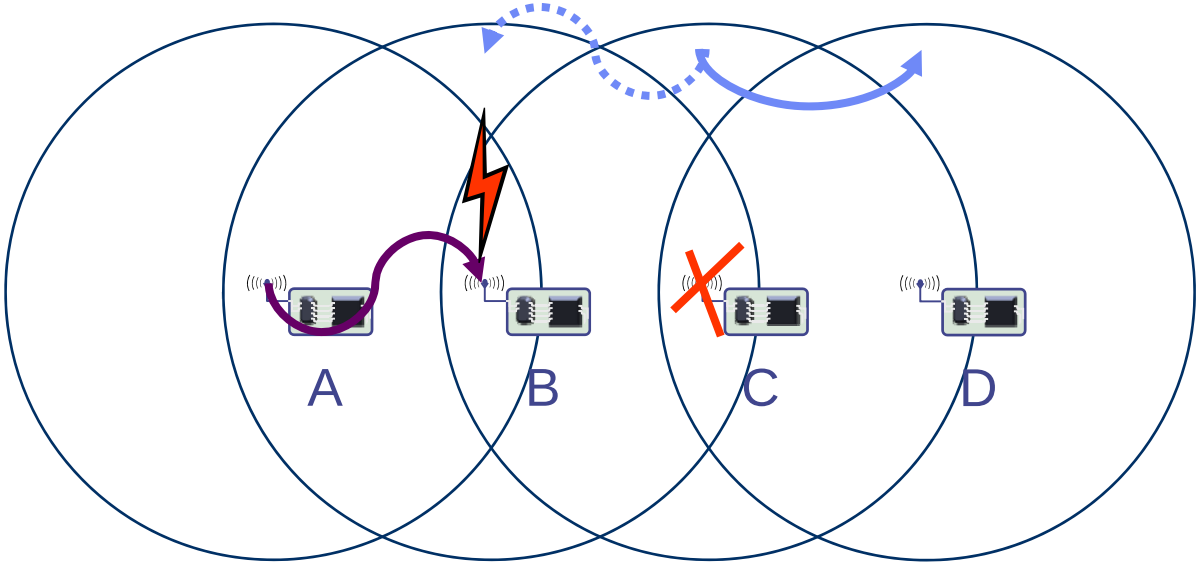
- Chapter 13: **Routing Protocols in Vehicular Ah Hoc Networks: A Survey and Future Perspectives**
- Chapter 14: **A Low Propagation Delay Multi-Path Routing Protocol for Underwater Sensor Networks**

Introduction of IEEE 802.11/Bluetooth

Yuh-Shyan Chen, Yun-Wei Lin, and C. Y. Chang, "An Overlapping Routing Protocol Using Improved Time-Slot Leasing in Bluetooth WPANs," ***Journal of Network and Computer Applications***, Vol. 32, No. 1, pp. 273-292, Jan. 2009.

Medium access control protocols

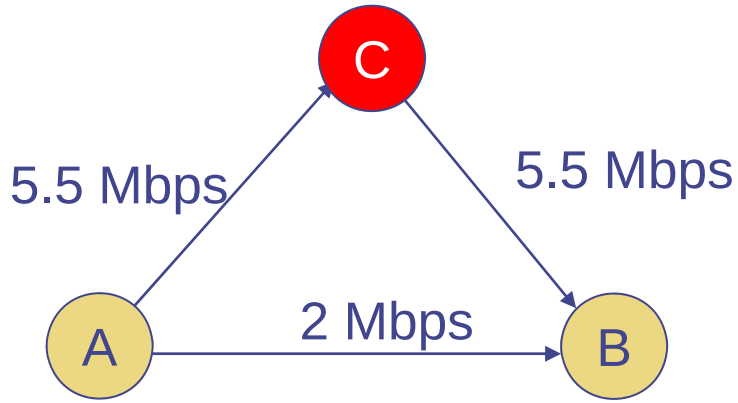
Hidden terminal scenario:



Also: recall exposed terminal scenario

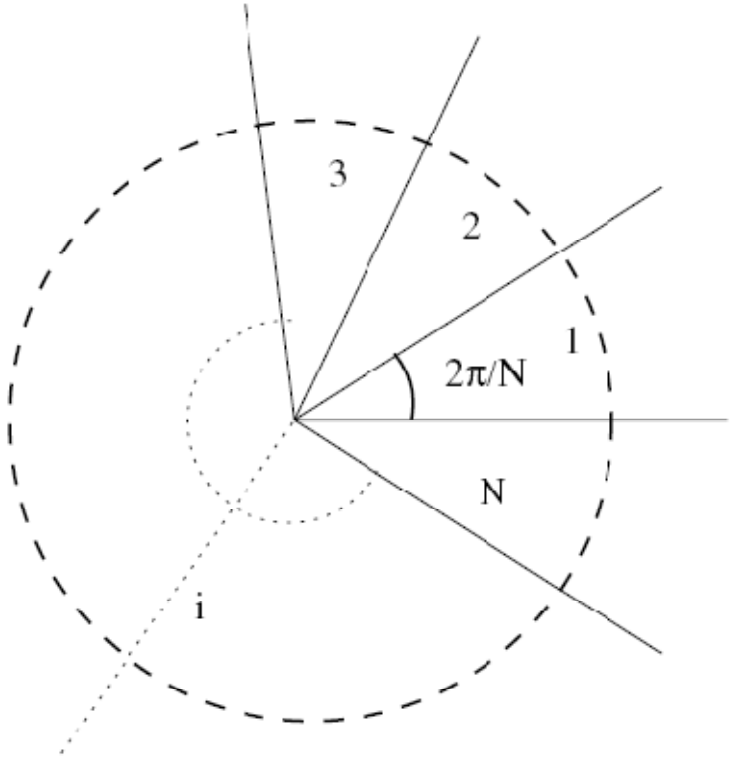
Yuh-Shyan Chen and Yun-Wei Lin, "C-MAC: An Energy-Efficient MAC Scheme Using Chinese Remainder Theorem for Wireless Sensor Networks," ***Journal of Information Science and Engineering***, Vol. 23, No. 4, pp. 1057-1071, July 2007.

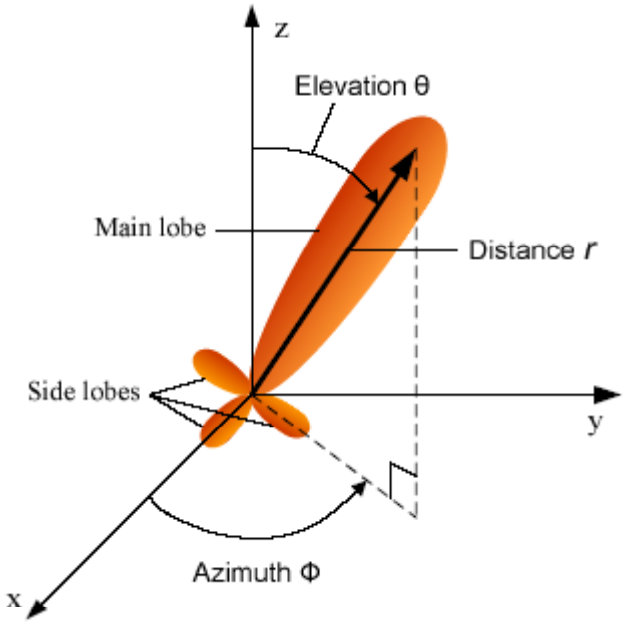
Relay-Enabled Medium Access Control Protocol for MANETs



Yuh-Shyan Chen, Chih-Shun Hsu, and Po-Ta Chen, "A Multiple Relay-Based Medium Access Control Protocol in Multirate Wireless Ad Hoc Networks with Multiple Beam Antennas," ***International Journal of Communication Systems***, Vol. 23, Issue 5, pp. 596-632, May 2010.

