

## The Next Generation Wireless Networks: The Reality behind the Hype

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IBM, T.J. Watson Research Center

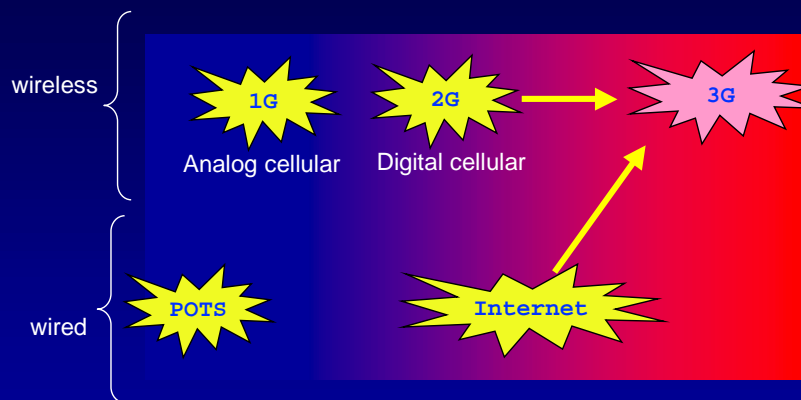
Hawthorne, NY

March 12, 2001

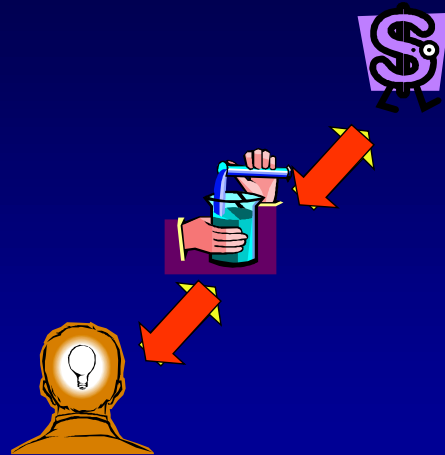
### Acknowledgements:

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Chatschik Bisdikian, Mahmoud Naghshineh, Theodoros Salonidis (IBM)

## The next big thing ?



## Bottom up Vs. top down research



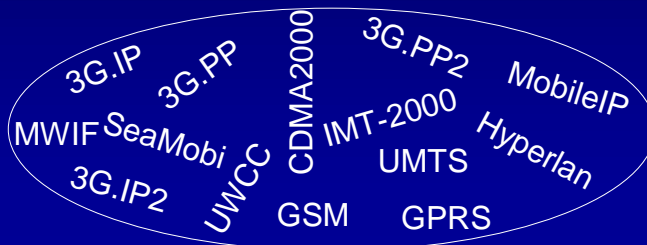
3G and Bluetooth are two classic examples of market driven forums

