Some views on emerging and future technologies for wireless mobile networks

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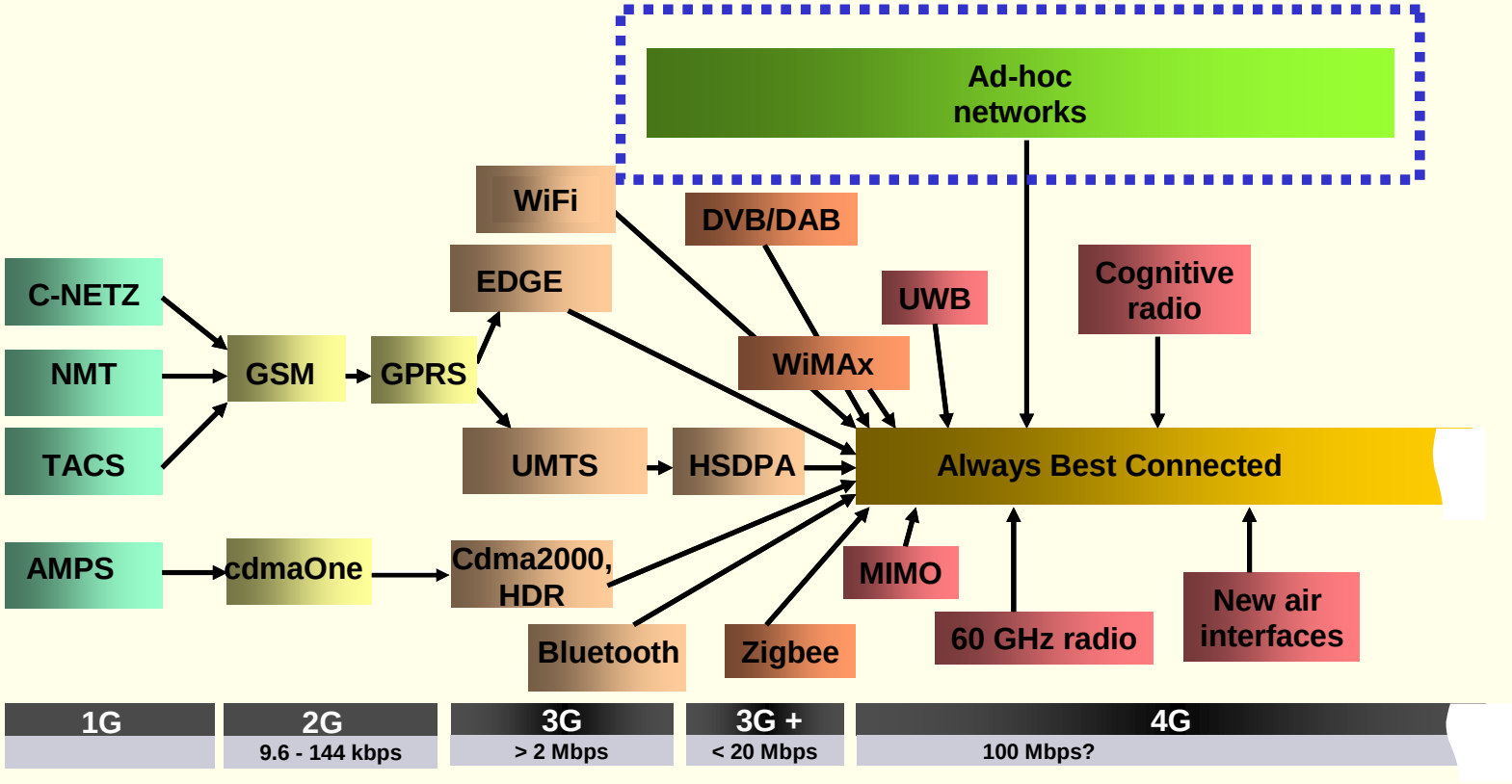
Outline

