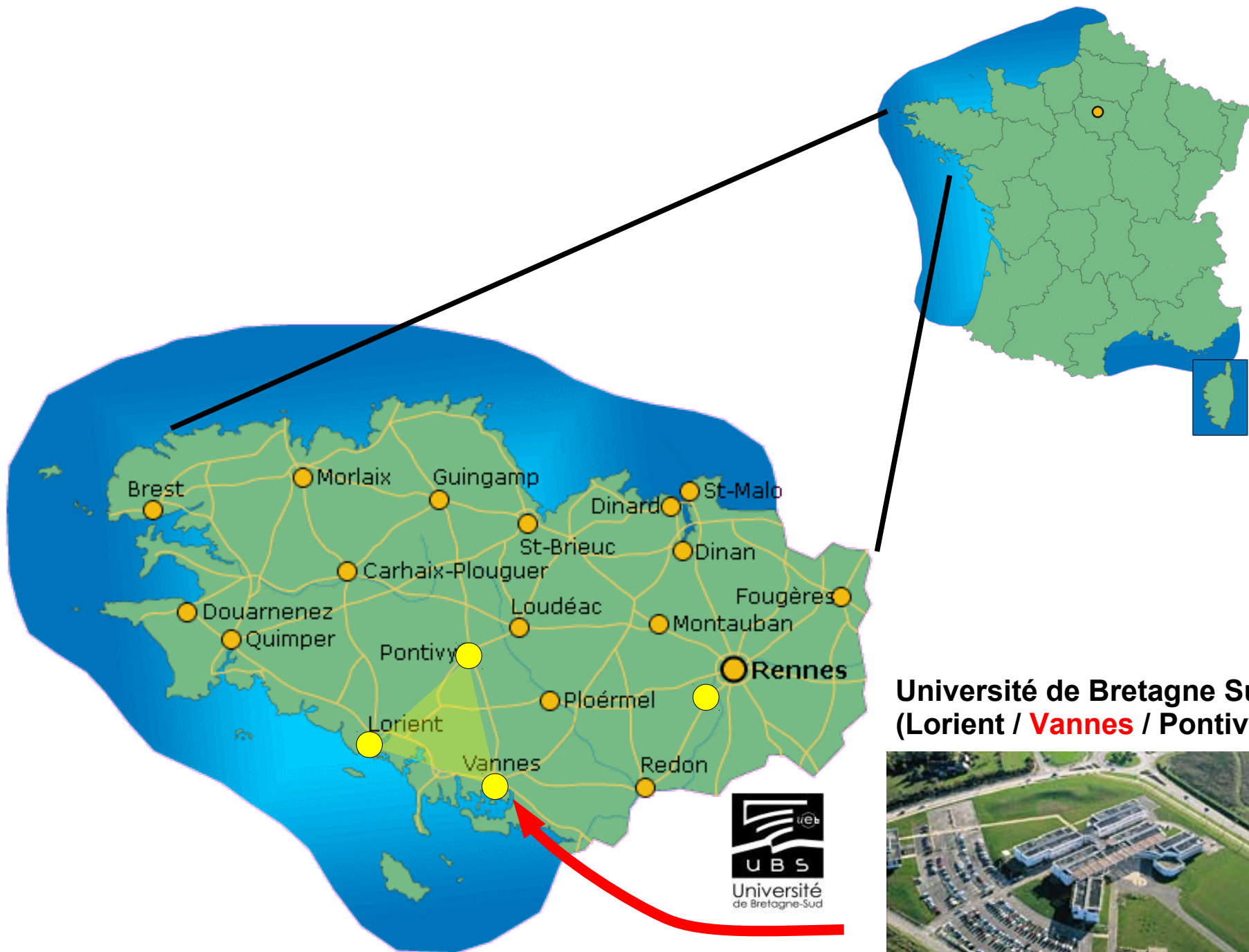


Support for Communication and Services in Disconnected Mobile Ad Hoc Networks

Frédéric Guidec

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

