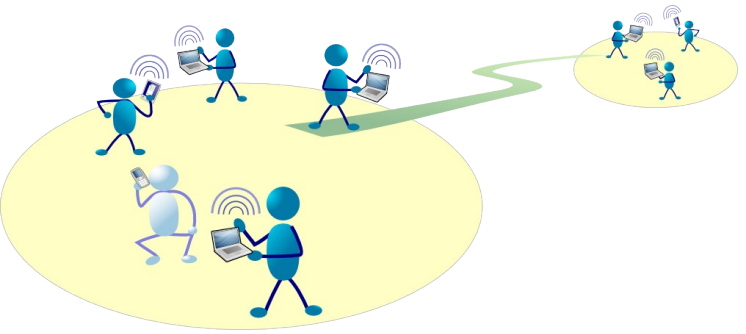
UMR IRISA



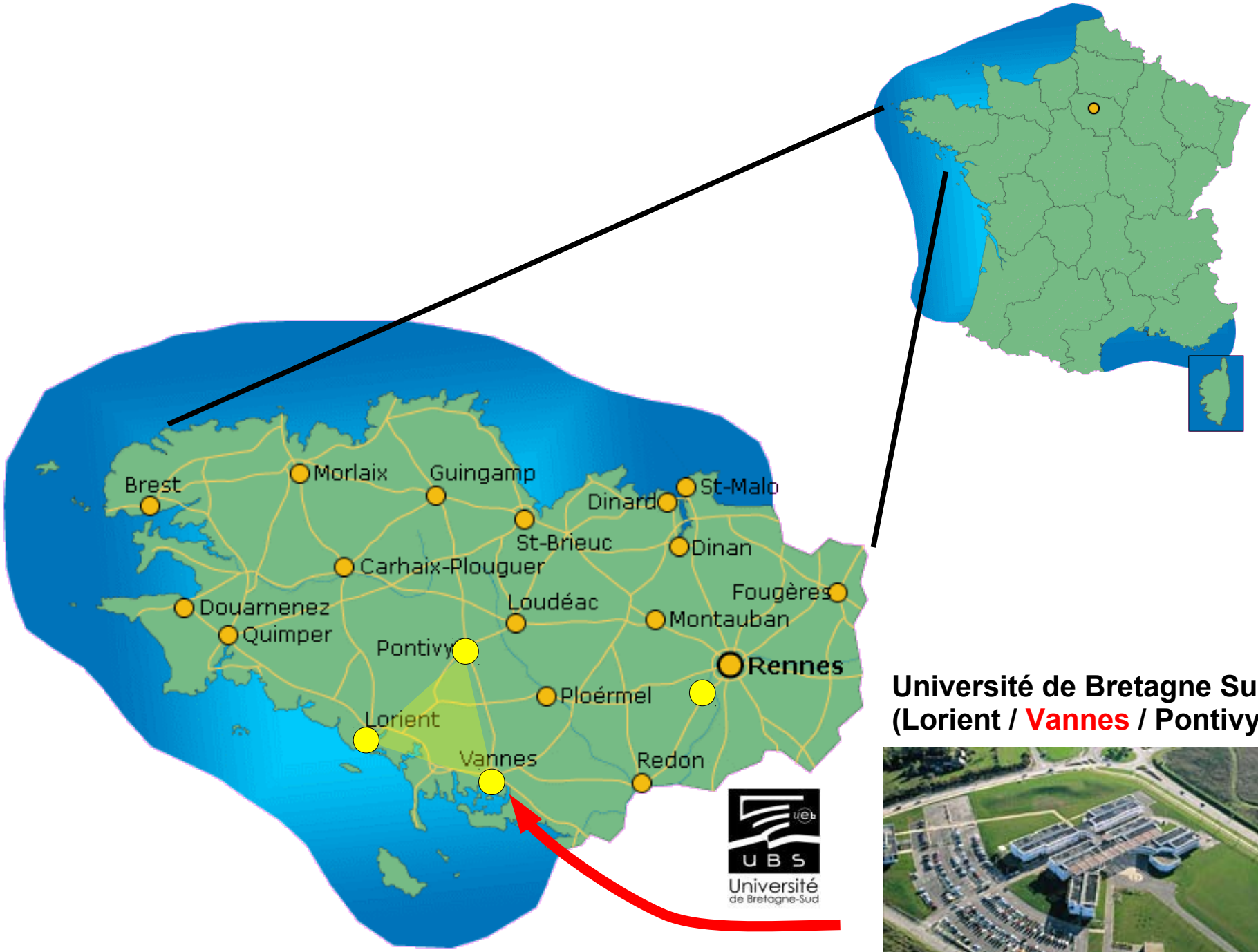
Support for Communication and Services in Disconnected Mobile Ad Hoc Networks

Frédéric Guidec

IRISA lab., CASA Team
Université de Bretagne-Sud (France)

Journées thématiques du département D2 IRISA
Juin 2012

UBS Université de Bretagne-Sud



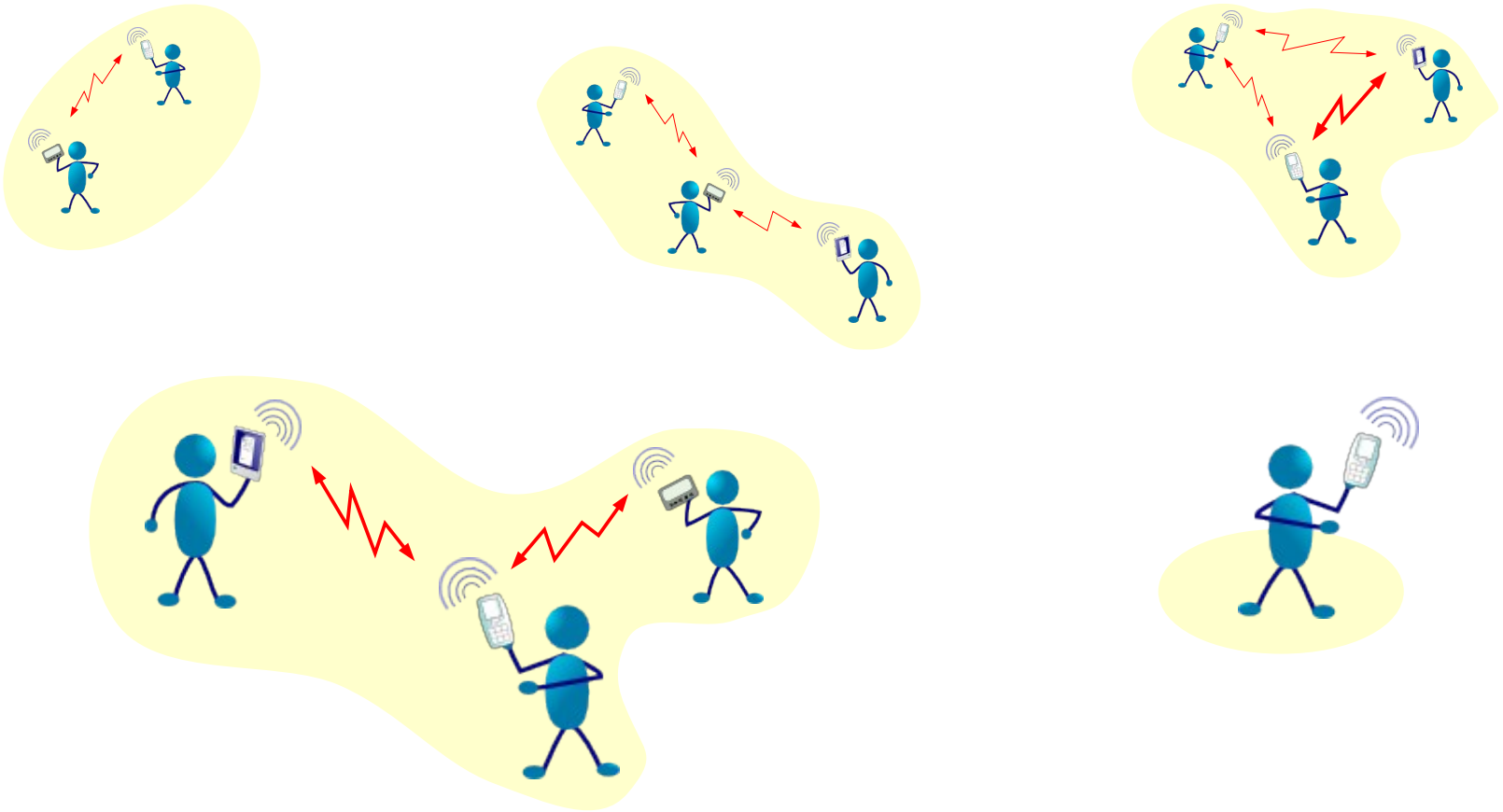
Université de Bretagne Sud
(Lorient / Vannes / Pontivy)