## The Promise of 3G

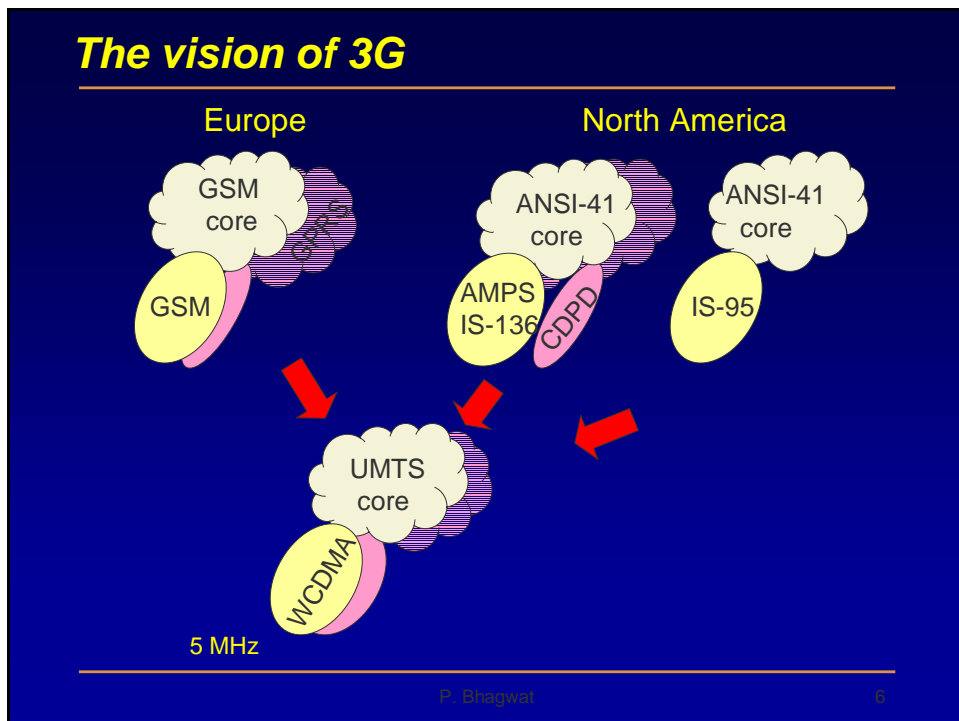
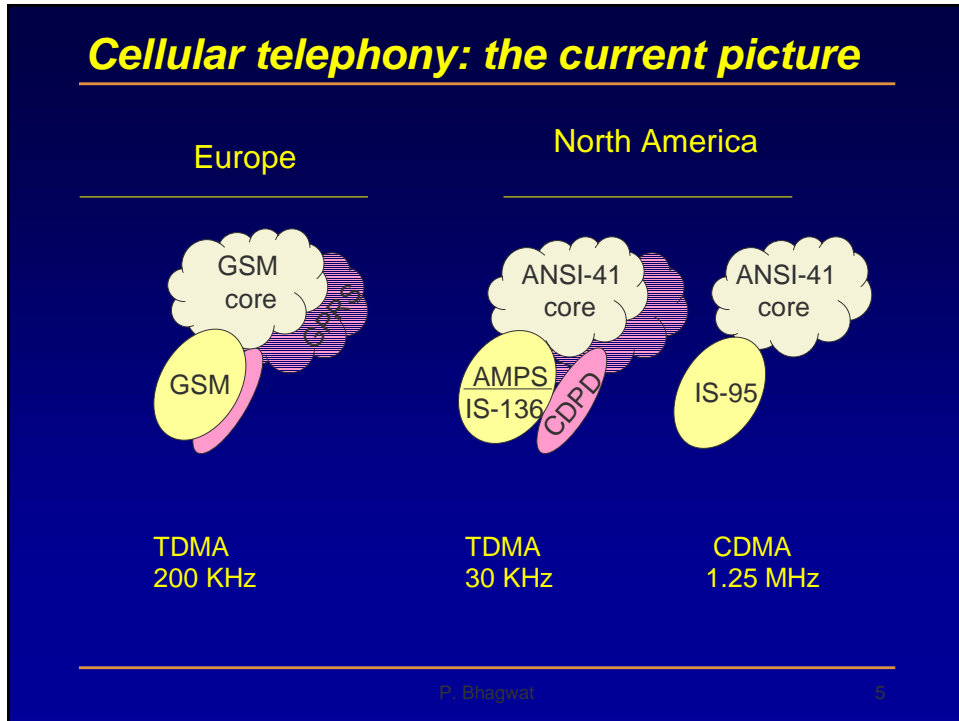
*“Access to information from anyplace, anytime”*