**Journées thématiques du département D2 IRISA
Juin 2012**



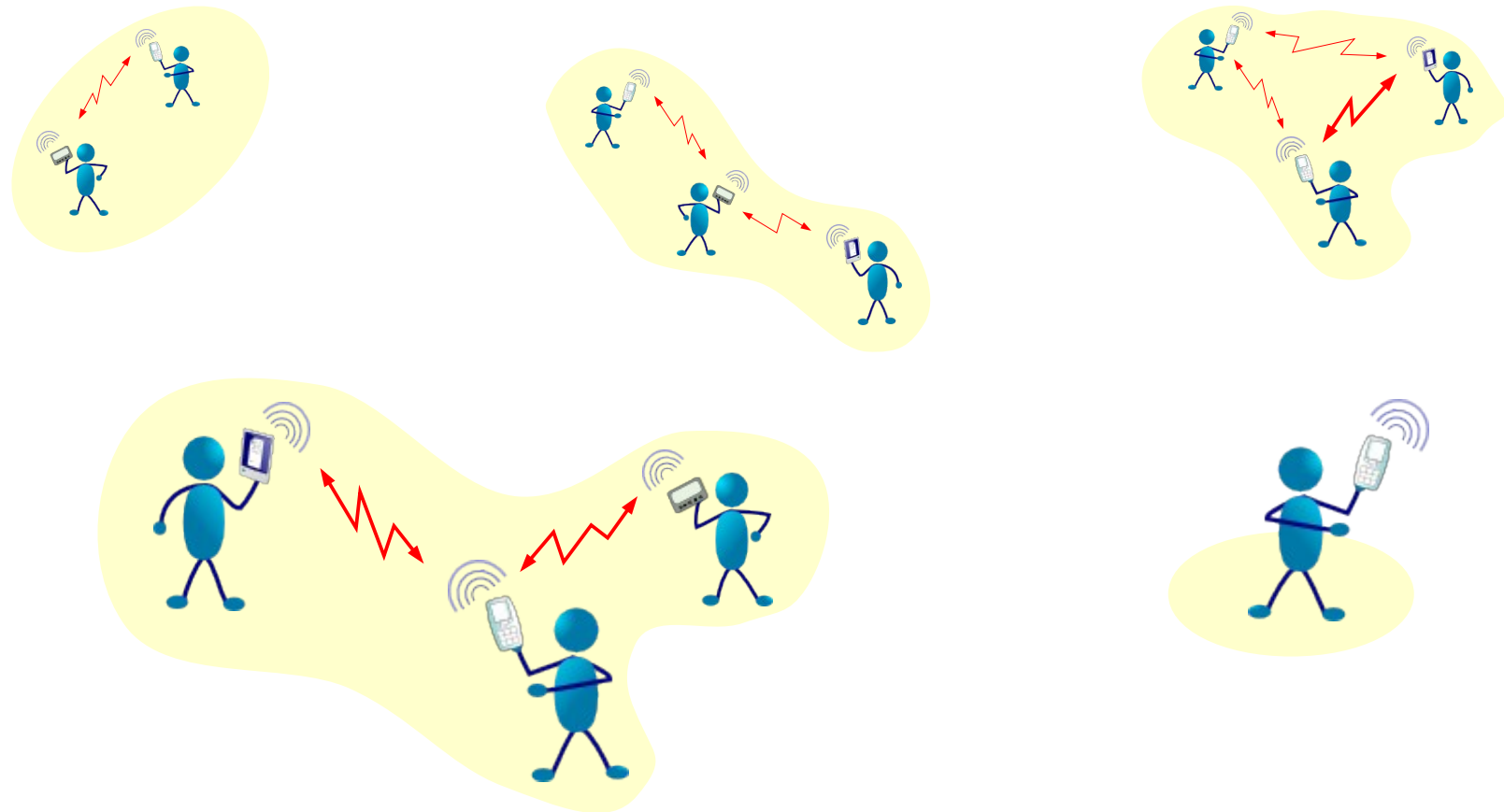
**Université de Bretagne Sud
(Lorient / **Vannes** / Pontivy)**