Directional and Smart Antenna





Yuh-Shyan Chen, Chih-Shun Hsu, and Shih-Jr Jan, "A Shoelace-Based QoS Routing Protocol for Mobile Ad Hoc Networks Using Directional Antenna," ***Wireless Personal Communications***, Vol. 54, No. 2, pp. 361-384, July 2010.

Broadcast

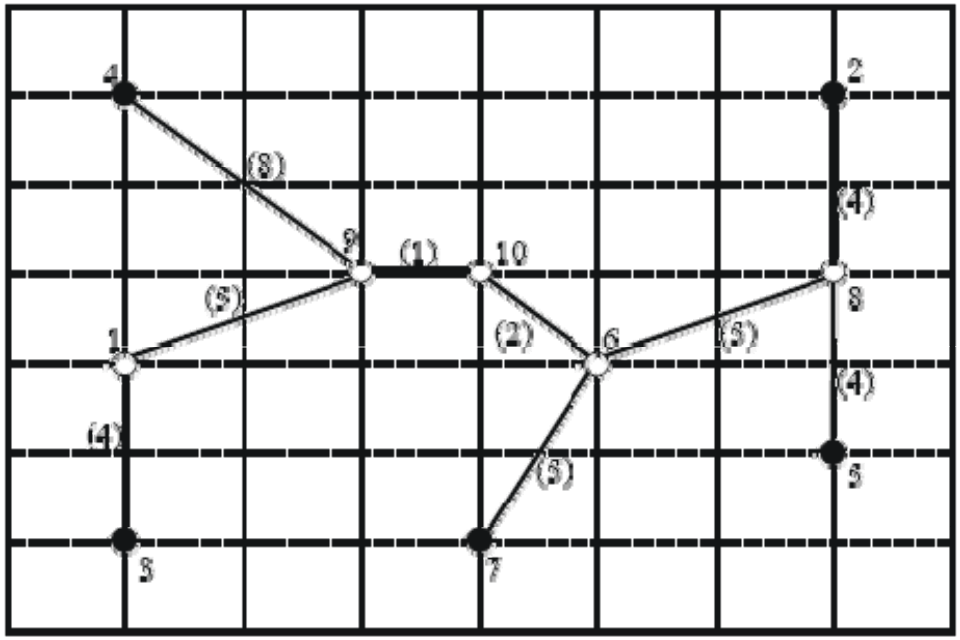
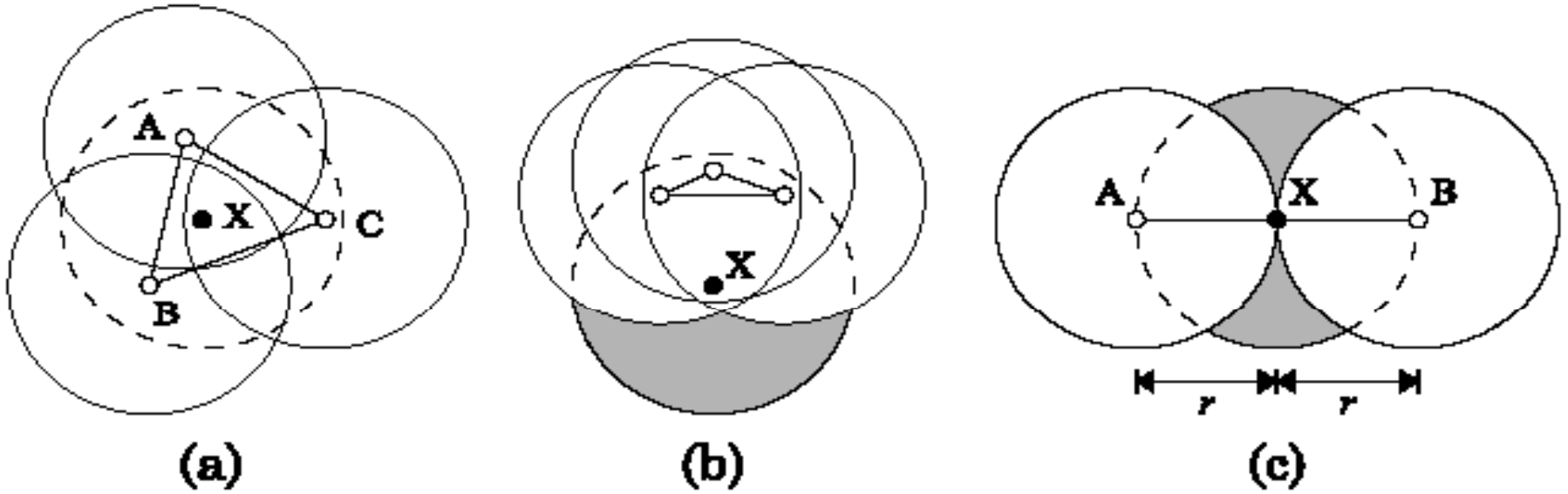