CASA Team

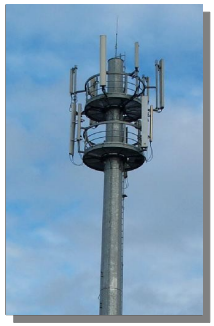
- General research field
  - Support for communication and services on mobile objects involved in partially or intermittently connected networks

- Team members
  - Permanent staff
    - Frédéric Guidec (associate professor, MCF-HDR)
    - Yves Mahéo (associate professor, MCF-HDR)
    - Nicolas Le Sommer (assistant professor, MCF)
    - Pascale Launay (assistant professor, MCF)
    - Frédéric Raimbault (assistant professor, MCF)
  - PhD students
    - Djamel Benferhat (ARED, 3rd year)
    - Ali Makke (MESR/CD56, 2nd year)
    - Abdulkader Benchi (Syrian Govt, 2nd year)
    - Armel Esnault (CDE, since Oct. 2012)

Support for communication and services in partially or intermittently connected mobile ad hoc networks (D-MANETs)

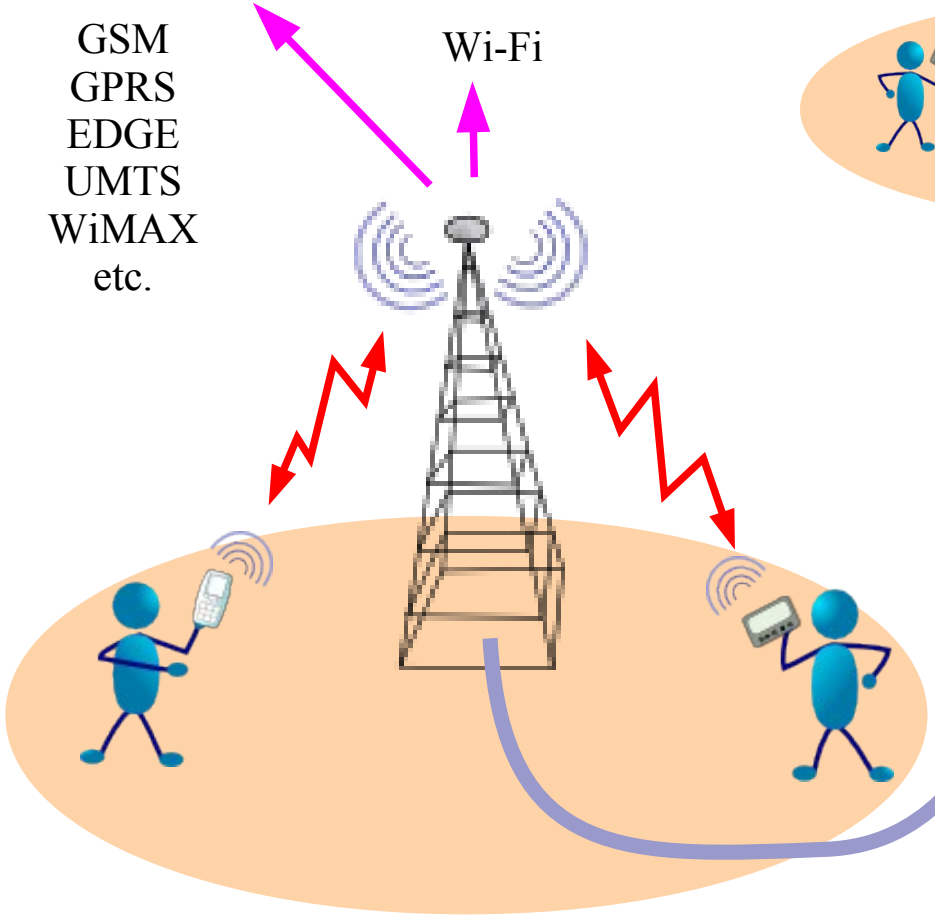


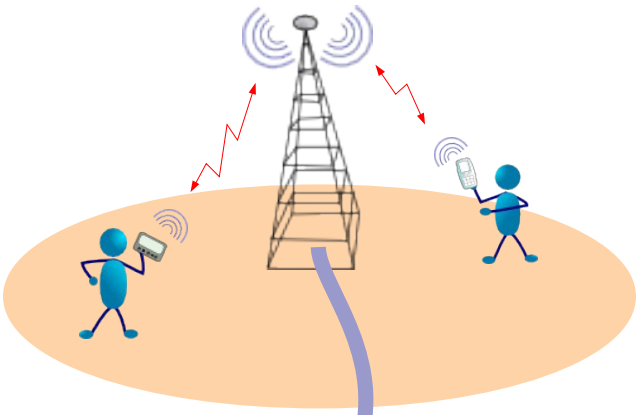
Mobile communication with an infrastructure

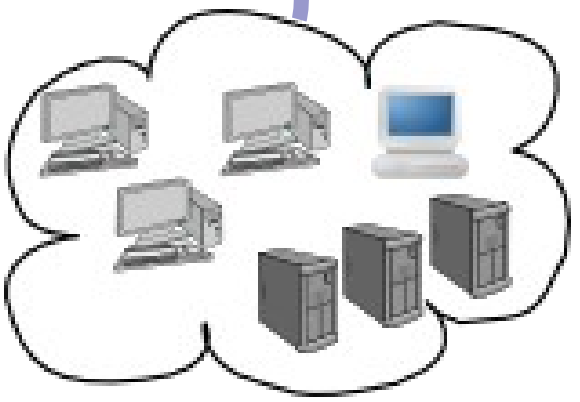


GSM
GPRS
EDGE
UMTS
WiMAX
etc.