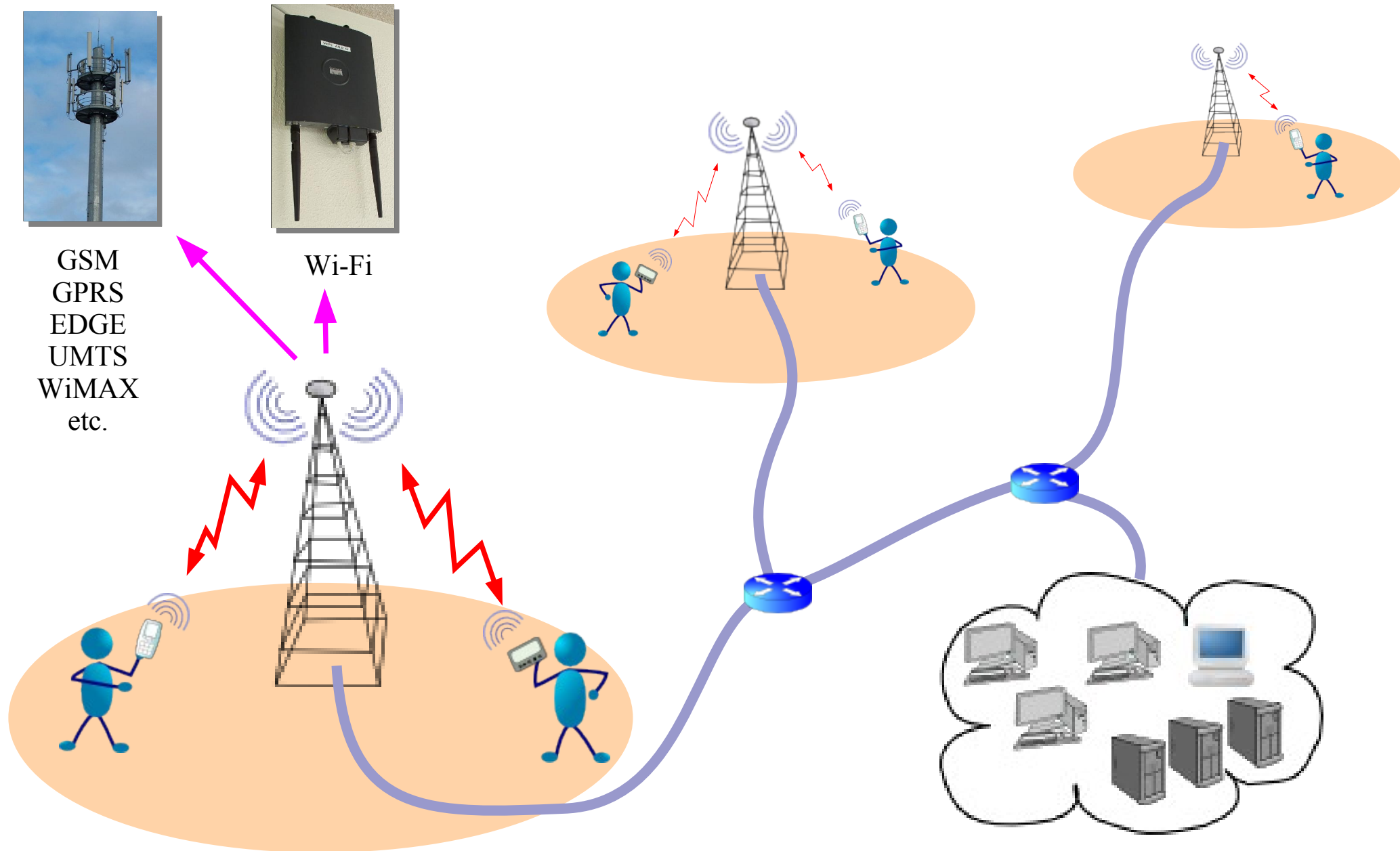
CASA Team

- 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 Gov^t, 2nd year)
 - Armel Esnault (CDE, since Oct. 2012)