Fig. 3: A MST broadcasting tree

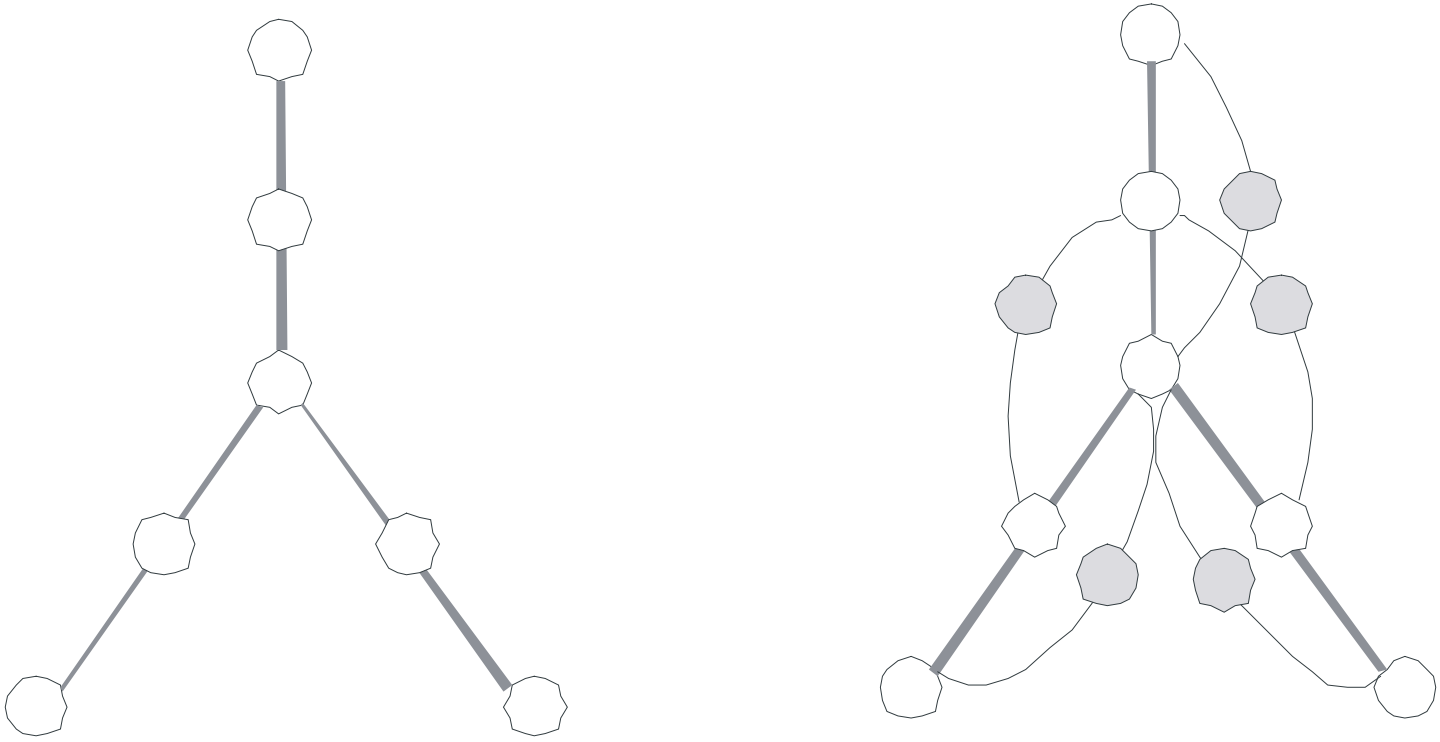
Jang-Ping Sheu, **Yuh-Shyan Chen**, Chih-Yung Chang, "Energy Conservation for Broadcast and Multicast Routing in Wireless Ad Hoc Networks," a book chapter in ***Handbook of Theoretical and Algorithmic Aspects of Sensor, Ad Hoc Wireless and Peer-to-Peer Networks***, CRC Press, (edited by Prof. Jie Wu), June, 2005.

Broadcast II: Broadcast Storm



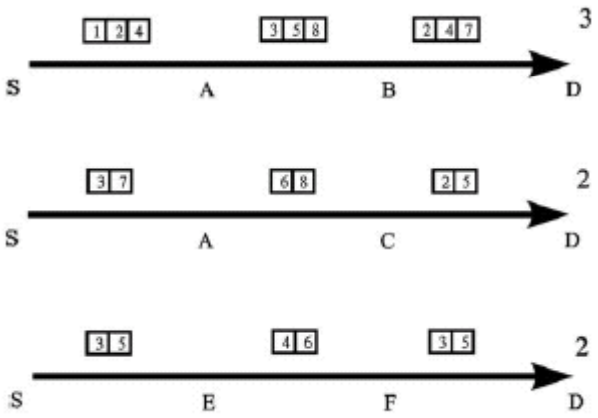
Y.-C. Tseng, S.-Y. Ni, **Yuh-Shyan Chen**, and J.-P. Sheu, "The Broadcast Storm Problem in a Mobile Ad Hoc Network," ***ACM/Springer Wireless Networks* (WINET)**, Vol. 8, No. 2, pp. 153-167, March 2002. (Citation number: 2359)

Multicast

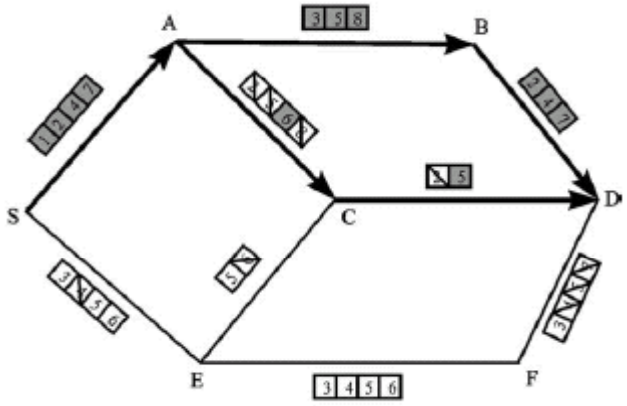


Yuh-Shyan Chen, Tzung-Shi Chen, and Ching-Jang Huang, "SOM: Spiral-Fat-Tree-Based On-Demand Multicast Protocol in a Wireless Ad-Hoc Network," ***IEEE Int'l Conf. on Information Networking*****,** (**ICOIN-15**), Beppu City, Japan, pp. 17-24, Jan. 31 - Feb. 2, 2001. (**Best Paper Award**)

Routing/QoS Routing



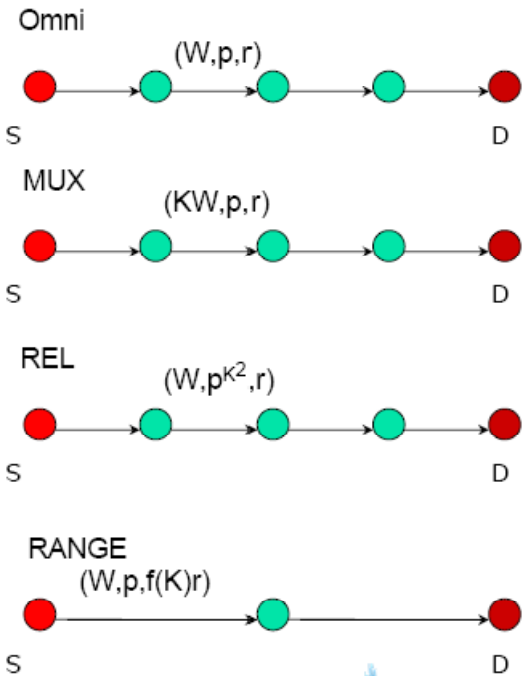
(a)



(d)