Wi-Fi





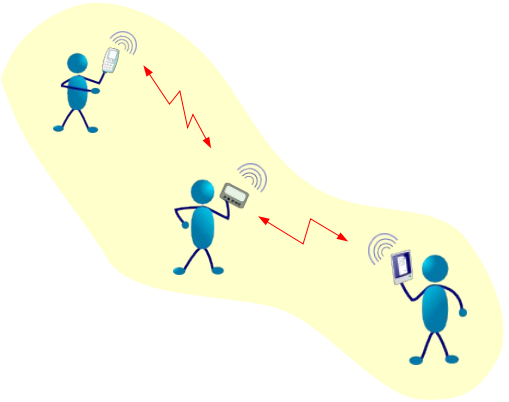


Ad hoc networking:
mobile networking without any infrastructure

MANET: Mobile Ad hoc NETwork

Multi-hop communication possible using dynamic routing protocols (OLSR, AODV, DSR, DYMO, etc.)

When a MANET becomes disconnected...



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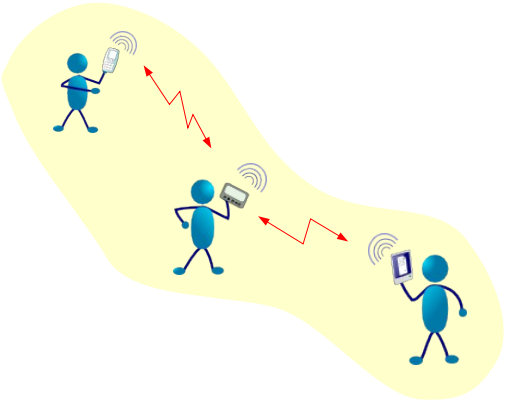
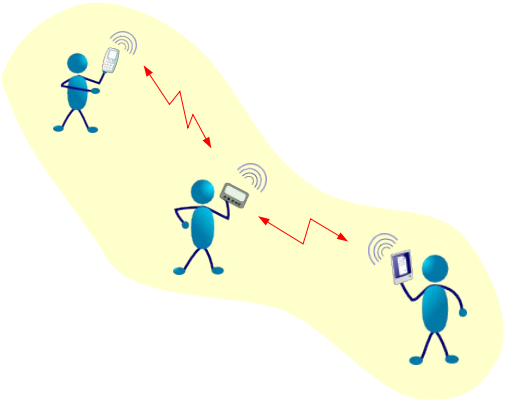


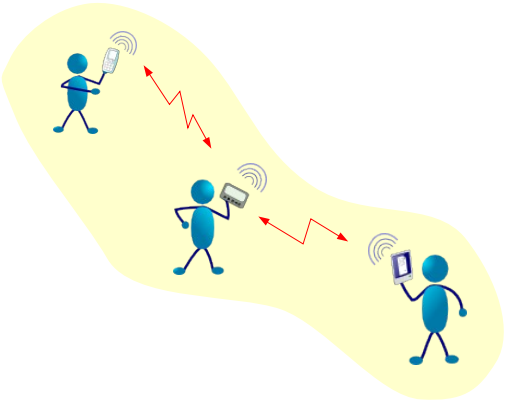
Fragmentation of the network in connectivity « islands »

When a MANET becomes disconnected...



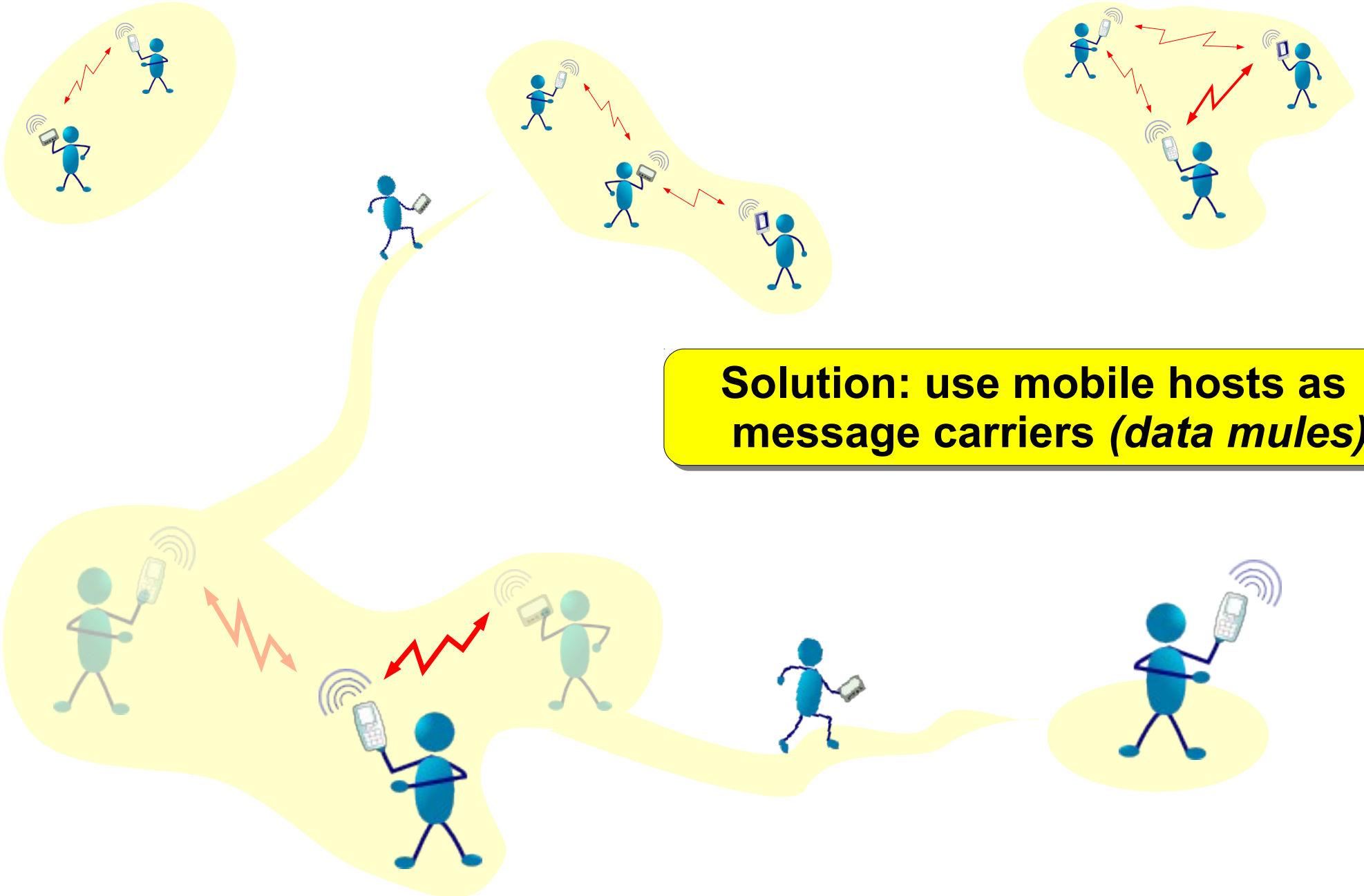
No end-to-end connectivity between different islands

When a MANET becomes disconnected...