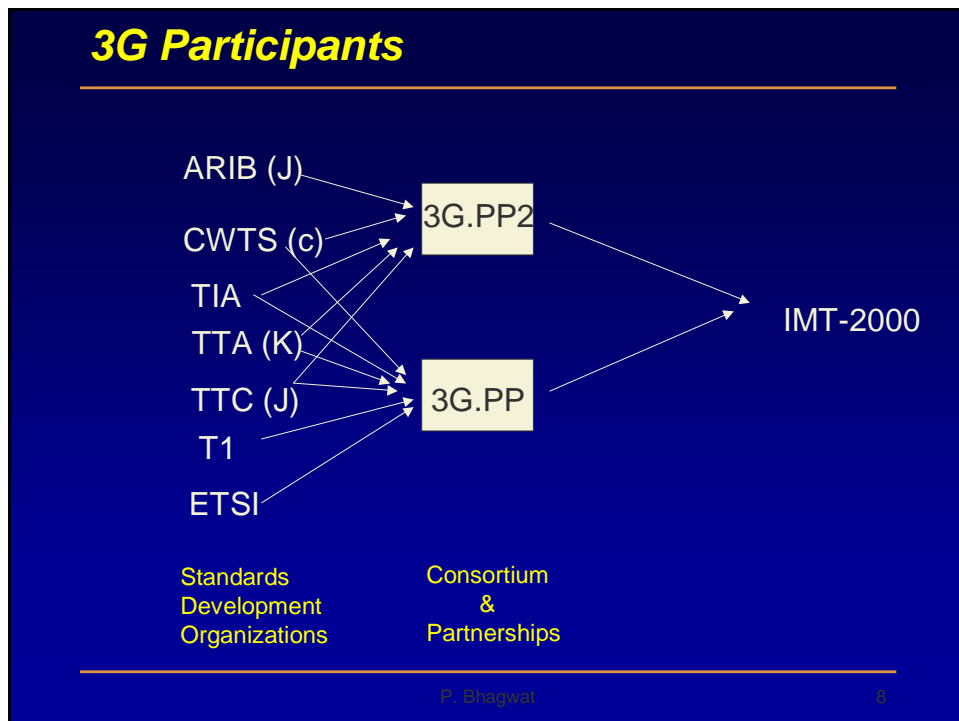
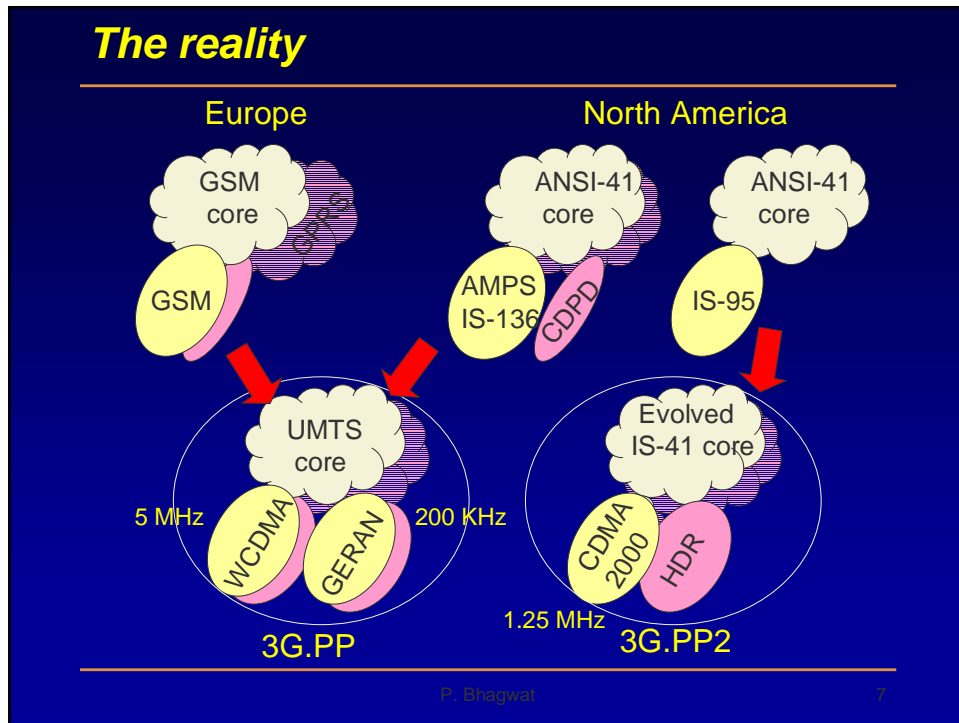
- ▶ Higher rate
  - 114 Kbps or higher in vehicular traffic
  - 384 kbps for pedestrian traffic
  - Variable rate traffic
- ▶ Geographic position determination capability
- ▶ Interoperability & roaming (single worldwide standard)