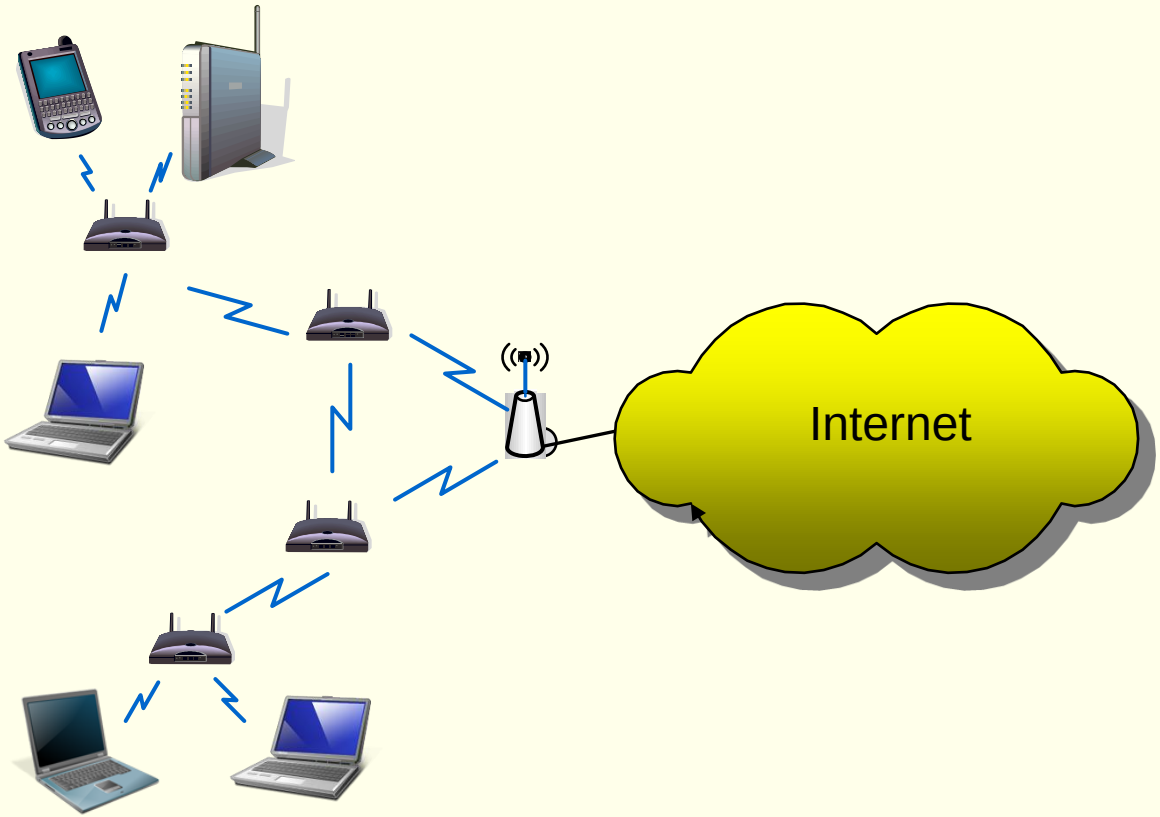
- The impact of ad-hoc based technologies in the evolution of mobile & wireless
- Experience from some projects on emerging wireless technologies
- Some views on the future wireless access