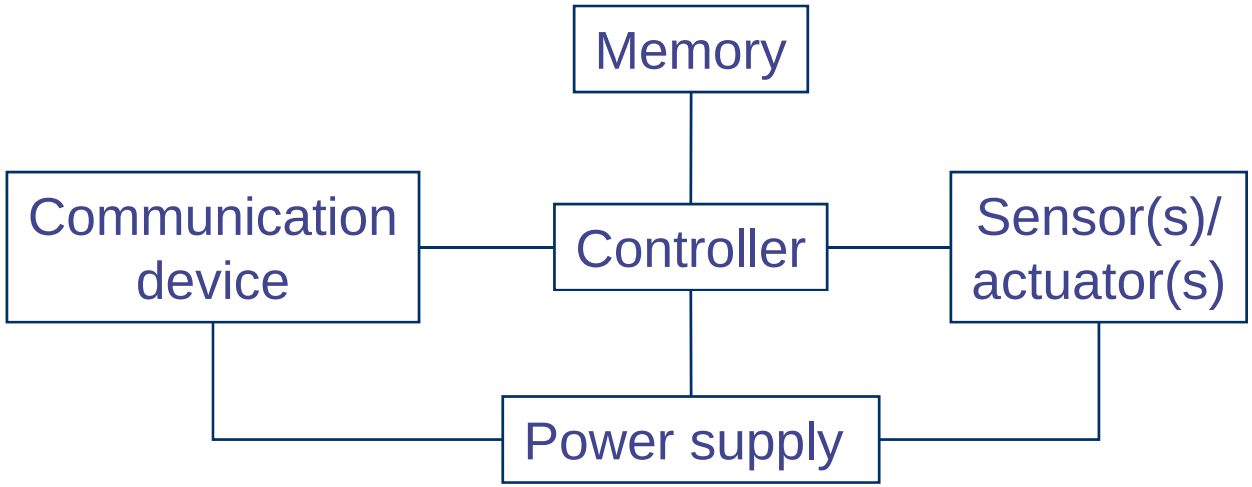
Yuh-Shyan Chen, Yu-Chee Tseng, Jang-Ping Sheu, and Po-Hsuen Kuo, "An On-Demand, Link-State, Multi-Path QoS Routing in a Wireless Mobile Ad-Hoc Network," ***Computer Communications***, Vol. 27, Issue 1, pp. 27-40, Jan. 2004.

QoS Routing on MIMO (Multiple Input Multiple Output) **MANETs**

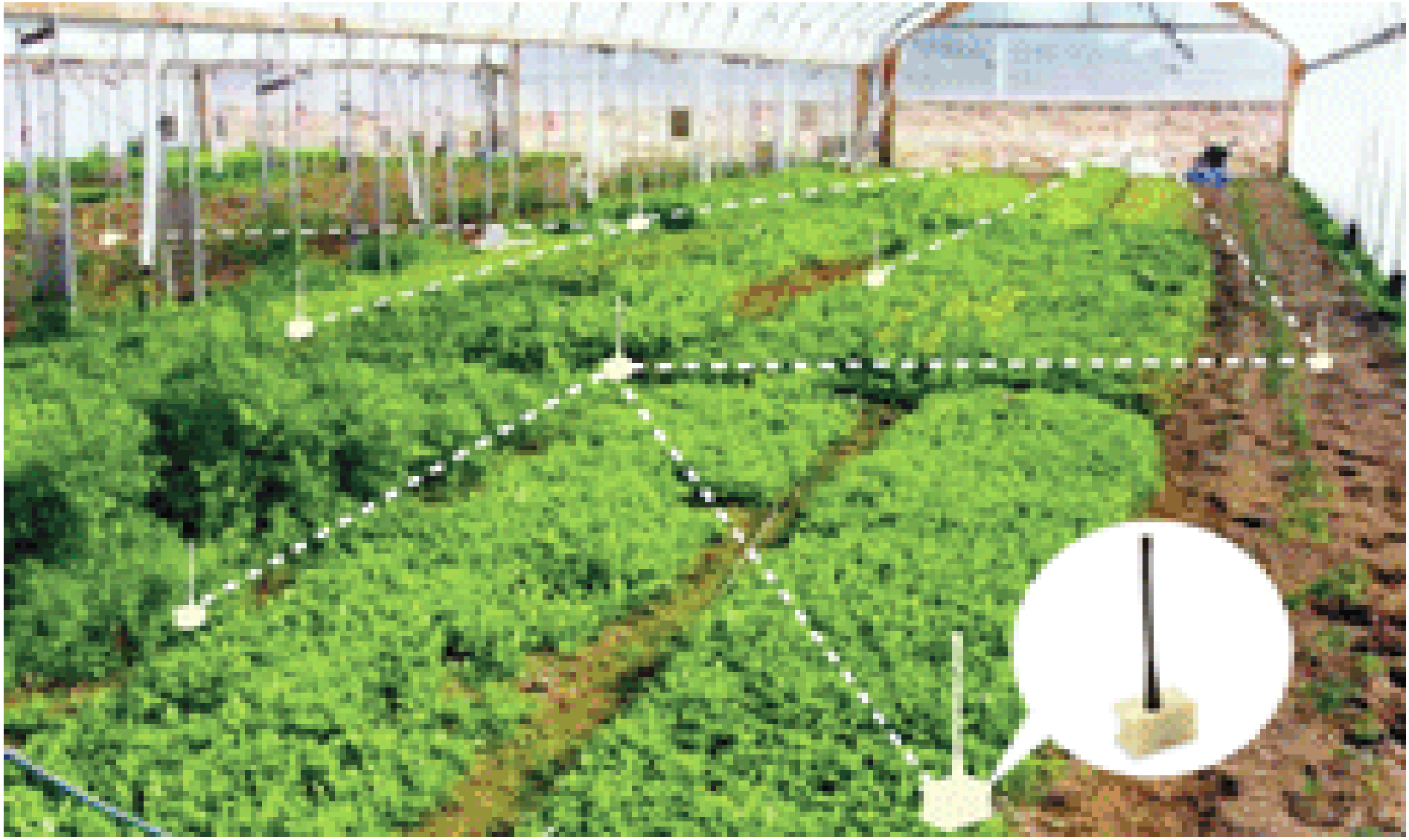


Yuh-Shyan Chen, Chih-Shun Hsu, and Po-Tsai Hsieh, "An Efficient Bow-Based On-Demand QoS Routing Protocol for MIMO Ad Hoc Networks", ***Computer Communications***, Vol. 32, Issue 15, pp. 1613-1630, Sep. 2009.