technically solved problems

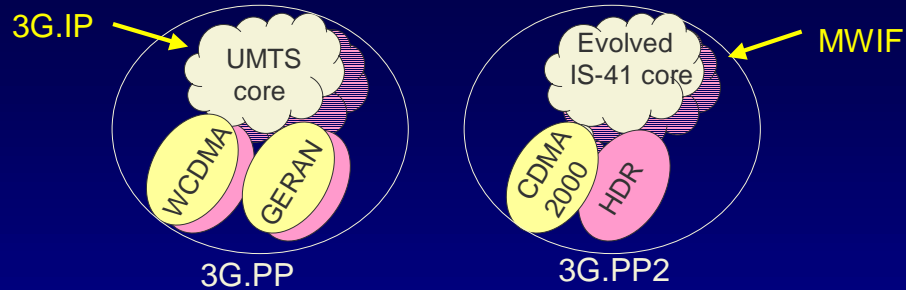


the real challenge





## 3G: The role of IP networking



Mobile IP (macro mobility) -- with enhanced AAA

SeaMobi (micro mobility)

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8

## 3G: Some Speculation\$

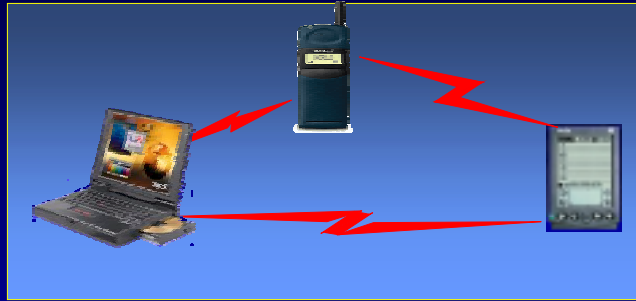
- "IP to the base station" efforts might take off
  - ▶ Potential for green field operator's entry is high
- Software radios can solve the roaming problem
  - ▶ but true mobility is not in the best interest of the operators
- Wireless video is technically feasible
  - ▶ but is economically infeasible

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10

## The Promise of Bluetooth

*"Freedom from cables"*



- ▶ High rate communication in local area
  - 1 Mbps link speed
  - Support for voice and data
- ▶ Low cost and low power
- ▶ Ad hoc connectivity
- ▶ Multi-hop communication