Evolution towards future mobile generations

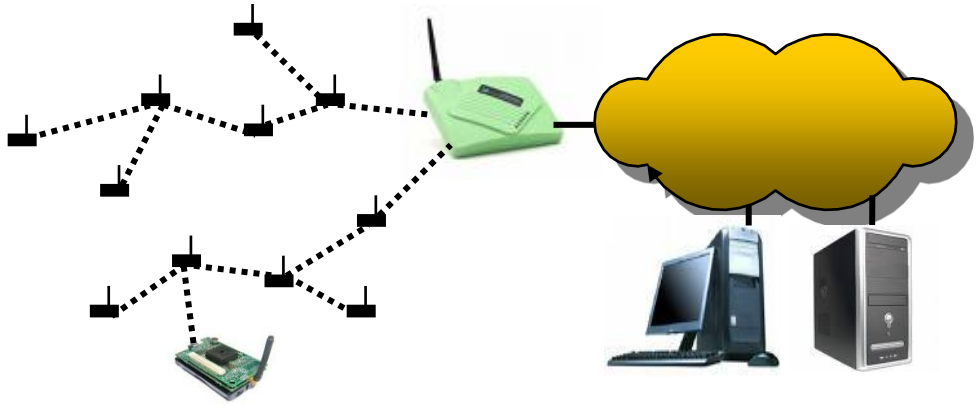


Analog voice	Digital voice	Digital voice + data	Full IP based “Integrated wireless world”