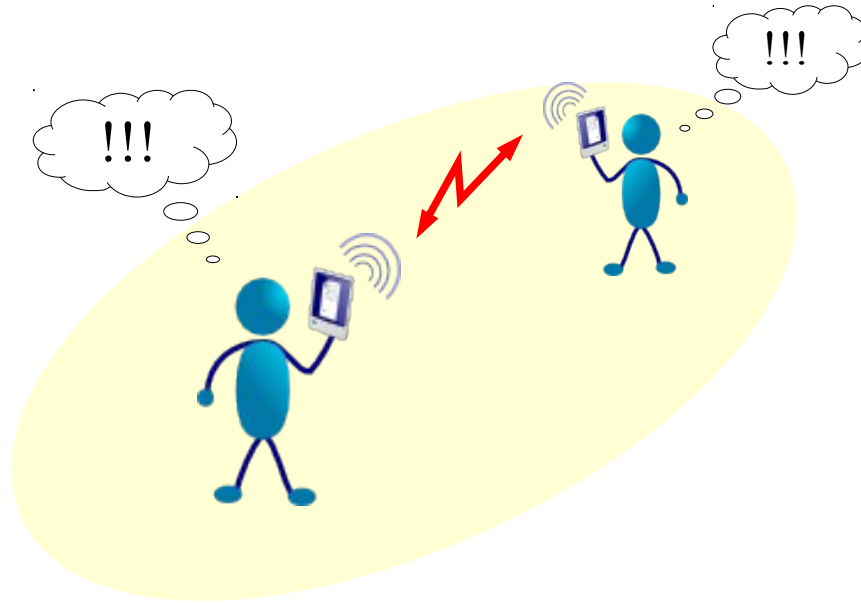
Support for communication and services in partially or intermittently connected mobile ad hoc networks (D-MANETs)