Traditional routing protocols (OLSR, DSR, etc.) are useless in such conditiions

When a MANET becomes disconnected...



Solution: use mobile hosts as message carriers *(data mules)*

When a MANET becomes disconnected...

- Each mobile host can...
  - *store* messages for a while
  - *carry* these messages while moving
  - *forward* them to other hosts when circumstances permit

  - *"Store, carry, and forward"* principle

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- *Delay/Disruption-Tolerant Networking (DTN)*
  - ↳ Application to MANETs ~ 2003-2004

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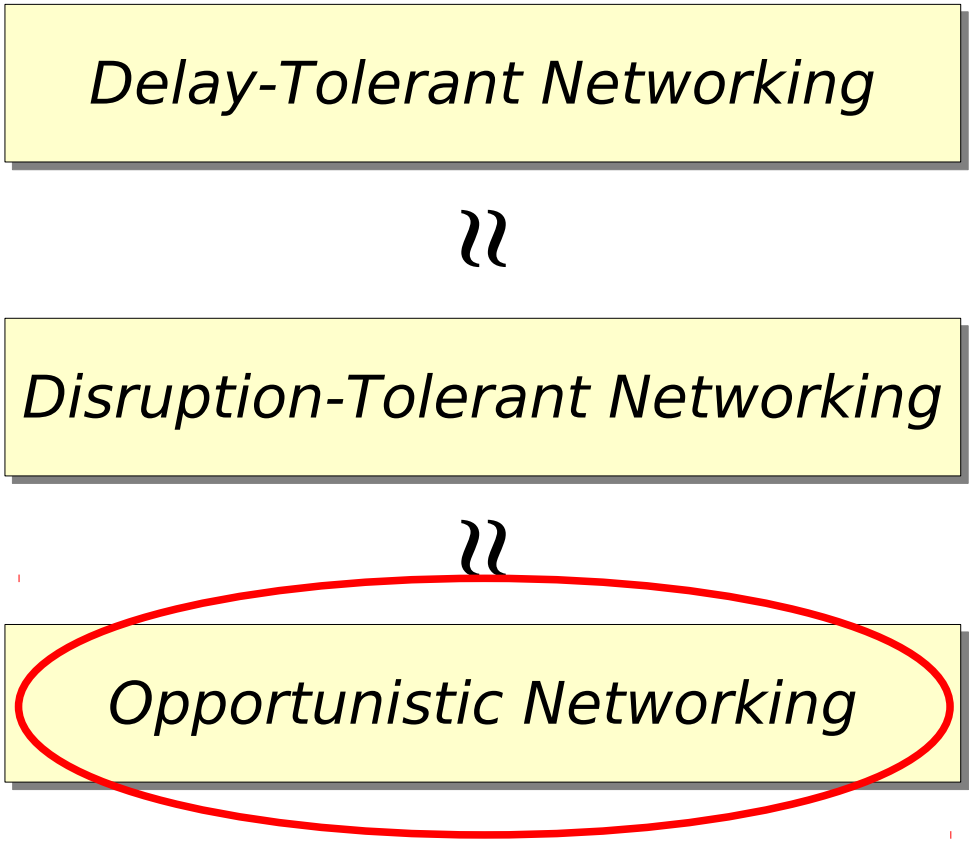
- *Delay/Disruption-Tolerant Networking (DTN)*
  - ↳ Application to MANETs ~ 2003-2004
- *Opportunistic Networking & Opportunistic Computing*

Terminology issue...



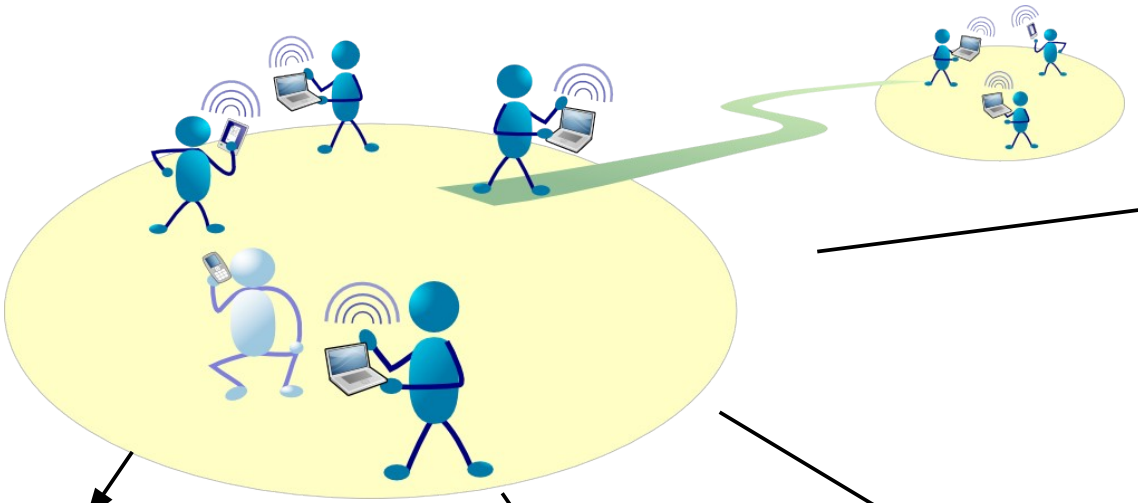
Focus on latency in transmissions
(IPN: Inter-Planetory Networking)

Focus on transmission-link disruptions

Focus on the transient and unpredictable nature of radio contacts

Application of the DTN model in mobile ad hoc networks (including sensor networks)