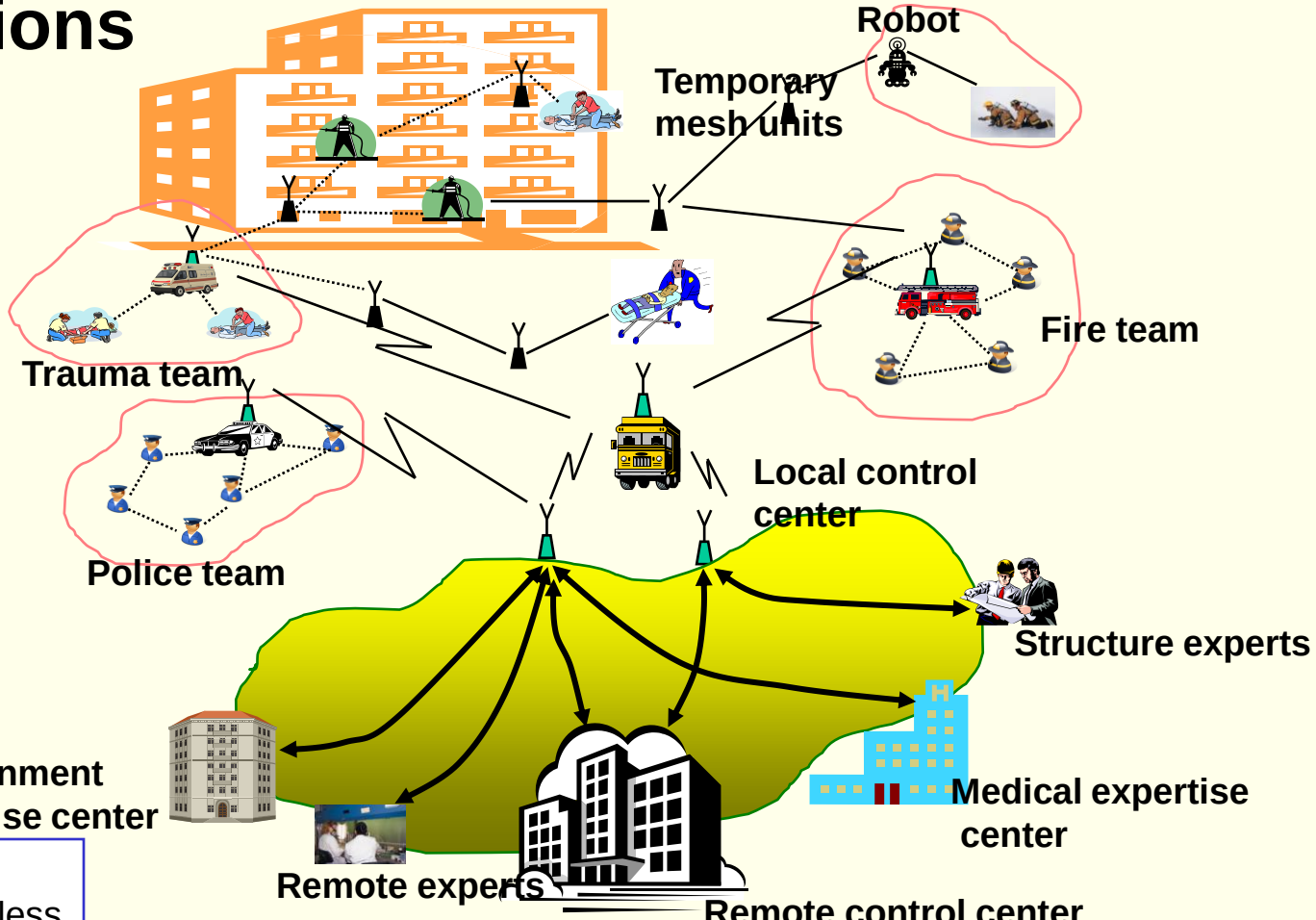
Now: Wireless mesh network



Now: Wireless sensor networks



Emerging: Ad-hoc networks in disaster relief operations

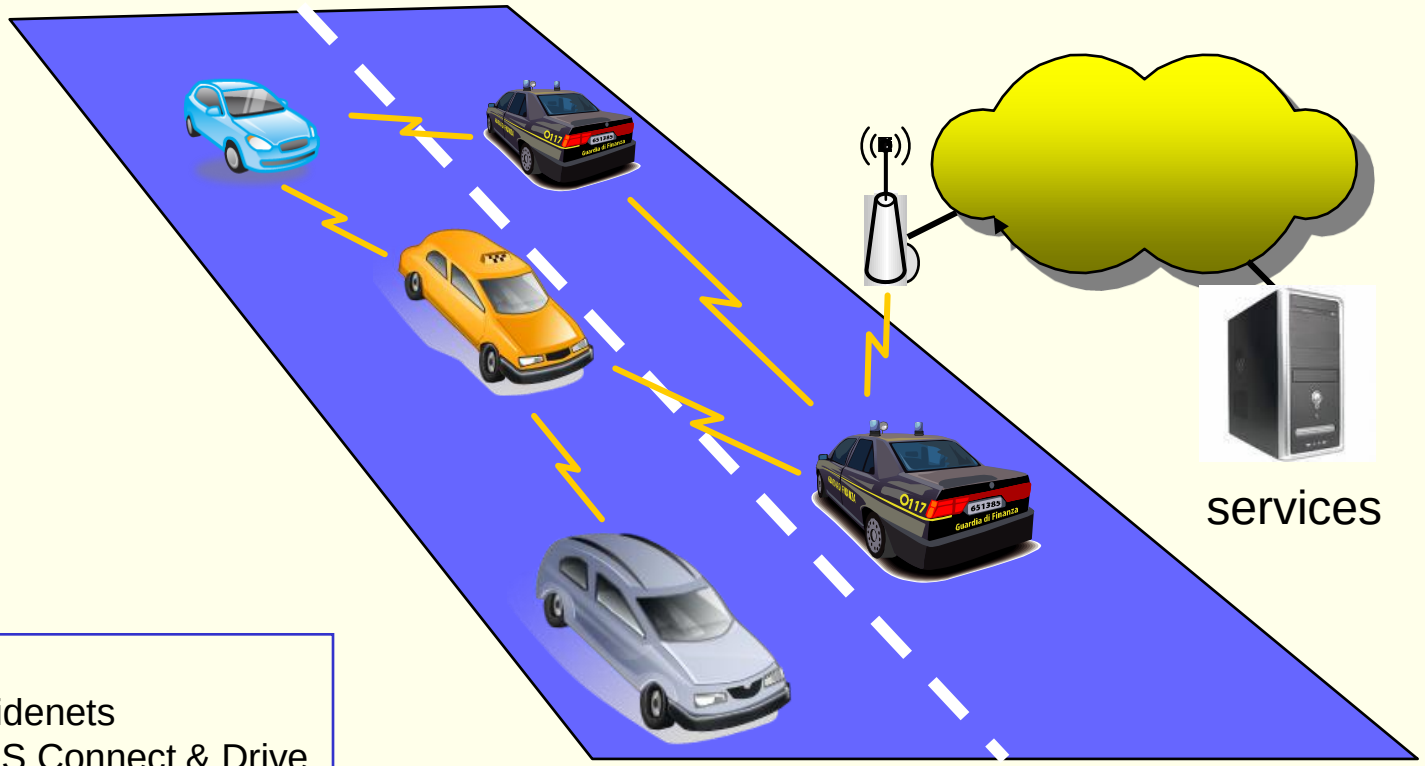


Projects:
ITEA Easy Wireless
Dutch AAF
MEDEA Geodes

Issues

- New demanding applications
  - Exchange of high resolution images
  - Evacuation plans
  - High capacity local and to infrastructure
- Need for robustness in harsh environments
- Traffic prioritization
- Some solutions
  - Use of multiple radio standards
  - Multi-homing