} Technically challenging problems

## Bluetooth Physical link

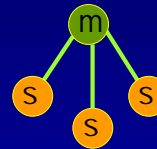
### ■ Point to point link

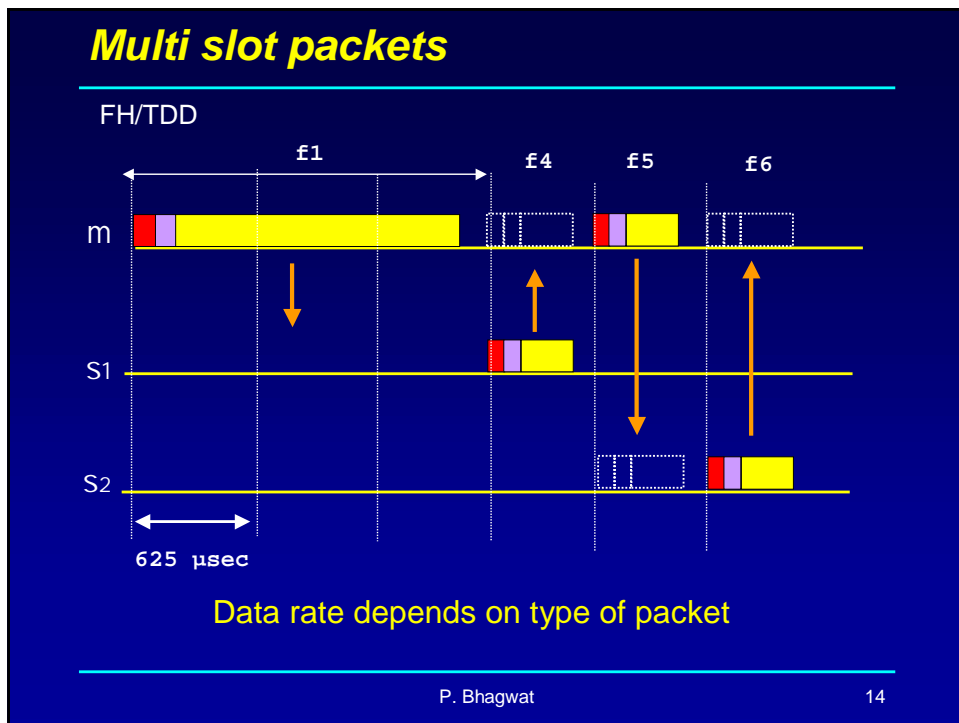
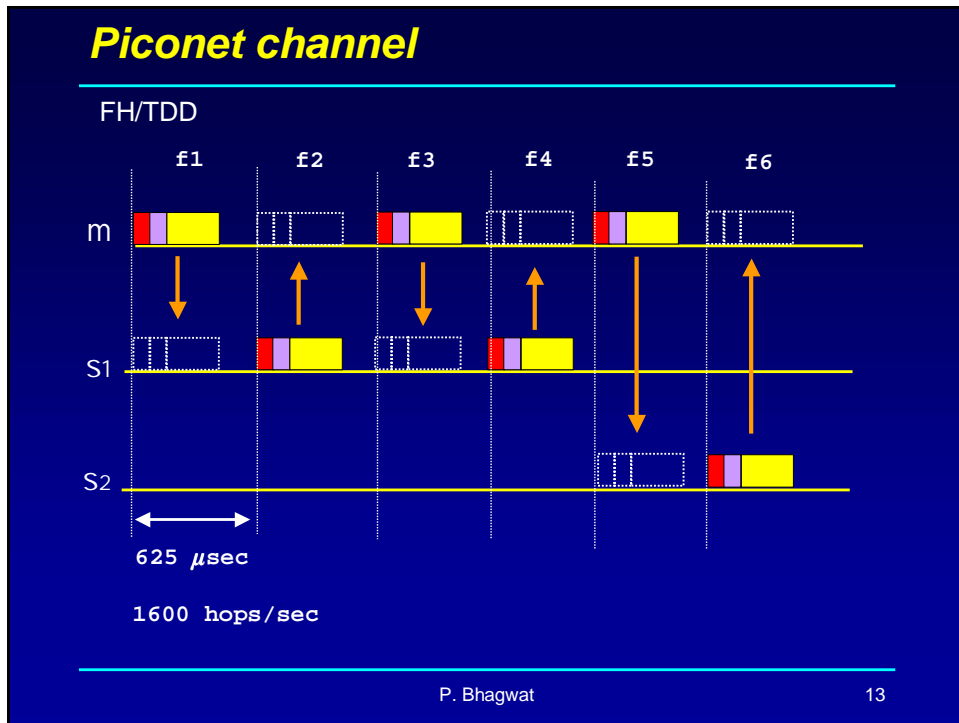
- ▶ master - slave relationship
- ▶ radios can function as masters or slaves



### ■ Piconet

- ▶ Master can connect to 7 slaves
- ▶ Each piconet has max capacity (1 Mbps)
- ▶ hopping pattern is determined by the master





## Bluetooth: achievable data rates

DH1 

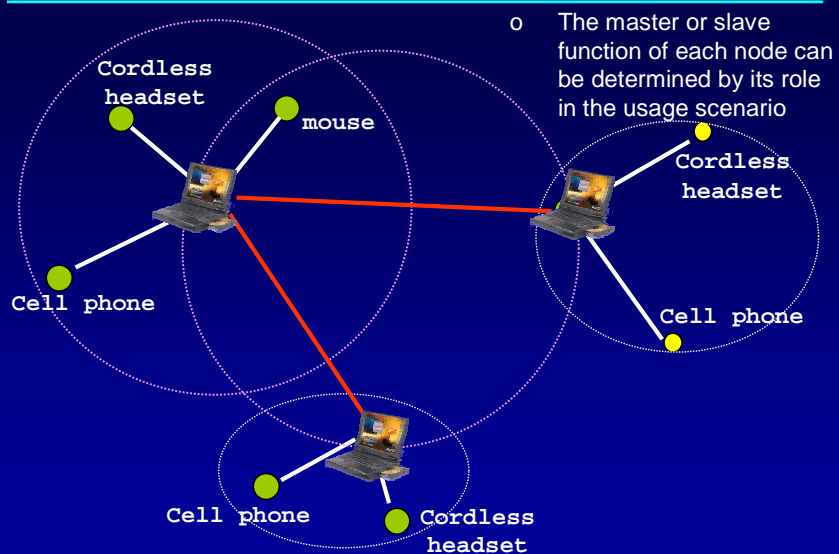
DH3 

DH5 

	Symmetric	Asymmetric		
	172.8	172.8	172.8	No FEC
	390.4	585.6	86.4	
	433.9	723.2	57.6	