Possible application fields for opportunistic communication



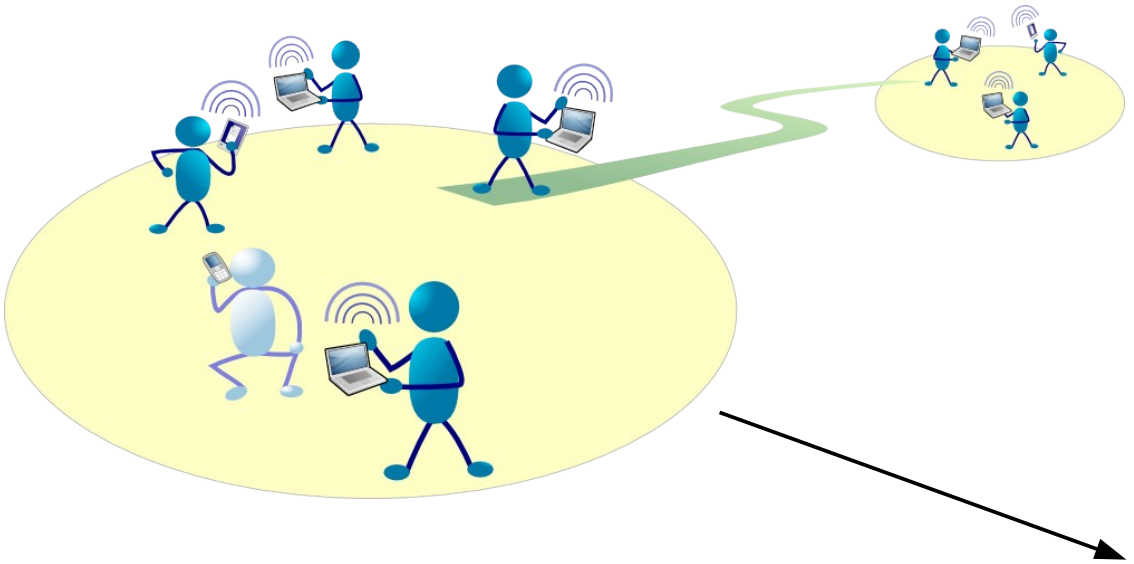
Disaster relief

Inter-vehicle communication

Community/Group/Tribal communication

Field work

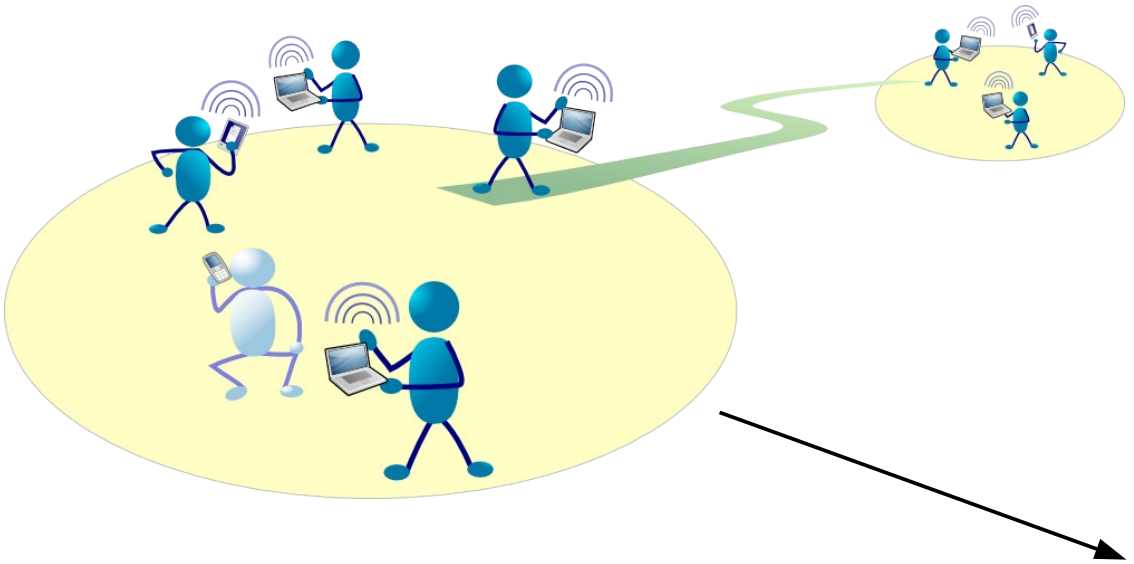
Possible application fields for opportunistic communication



Arab Spring
Tahrir Square, Egypt 2011

Egypt, Jan. 2011: Google services inaccessible during 5 days (source: Renesys + Google Transparency Report)

Possible application fields for opportunistic communication



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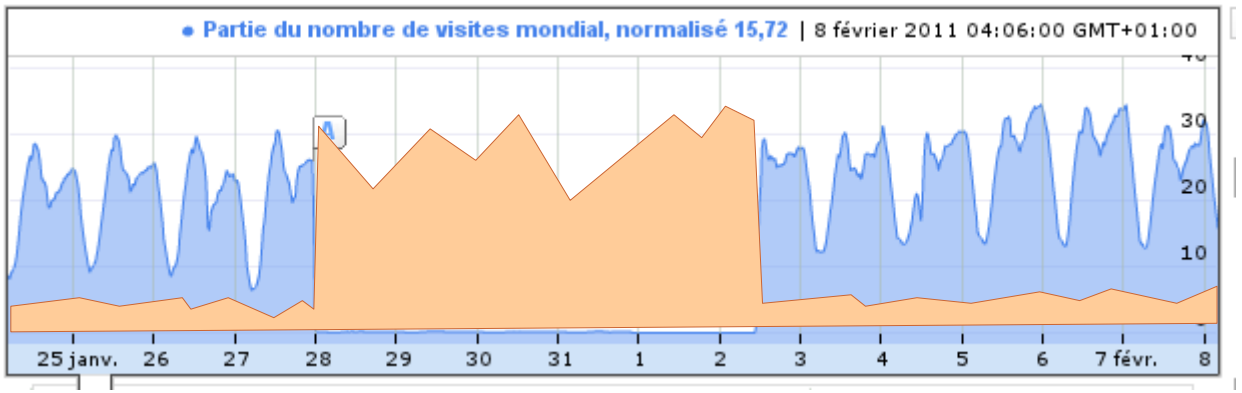
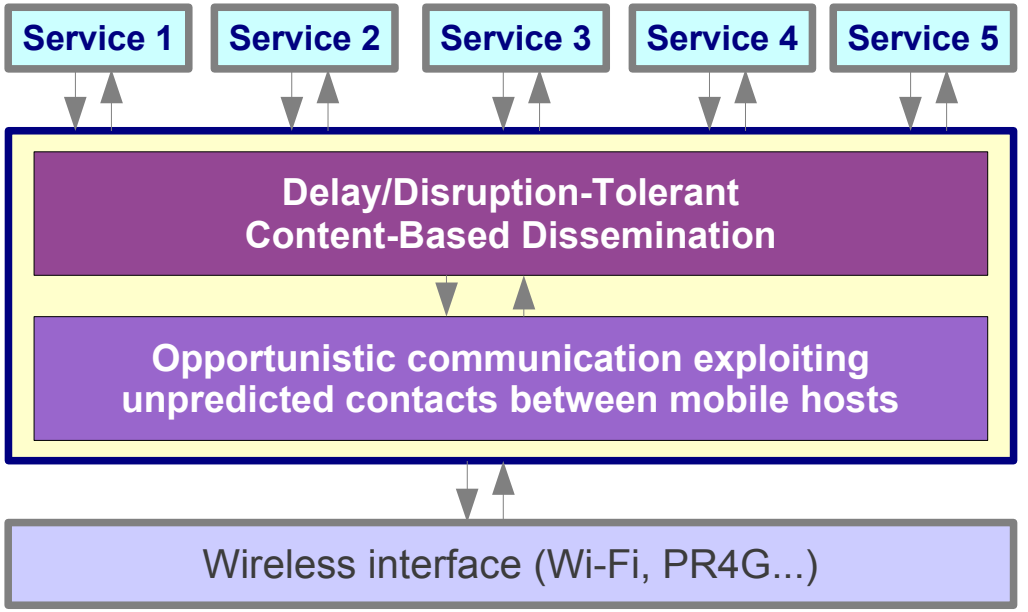


Our activity along this line

- Support for communication in D-MANETs
  - **Epidemic content-based message dissemination**: DoDWAN middleware system
    - 100 % Java code, running on Linux, Windows, Android (distributed under GPL)
- Support for distributed services in D-MANETs
  - **Service advertisement and discovery**: DiSWAN middleware system
  - **Geo-located services**: OLFServ middleware system
  - **Programming abstractions** for the development of distributed applications (thesis in progress)
    - JOMS: JMS *provider* for D-MANETs
    - JION: Java-spaces for D-MANETs
  - Service provision in **hybrid MANETs** (with infostations) (thesis in progress)
- DTN in disconnected wireless sensor networks (D-WSN)
  - **Capture of biometric data** (ECG) on marathon runners (thesis in progress)
    - CoMoBioS project (Communicating Mobile Biometric Sensors)
- Distributed applications for D-MANETs and trials in real conditions
  - E-mail, discussion forums, gaming, filesharing, software updates...