  - Multi-channel multi-radio
  - New routing metrics (cross layer)
- Need of experimental research!!!!

Emerging: Vehicular networks

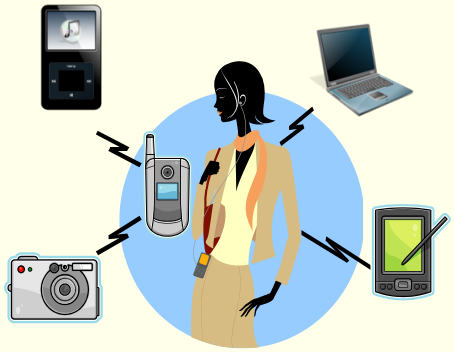


Projects:
IST 6FP Hidenets
Dutch HTAS Connect & Drive
MAIS programme
Corvette Programme

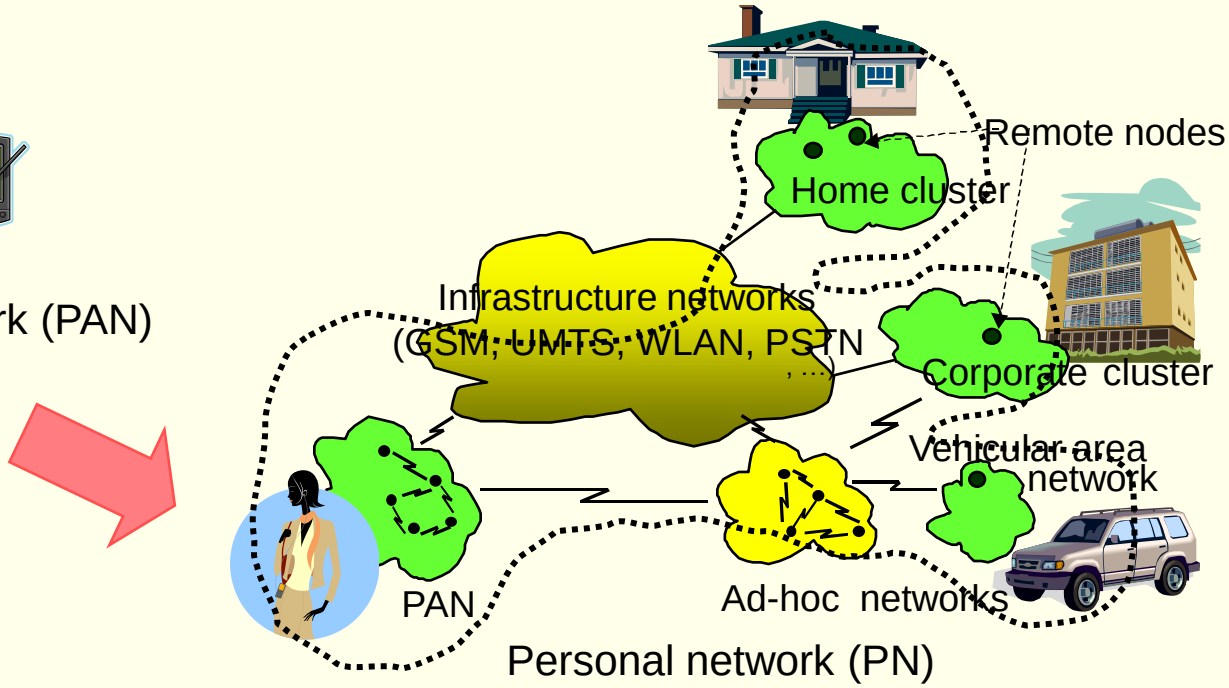
Issues

- Diversity of applications
  - Safety
  - Entertainment
  - Traffic management
    - Cooperative cruise control
    - Reduction of CO2 emission
- Some impose very demanding requirements in terms of availability and robustness of the network