Single node architecture

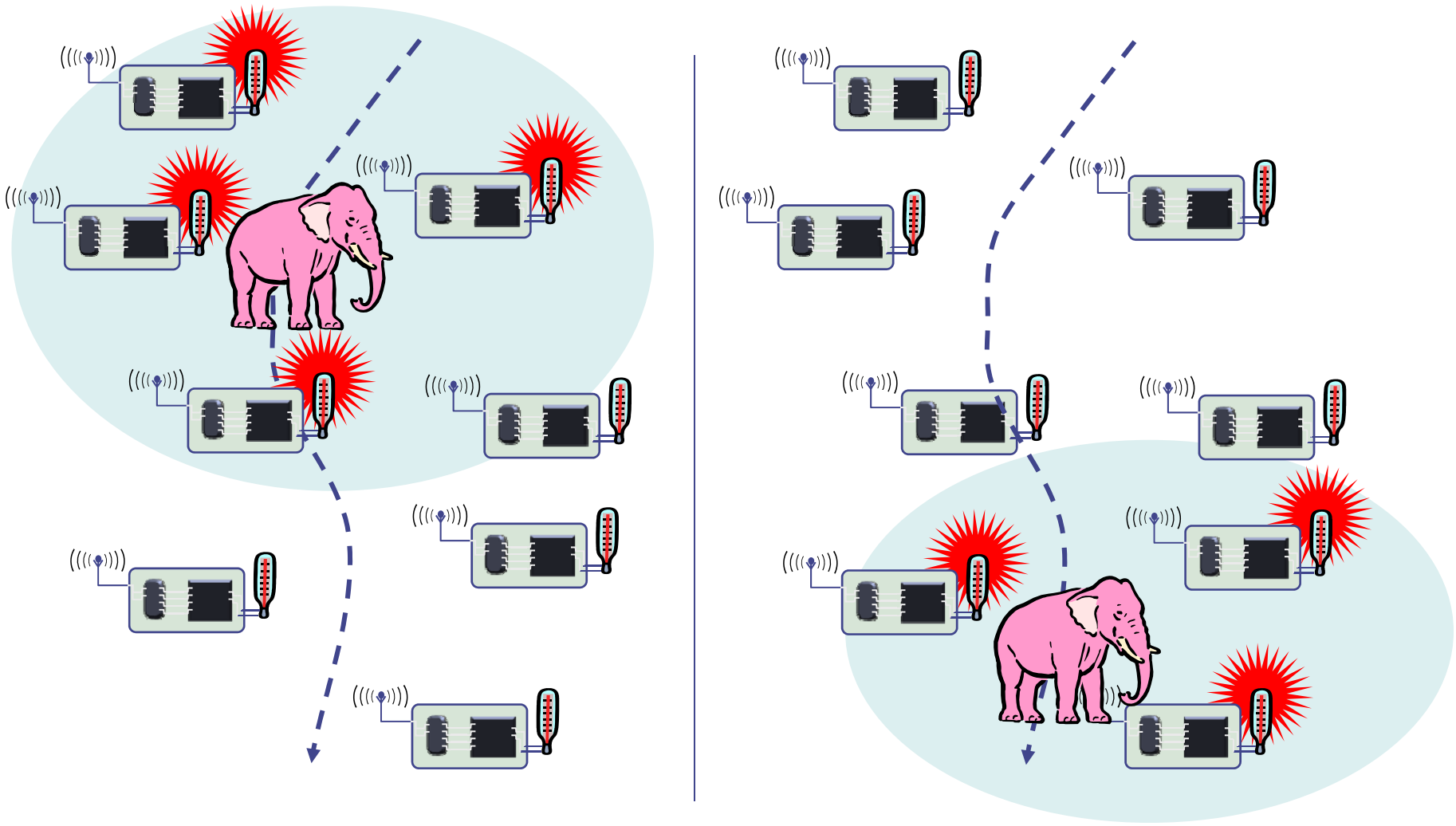


Environment Monitoring System

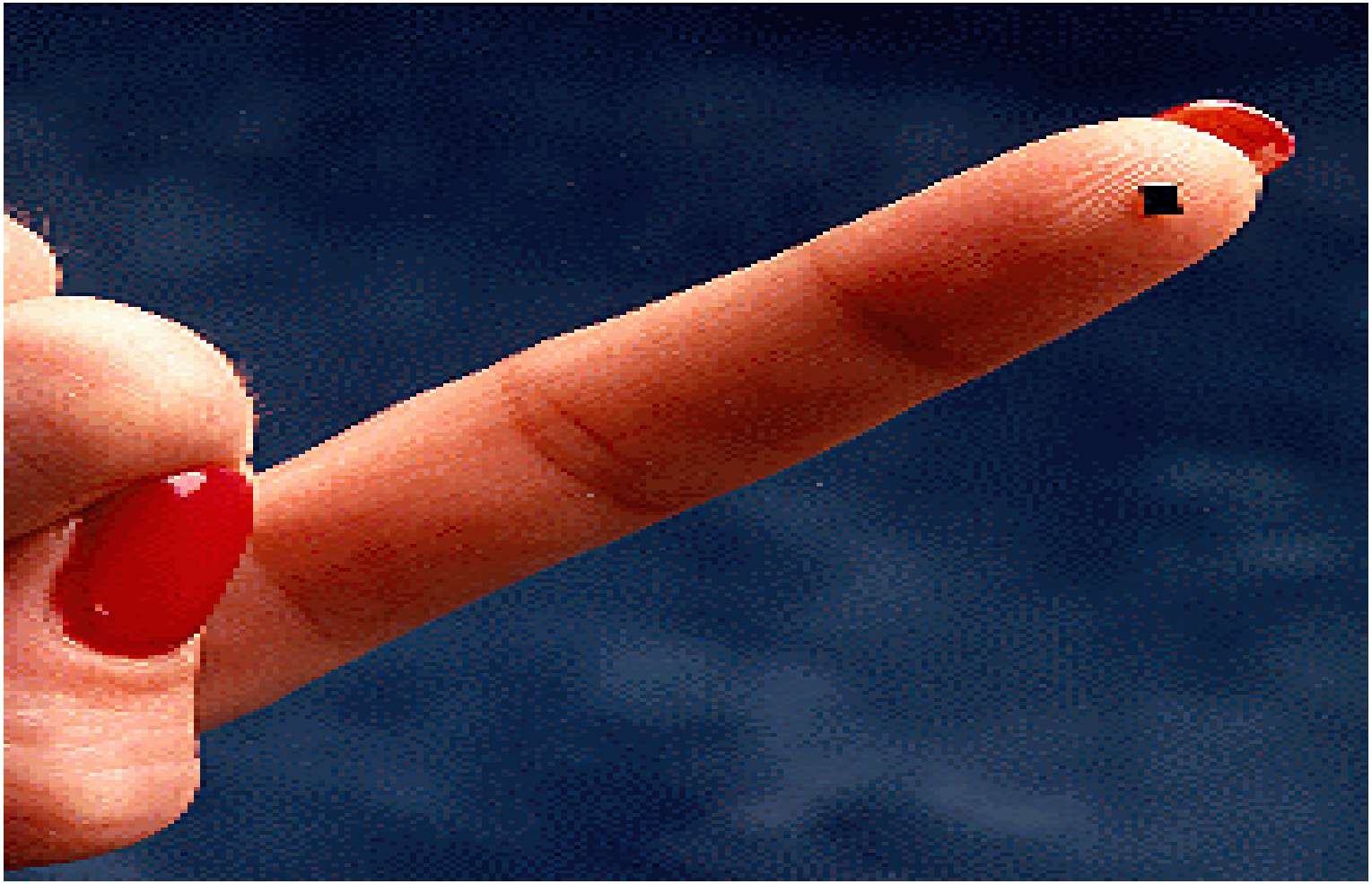


Sensors in Unknown Terrain

Network architecture

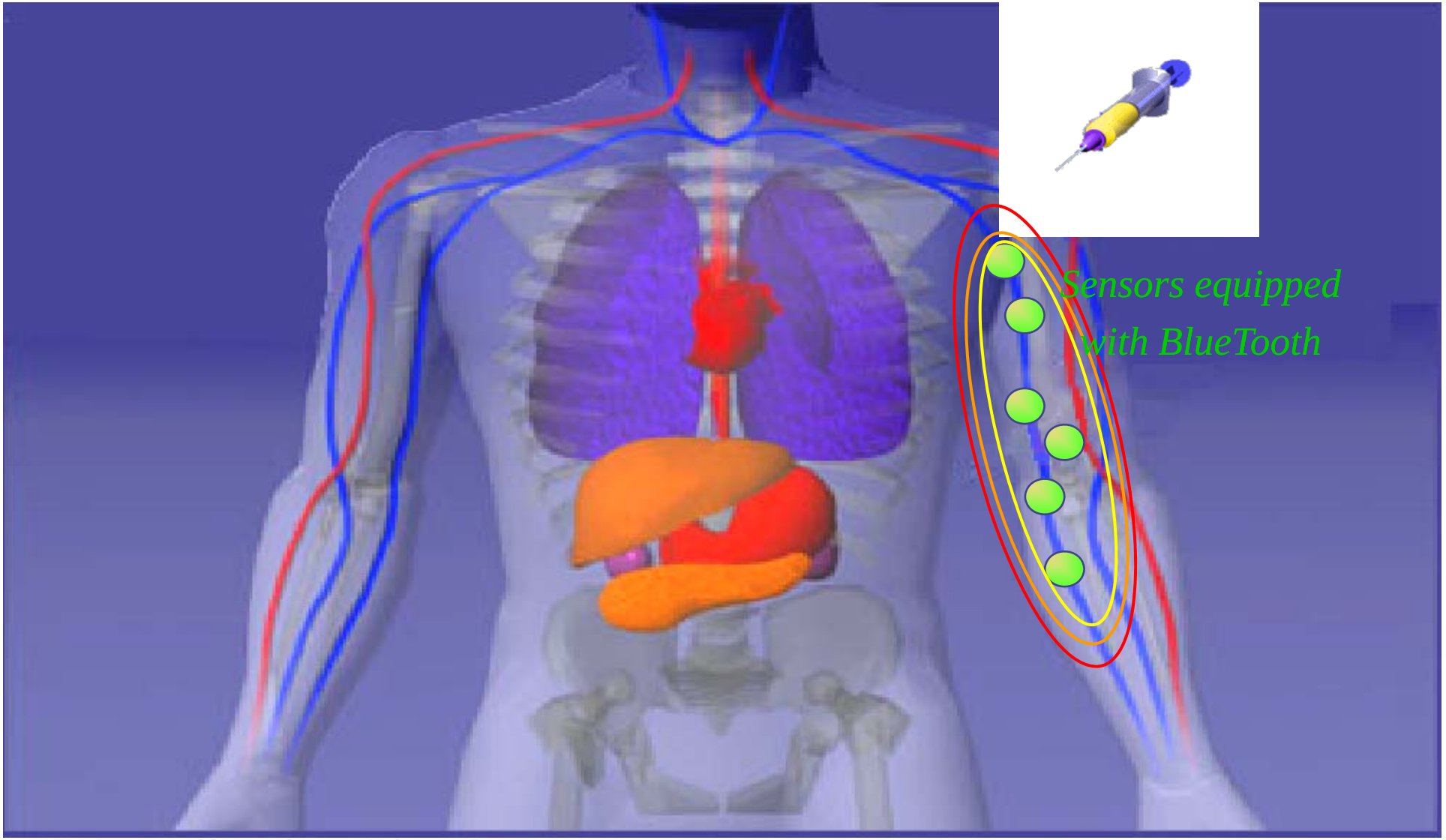


Wireless Bio-Sensor

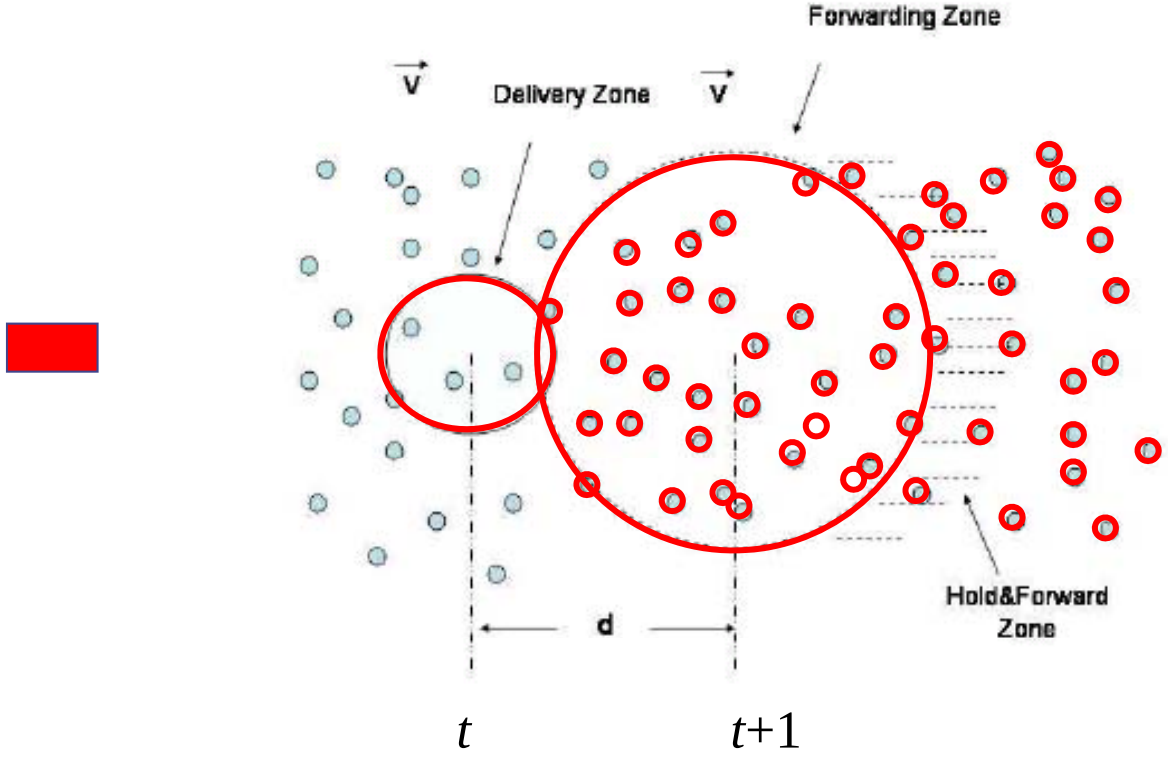


Medical and **Healthcare** Applications

Source: USC Web Site



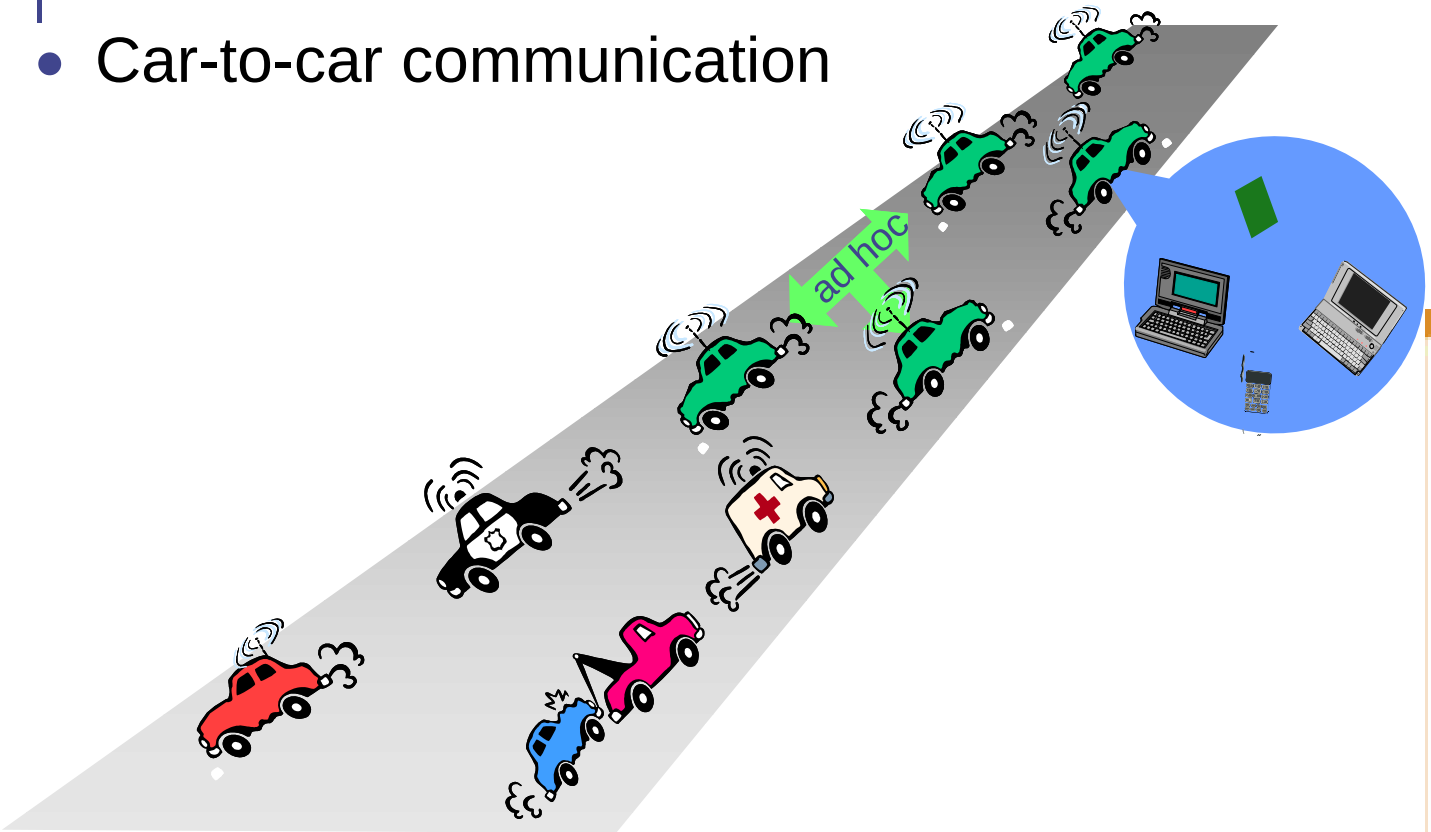
Mobicast Routing Problem on WSNs