DoDWAN: communication middleware system for disconnected MANETs

- DoDWAN: *Document Dissemination in Wireless mobile Ad hoc Networks*
- Main features
  - Opportunistic **content-based** message dissemination in D-MANETs
  - Deliberately **simple**
    - No assumption on mobility or contact patterns
    - No history of contacts, no contact oracle
    - Epidemic-style moderated by each host's “interest profile”

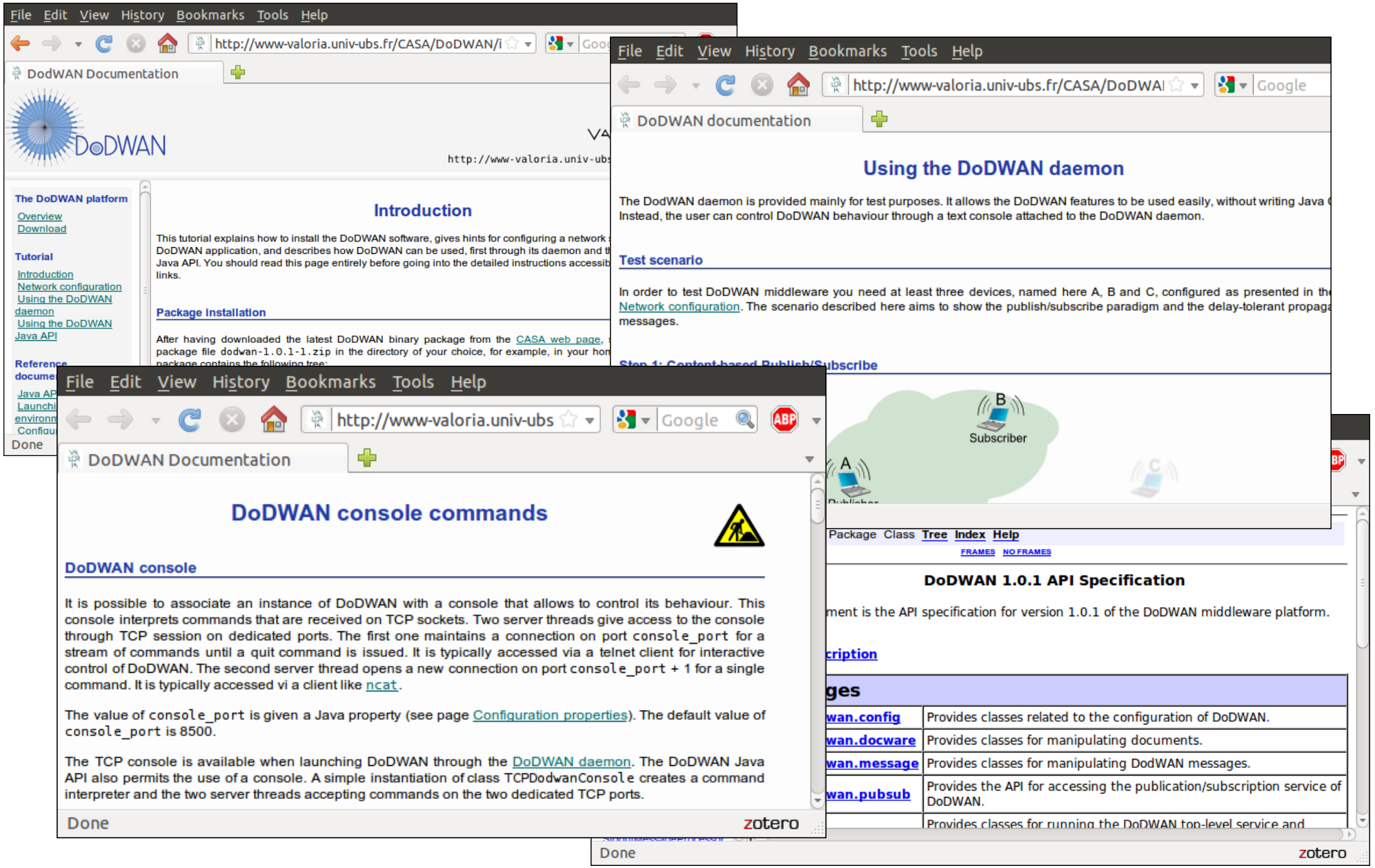


Further details about DoDWAN

- Protocol layering
  - DoDWAN / UDP / IPv4 or IPv6 / IEEE 802.11
    - Also been tested on Bluetooth, Zigbee, and PR4G (tactical battlefield radios)...
- Source code : 100% Java, easily extensible
  - About 170 Java classes, 27.000 lines, 300 kB bytecode
- *Publish/subscribe* API for application services
- Distributed under the GPL licence (source code, sample code, javadoc, tutorial...)
  - http://www-irisa.univ-ubs.fr/CASA/DoDWAN