Emerging: From PAN to Personal Networks[1]



Personal area network (PAN)



[1]I.G. Niemegeers and S.M. Heemstra de Groot, *"Research Issues in Ad-Hoc Distributed Personal Networking"*, Special issue of Wireless Personal Communication, Vol. 26, No. 2-3, 2003, pp 149-167.

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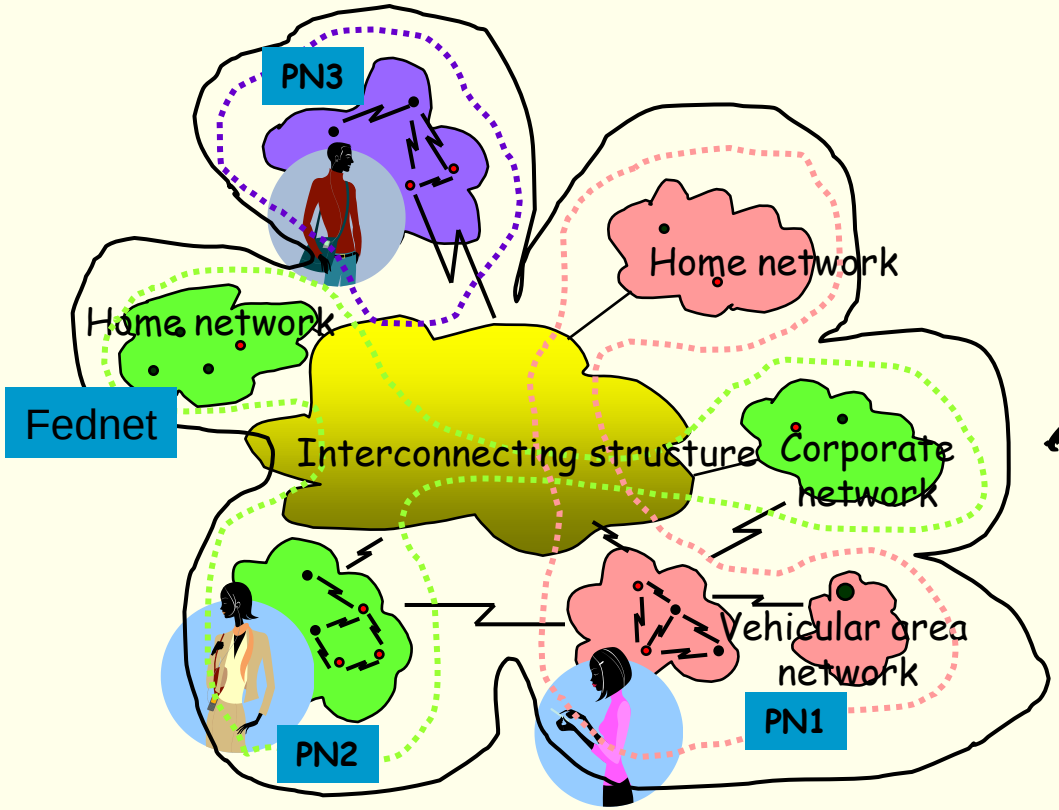
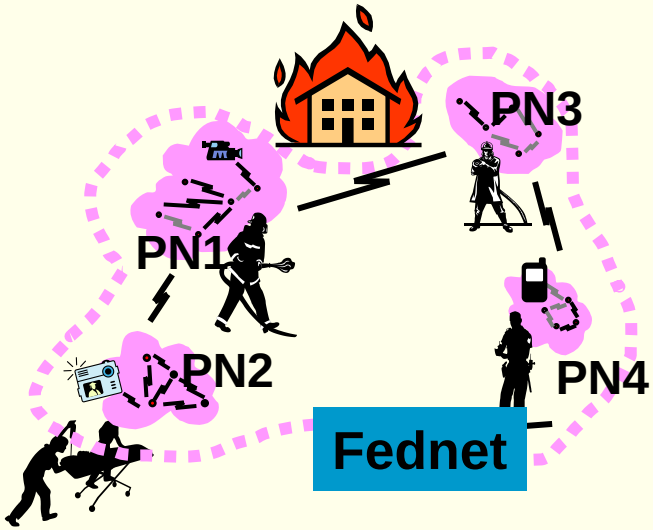
Emerging: the user as service provider (e.g. federation[2] of PNs)