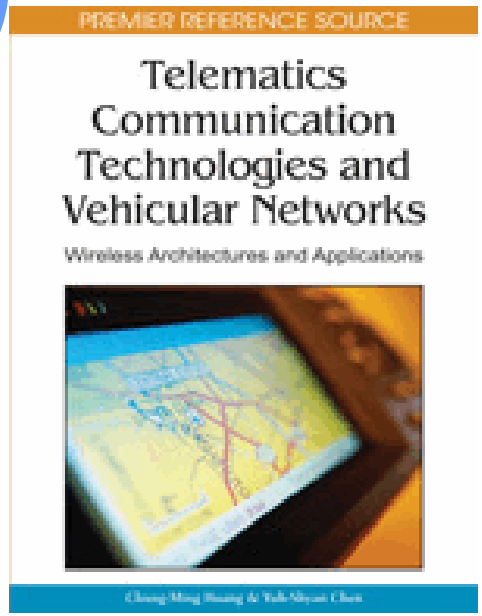


Yuh-Shyan Chen, Shin-Yi Ann, and Yun-Wei Lin, "VE-Mobicast: A Variant-Egg-Based Mobicast Routing Protocol for Sensornets," ***ACM/Springer Wireless Networks* (WINET)**, Vol. 14, No. 2, pp. 199-218, April 2008.

Vehicular Ad Hoc (Sensor) Networks

- Car-to-car communication





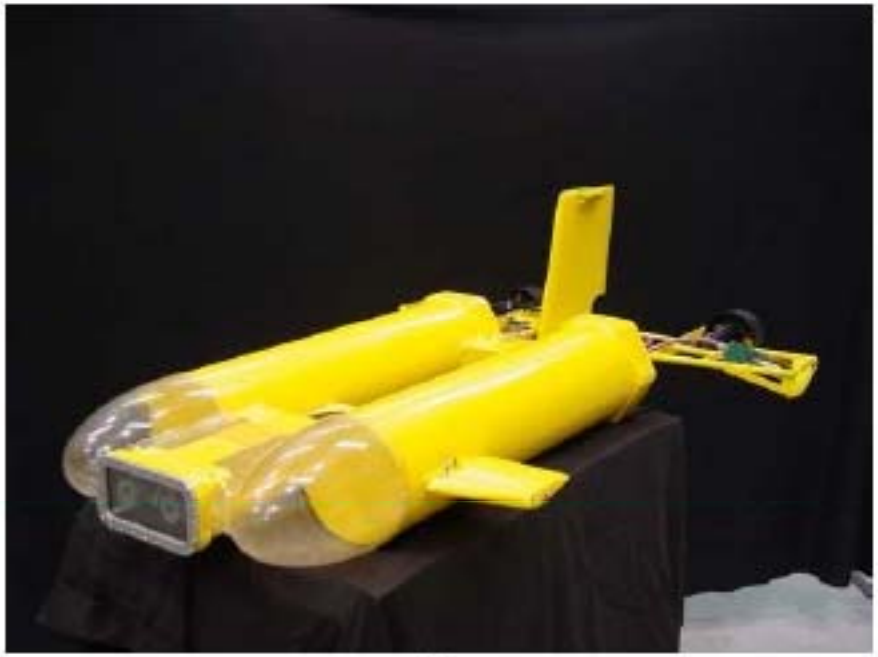
Huang Chung-Ming and **Yuh-Shyan Chen,** Telematics Communication Technologies and Vehicular Networks: Wireless Architectures and Applications, ***IGI Global***, Dec. 2009.

Underwater Networks

Yuh-Shyan Chen, Tong-Ying Juang, Yun-Wei Lin, and I-Che Tsai, "A Low Propagation Delay Multi-Path Routing Protocol for Underwater Sensor Networks," ***Journal of Internet Technology***, Vol. 11, No. 2, pp. 153-165, March 2010.

(a) a mobile node (Amour AUV),
(b) a mobile node (Starbug AUV).