Open-source distribution of DoDWAN

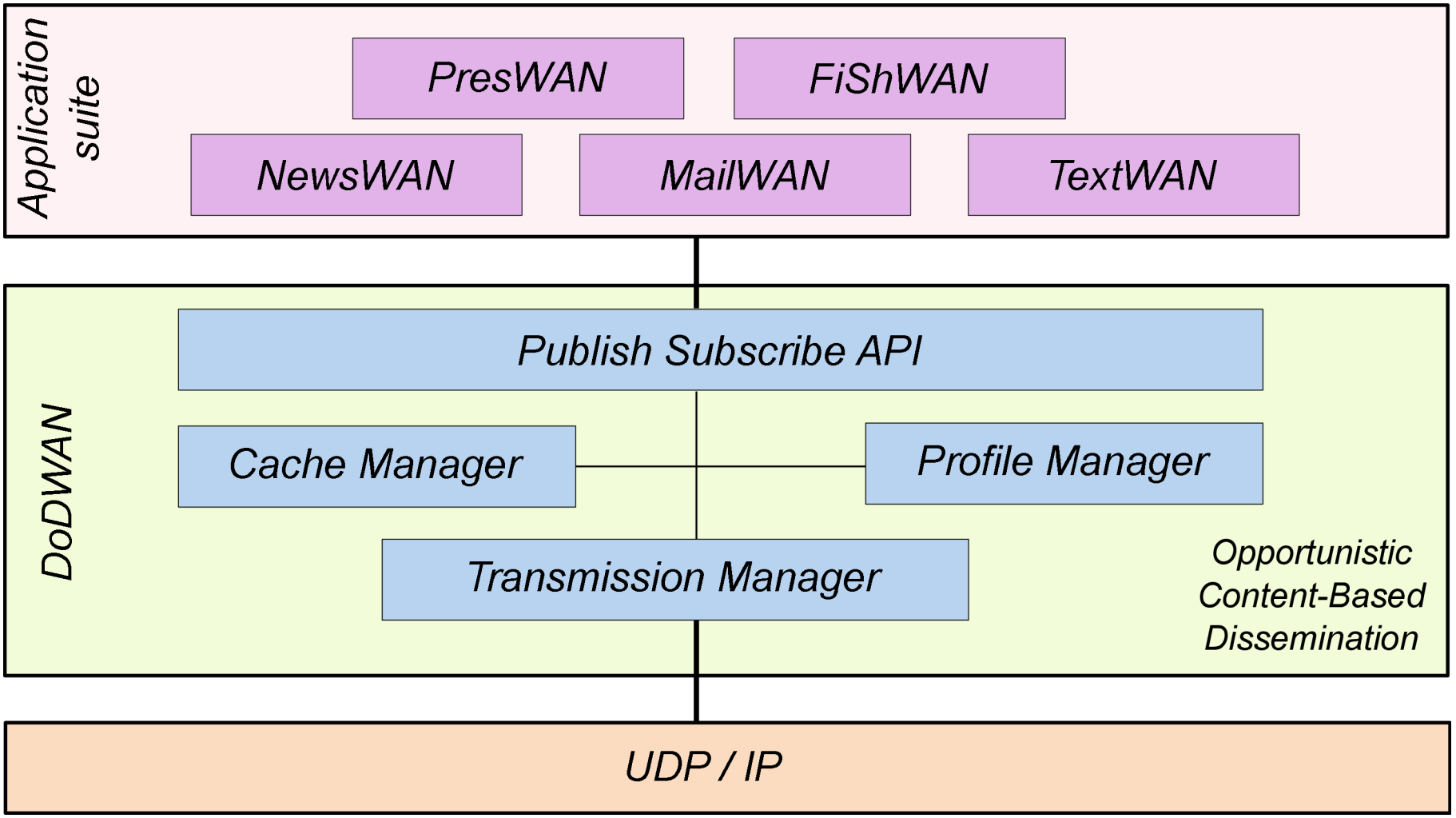
http://www-irisa.univ-ubs.fr/CASA/DoDWAN



DoDWAN-Apps: a delay/disruption-tolerant application suite for disconnected MANETs

- Motivation
  - Running protocols in simulators can bring interesting results
  - Running the same protocols in real conditions can bring a lot more results (but it may be a lot more difficult to achieve!)
    - ↳ Need for real users in a real environment
  - Users do not "run" communication protocols or distributed algorithms: they run applications that rely on these protocols and algorithms
    - ↳ Need for real full-featured applications users can play with
- DoDWAN-Apps: opportunistic computing applications for D-MANETs
  - No client-server model: peer-to-peer model everywhere
  - Delay/disruption tolerance → asynchrony and no (or very loose) consensus

Architecture of DoDWAN-Apps



Overview of DoDWAN-Apps

- PresWAN: visualization of neighbor hosts (or users)
- MailWAN: (peer-to-peer) e-mail
  - SMTP-compliant, usable with a standard SMTP user-agent
  - Peer-to-peer, not client-server!
- NewsWAN: (peer-to-peer) discussion forums
  - NNTP-compliant, usable with a standard NNTP user-agent
  - Peer-to-peer, not client-server!
- FiShWAN: filesharing between mobile hosts
- TextWAN and VoiceWAN: text and voice messaging

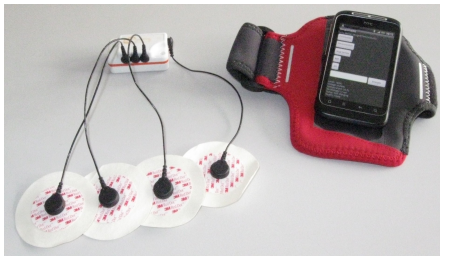
Trials conducted with DoDWAN-Apps

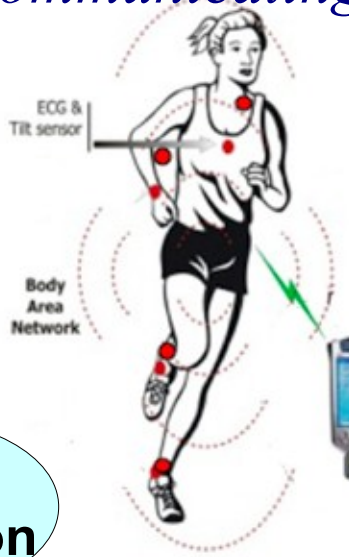
- General context
  - Several trials conducted between 2009 and 2012...
    - ... at École Normale Supérieure de Cachan-Bretagne
    - ... at Université de Bretagne-Sud
    - ... during ExtremeCom'12 in the Swiss Alps
  - Up to 25 volunteers during each trial
  - Duration: between a few days week and 5 months
  - Volunteers equipped with netbooks and/or smartphones running DoDWAN-Apps, and requested to use the available applications as much as possible

- Motivation
  - Collect communication traces and user inputs
  - Observe how DoDWAN's protocol performs in real conditions
  - Observe how users behave in real conditions(!)

Project CoMoBioS

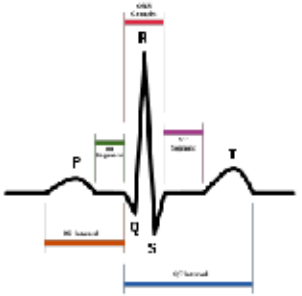
(Communicating Mobile Biometric Sensors)