Fednet in emergency operations

Projects:
IST 6FP MAGNET
IST 6 FP MAGNET Beyond
Dutch PNP2008

[2]I.G. Niemegeers and S.M. Heemstra de Groot, "FEDNETS: Context-aware Ad-hoc Network Federations", *International Journal on Wireless Personal Communications*, Volume 33, June 2005, pp.319-325.

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Issues

- New applications
- Mobility support
- Usability

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Future networks

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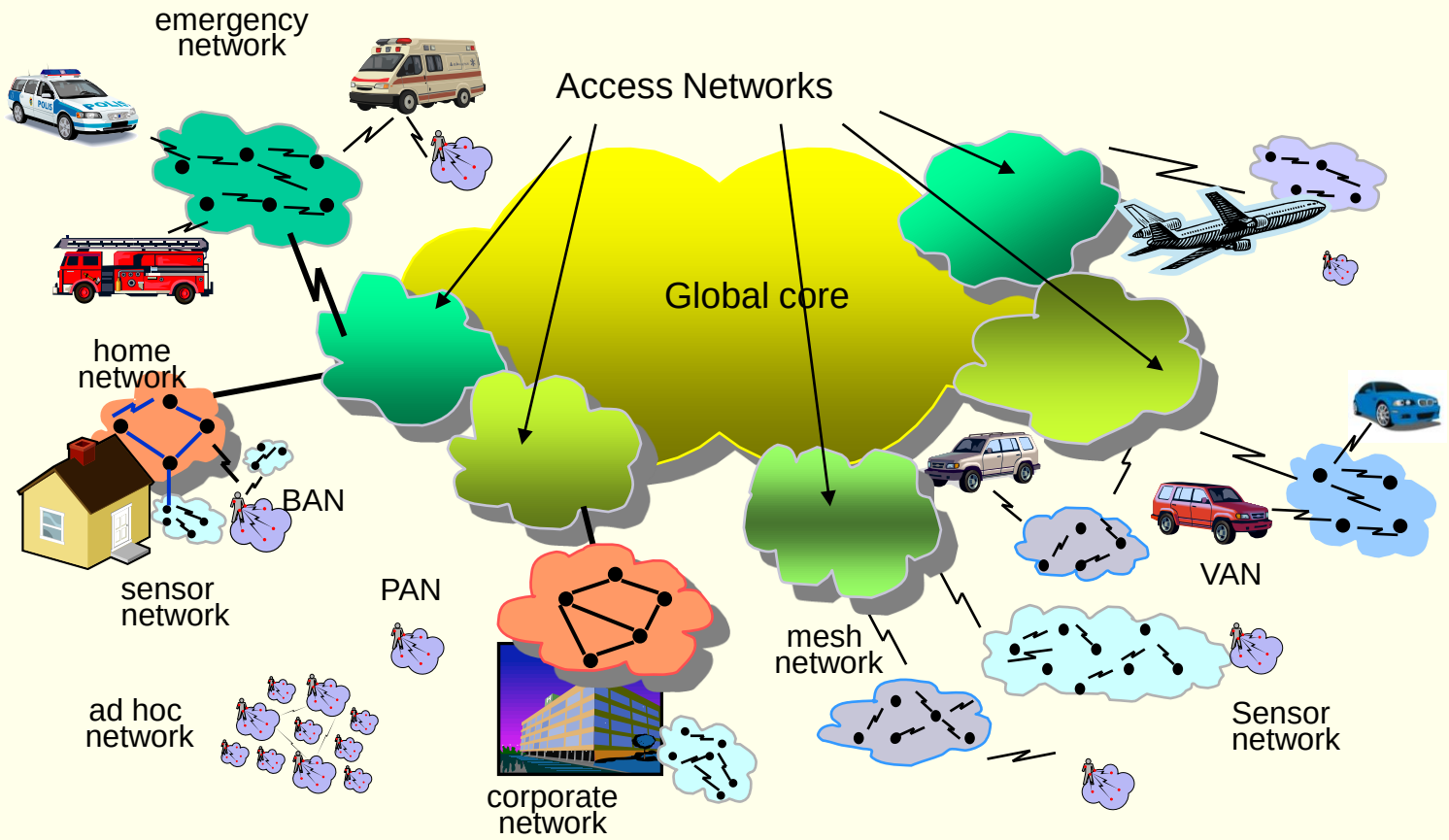
The future wireless world: explosion at the edges