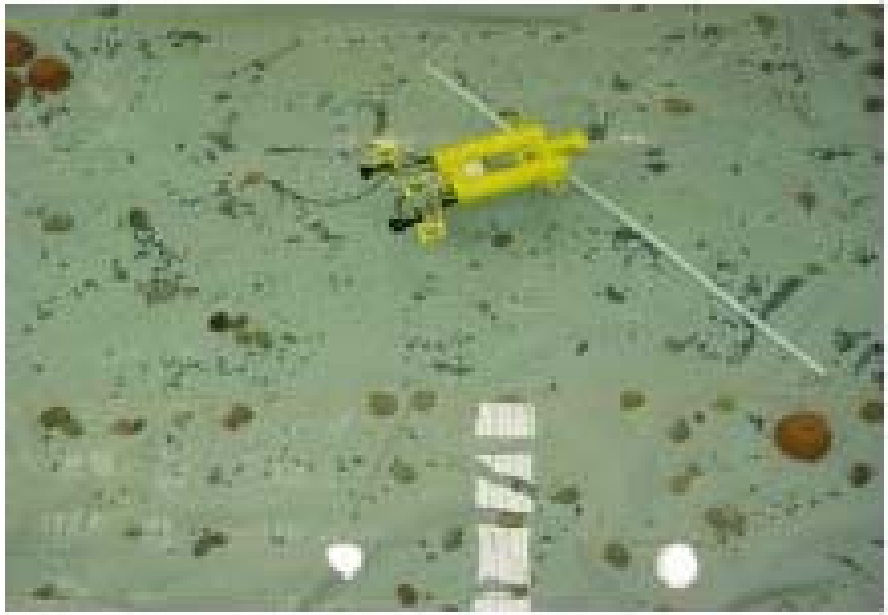
(a)



(b)

(a) Starbug in Moreton Bay, Brisbane.
(b) Starbug in the pool.

(a)



(b)

Green Communications

- Nowadays, the whole world of telecommunications and information communities is facing a more and more serious challenge
  - One side the transmitted multimedia-rich data are exploding at an astonishing speed and on the other side the total energy consumption by the communication and networking systems/devices and the relevant global CO2 emission are terribly increasing.
- It has been pointed out that “currently 3% of the world-wide energy is consumed by the ICT (Information & Communications Technology) infrastructure that causes about 2% of the world-wide CO2 emissions, which is comparable to the world-wide CO2 emissions by airplanes or one quarter of the world-wide CO2 emissions by cars”.

Cont.

- According to the recent research report, energy costs account for as much as half of a mobile operator's operating expenses.
- Therefore**, telecommunications applications** can have a direct, tangible impact on lowering greenhouse gas emissions, power consumption, and achieve efficient recycling of equipment waste.
- To find radio network solutions that can improve **energy-efficiency** is not only benefit for the global environment but also makes commercial sense for telecommunication operators supporting sustainable and profitable business.

Cont.

- Gratifyingly, the emerging **Cognitive Radio (CR)** system and techniques are potentially capable of contributing to solve the abovementioned problems for realizing "Green Communications".
- Cognitive Radio is characterized of an adaptive, multi-dimensionally environment-aware, autonomous radio system empowered by advanced intelligent functionality, which interacts with its operating environment and learns from its experiences to reason, plan, and decide future actions to meet various needs.

Cont.

- This approach can lead to a significant increase in **radio resource (spectrum) efficiency**, **networking efficiency** as well as energy efficiency under various key constraints.
- Within the framework of "Green Communications", a number of CR-enabled key approaches can be expected towards persistent awareness of the strict energy constraints, including energy-efficient network architecture & protocols, energy-efficient CR transmission techniques (e.g., reduced transmission power & reduced radiation), cross-layer optimization methods, and opportunistic spectrum sharing without causing harmful interference pollution (i.e. Green Spectrum).

Cont.

- It is important to discuss not only the current status and the relevant technical challenges within various **energy-efficient wireless access** approaches, including but not limited to CR-enabled solutions, but also to make out a roadmap for the future “Green Communications” era.
- It is planned to bring together the key-players coming from the industry, academy, and government bodies around the world with various backgrounds and expertise, while targeting for deeply addressing various significant aspects of “**Green Communications**” and their potentially enabling technologies.

Green Computing

Cont.

- The world's sources of computing power are concentrated in remote server warehouses strategically located near the sources of renewable energy that power them, such as wind and solar farms.
- The usage of the power sources could shift across the globe, depending on where energy is most abundant.
- Hopper, a professor of computer technology at the University of Cambridge and head of its Computer Laboratory.
  - "We lose energy by relying on the national grid. I propose a system that is more efficient, much less expensive, and that would have an immediate impact on the world's energy consumption. It's always cheaper to move data than energy."
  - Hopper's suggestion of **a personal energy meter**.

Cont.

- Much of the green computing movement's focus today is on data centers.
  - The approximately 6,000 data centers in the United States.
  - consumed roughly 61 billion kilowatt-hours (kWh) of energy in 2006.
  - A strategic infrastructure architect at Microsoft. The total cost of that energy, $4.5 billion, was more than the cost of electricity used by all the color televisions in the U.S. in 2006, Curtis says.
  - The Department of Energy (DOE) reports that data centers consumed 1.5% of all electricity in the U.S. in 2006.
  - Their power demand is growing 12% a year.
  - If data centers' present rate of consumption continues, Curtis warns, they will consume about 100 billion kWh of energy at an annual cost of $7.4 billion by 2011.

Cont.

- The federal government wants data centers' energy consumption to be reduced by at least 10% by 2011.
- That translates into an energy savings equivalent to the electricity consumed by a million average U.S. households,
  - according to Paul Sheathing, a spokesman for DOE's Office of Energy Efficiency and Renewable Energy.
  - You can spin the dial on some straightforward actions, such as orienting racks of servers in a data center to exhaust their heat in a uniform direction, thus reducing overall cooling costs….
  - A comprehensive plan for achieving green computing really does require an architectural approach
- Power consumption at the server level has increased along with performance increase, and business needs have grown even faster.

Cont.

- More attention must be devoted to data centers' ever-increasing power density and heat removal, Wang says.
- "In the past, the sole focus was on IT equipment processing power and associated equipment spending.
- The infrastructure— power, cooling, data center space— was always assumed to be available and affordable," he says. "Now the infrastructure is becoming a limiting factor."
- Microsoft, Google, and Yahoo are addressing the environmental concerns about their data centers' carbon footprint, the measure of the environmental impact of an individual or organization's lifestyle or operation,

Cont.

- Meanwhile, a global consortium of computer companies, including AMD, Dell, IBM, Sun Microsystems, and Vmware, organized The Green Grid in 2007, with the goal of improving energy efficiency in data centers and business computing systems.
- To achieve that goal, The Green Grid collaborates with individual companies, government agencies, and industry groups to provide recommendations on best practices, metrics, and technologies that will improve data centers' energy efficiency.

Earth-Friendly Computers

- As with any evolving idea, people will need to think differently and more deeply when it comes to green computing.
- It is not unusual, for instance, for companies to replace their older computers with new, more energy efficient ones in an effort to become more earth-friendly.

For the Future of the Planet

- **The first goal** is an optimal digital infrastructure in which computing's overall energy consumption is reduced and the efficient use of energy in the manufacture, operation, and disposal of computing devices is maximized.
- **The second goal** is "to sense and optimize the world around us with reference to a global world model," which would "inform us about the energy consumption and other effects of our activities on the natural environment."
- **The third goal** is a new emphasis on predicting and responding to future events by modeling their behavior.
- **Lastly**, "interested in the possible benefit of digital alternatives to our physical activities,"

學期成績計算方法

- 期中考 (30%)
- 期末考 (30%)
- Homeworks (10%)
- Oral presentation (15%)
- 實驗 (15%)