Mobile communication with an infrastructure



Ad hoc networking: mobile networking without any infrastructure

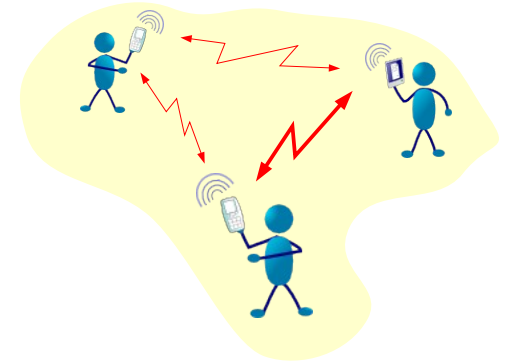


MANET: Mobile Ad hoc NETwork

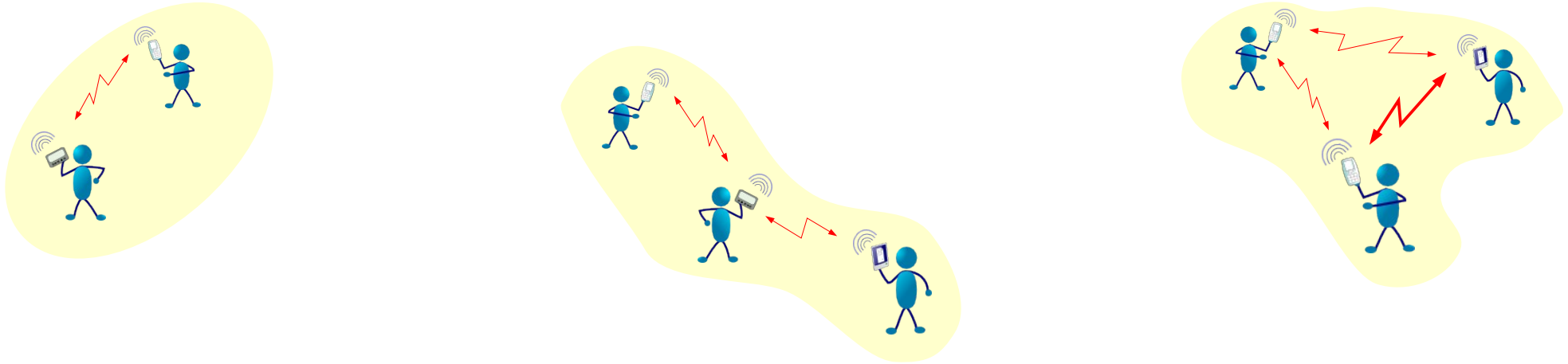


Multi-hop communication possible using dynamic routing protocols (OLSR, AODV, DSR, DYMO, etc.)

When a MANET becomes disconnected...



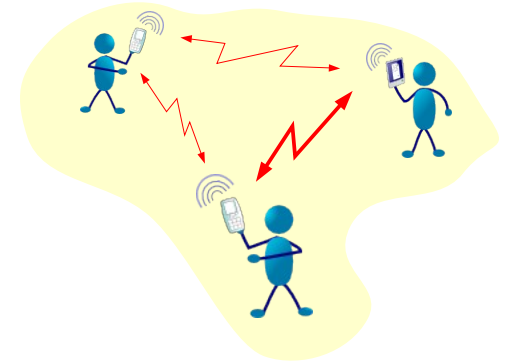
When a MANET becomes disconnected...



**Fragmentation of the network
in connectivity « islands »**



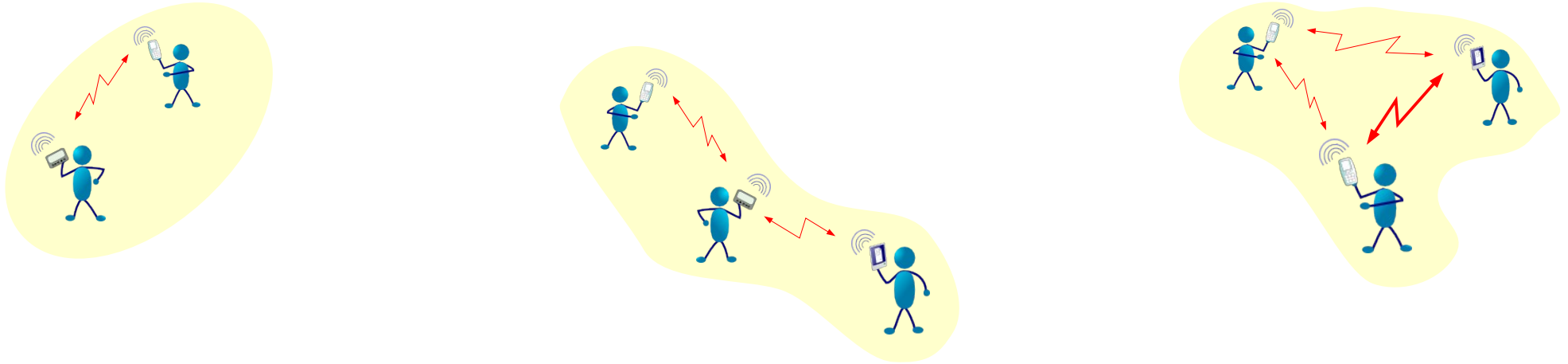
When a MANET becomes disconnected...