Characteristics of future networks

Periphery, the capillaries of the Internet, is where the "revolution" takes place

- Huge scale: orders of magnitude more communicating devices
- Huge number of "owners" involved (not operators)
- Unplanned and ad-hoc connected
- Heterogeneity:
  - capabilities and characteristics of devices
  - access technologies
  - applications/services, including surge in embedded applications
- Dynamics

This seems bound for future network chaos: scale, competing entities, spectrum, etc.

New and some old concerns

- Manageability
- Ease of use: end user (increasingly no direct end-user, embedded applications)
- Ease of developing applications/services
- Huge capacity increase
- Spectrum usage
- Interference
- Energy concerns
- Health (Radiation)
- Security, dependability, robustness
- Identity management

Helping to address the problems

Some emerging solutions

- Diversity
  - Use of multiple radio channels
  - Use of multiple radio technologies
  - Multi-path routing
  - Multi-homing
- Increase of capacity
  - Hybrid fibre-wireless
  - New radio interfaces
- Cooperation

Fibre -wireless

- Fibre will replace copper in short to mid term (buildings, home, train, ships, car)
- Future broadband access: fibre- wireless combining strength of both technologies
  - WDM + heterogeneous wireless
- Challenges
  - Seamless integration fibre-wireless
  - How to off-load the bandwidth limited wireless network
  - Reconfiguration techniques
  - Energy awareness

Cooperation and cognition in wireless networks(1)

- Cognitive radio
  - For detection of primary users
  - Transmission opportunity exploitation
- Cooperative relaying
  collaboration through distributed transmission and processing
  - (E.g. distributed multiple antenna system, cooperative MAC protocols
  - Advantages
    - Increase of reliability and performance
    - Reduction of transmission power
    - Decrease interference
    - Improve spatial frequency reuse
    - Enlarge transmission range

Cooperation and cognition in wireless networks(2)

- Cognitive and cooperative networks
  - Cooperation and intelligence at all levels of the protocol stack
  - Involving higher layer protocols
  - Exploiting redundancy (e.g. Large cooperative wireless embedded systems, PN technology)
  - Cognitive control plane
  - Cooperation wireless fibre- (new concepts, as e.g. moving cells)

Cooperation and cognition in wireless networks: Issues

- How to perform cooperation?
  - When is cooperation beneficial?
  - Who should help and who not?
  - Can be done in a distributed manner?
- How to enforce cooperation?
  - Incentives
  - How to detected and exclude misbehaving users
- How to implement this in practice?
  - Common control channel?
  - Complexity

Summary

- Ad-hoc infrastructure important emerging wireless technology
- Revolution at the edges (capillaries of the network)
- Two interesting technologies:
  - Fi-Wi
  - Cooperation and cognition
    - Many opportunities for improving network resilience but also new challenges