	Symmetric	Asymmetric		
	108.8	108.8	108.8	with FEC
	258.1	387.2	54.4	
	286.7	477.8	36.3	

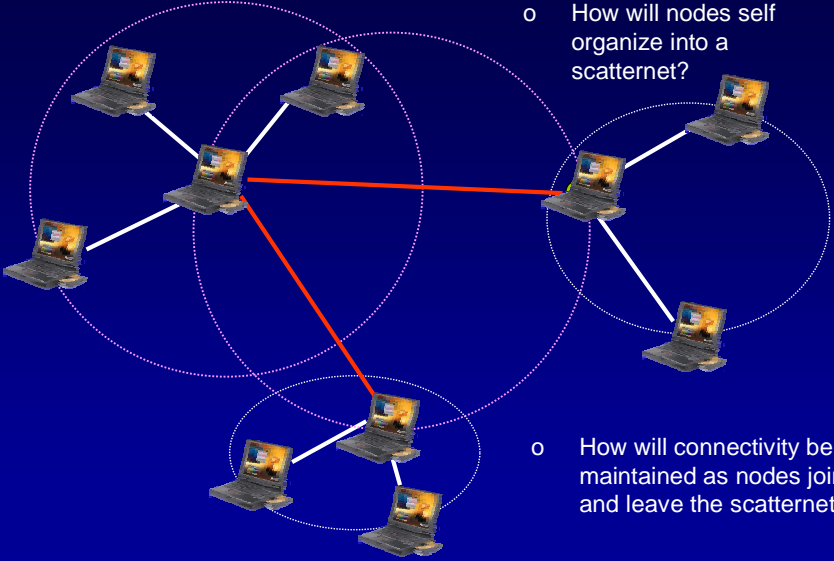
## Ad hoc networking: case 1





## Ad hoc networking: case 2

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The diagram shows a network of laptops. Each laptop has a dotted circle around it representing its communication range. Some laptops are connected by solid white lines, indicating they are within range of each other. A prominent red line connects two laptops that are not directly adjacent, representing a multi-hop connection. The overall network structure is irregular and dynamic.

- o How will nodes self organize into a scatternet?
- o How will connectivity be maintained as nodes join and leave the scatternet?

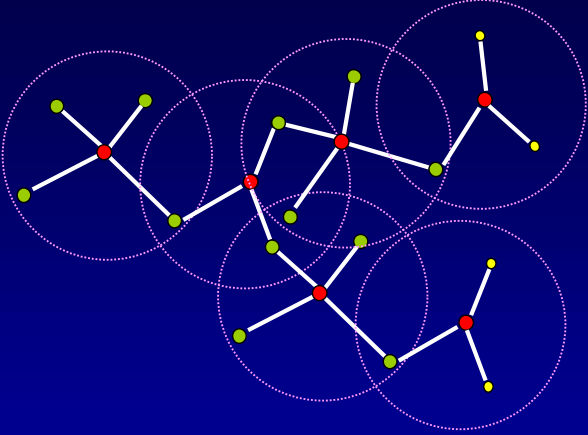
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17

## Multihop forwarding

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The diagram shows a network of nodes (represented by red and green dots) with their communication ranges (dotted circles). A path of nodes is highlighted with solid white lines, showing how data can be forwarded from one node to another through multiple hops. The path starts at a red node on the left and ends at a red node on the right, passing through several intermediate nodes.

- o What throughput can we expect between two nodes?
- o How does throughput scale as scatternet grows?
- o How does scatternet topology affect achievable throughput ?

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18

## *Concluding remarks*

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- Bluetooth is ideal for cable replacement
- Initial applications of Bluetooth will exploit its point-to-point or point-to-multipoint connectivity feature
- Multi-hop over Bluetooth will take some time to mature
- Ultimately the success or failure of Bluetooth will be determined by the market forces, not by its technical strengths or weaknesses