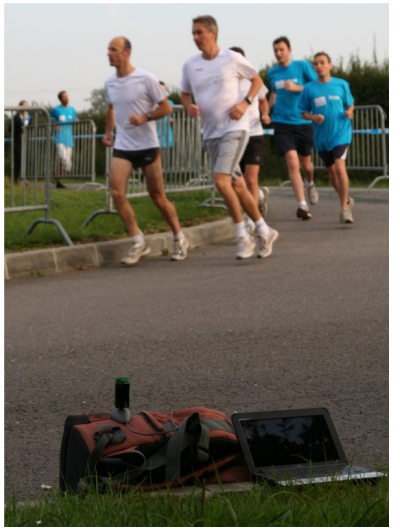


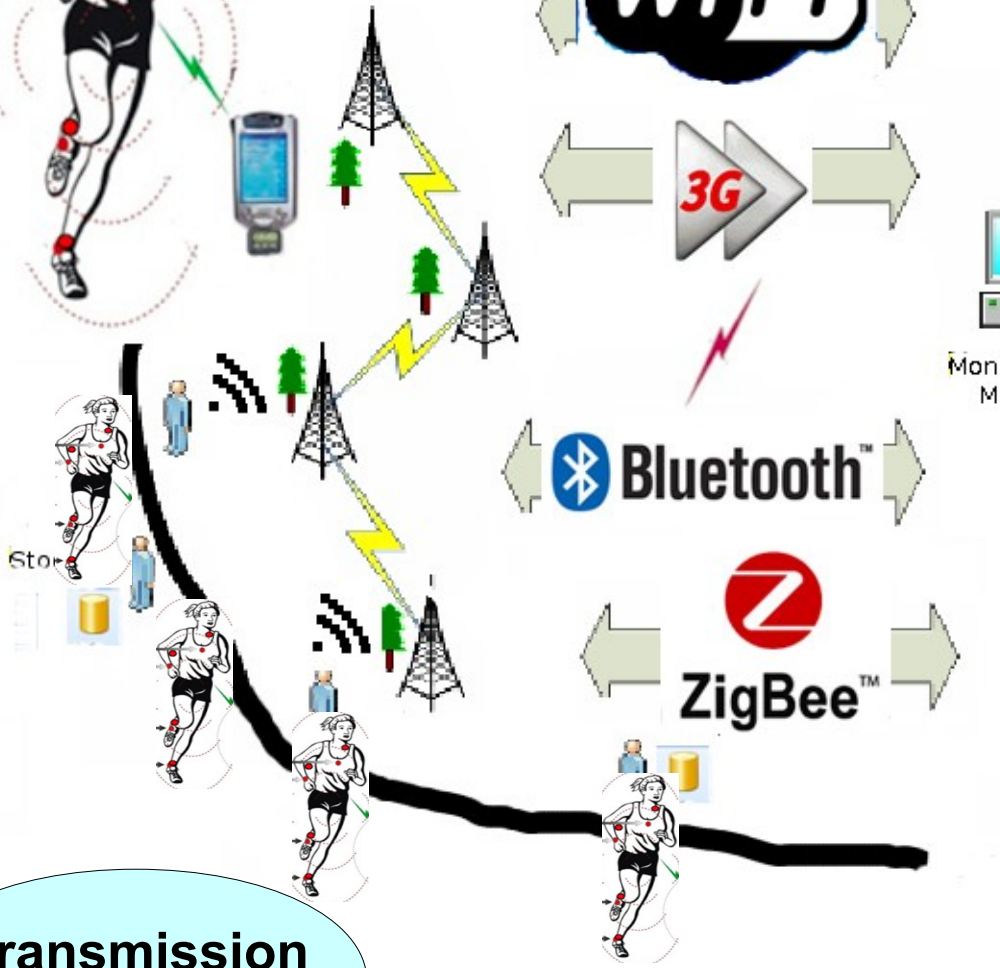
Data Acquisition

Data Processing



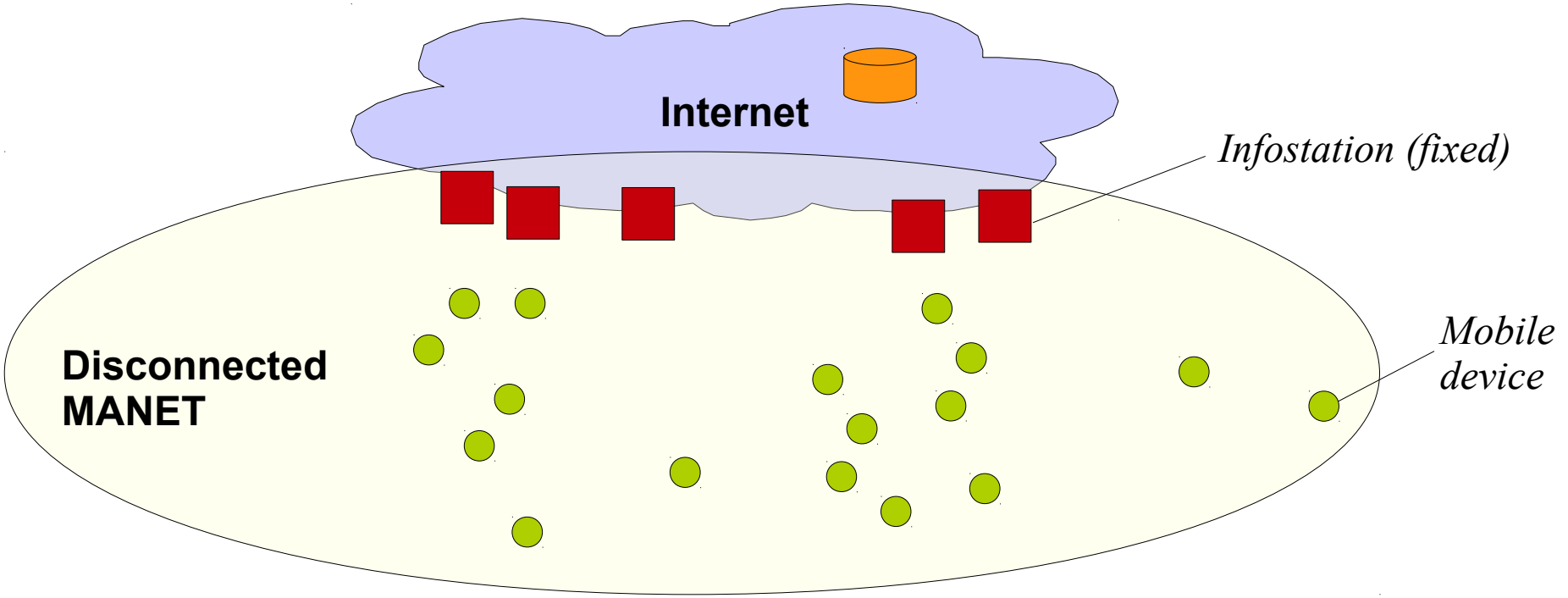
Transmission and/or Storage





Service Provision in "Hybrid" MANETs

- Service providers are part of the infrastructure
- Mobile devices benefit from services through infostations
- The deployment of infostations is not planned (sparse coverage)
- Mobile-infostation communication in opportunistic ad hoc mode
- Cooperation between infostations is possible (though not required)



High-level Programming Abstractions for Opportunistic Computing

- The development of distributed applications for D-MANETs requires elaborate programming tools (beyond the *send/receive* and *publish/subscribe* primitives)

- Need to account for the constraints inherent to opportunistic communication
  - (Highly!) asynchronous
  - *Best effort*

- Investigating abstractions that can help develop distributed applications for D-MANETs
  - Message queues and topics (non-centralized!)
  - Future objects
  - Tuple-space
  - etc.

Ongoing and Future Projects

- CoMoBioS: Communicating Mobile Biometric Sensors
  - EPT PucesCom, 2010-2012
  - UBS, ENS Cachan-Bretagne, M2S
  - Possible sequel with M2S, LTSI...
    - From marathon runners to ambulatory patients

- TACTICS: Tactical Service Oriented Architecture
  - EDA (European Defense Agency), 2012-2015
    - Thales, DGA, FKIE (Allemagne), KTH (Suède), LCI (Pologne)...
  - Service-oriented architecture for tactical networks

- SeaWAN: opportunistic ad hoc communication between ships at sea
  - Negociations in progress
    - IXELEK, NKE, Navix...

http://www-irisa.univ-ubs.fr/CASA