**No end-to-end connectivity
between different islands**



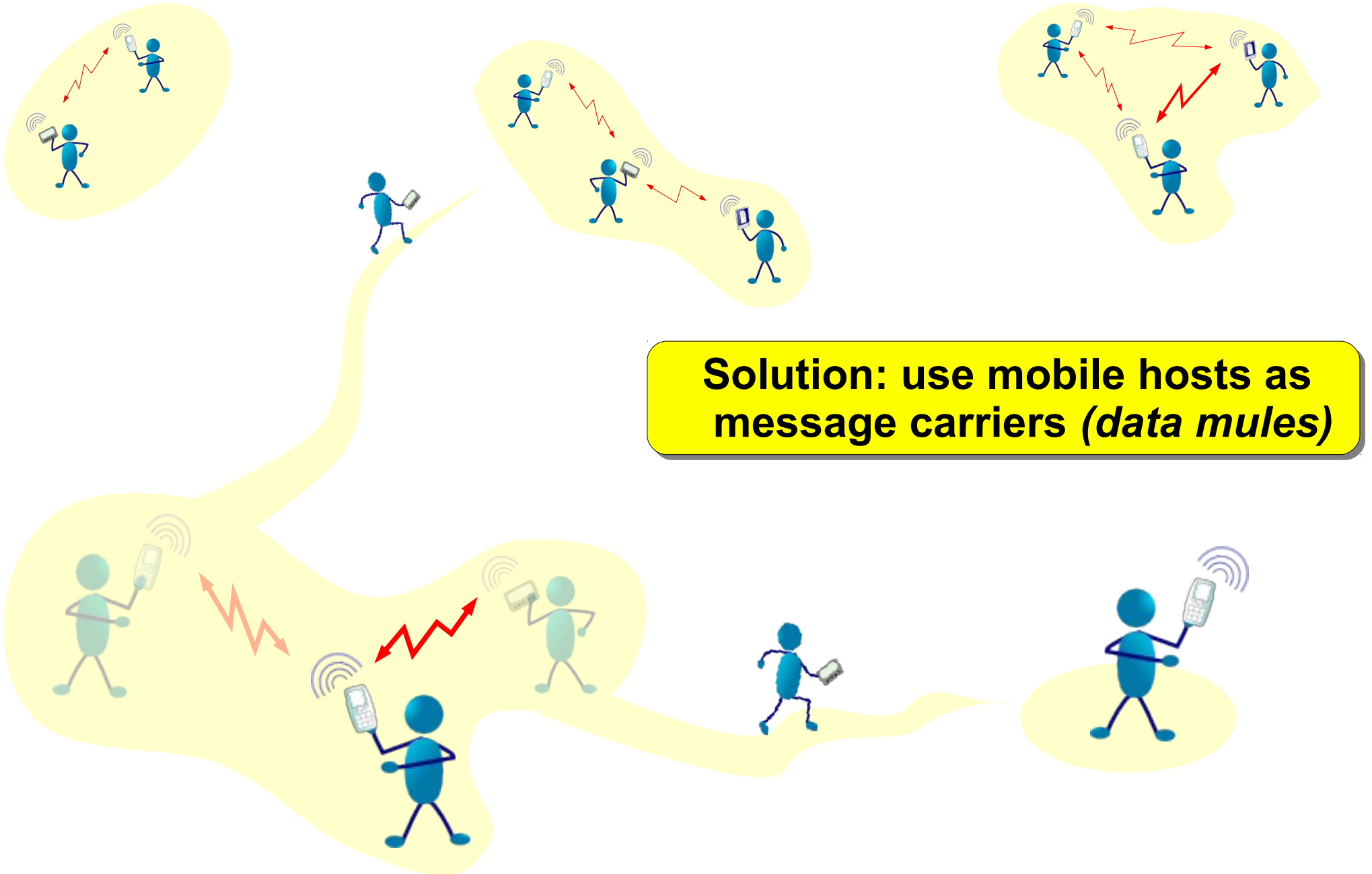
When a MANET becomes disconnected...



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



When a MANET becomes disconnected...



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



When a MANET becomes disconnected...

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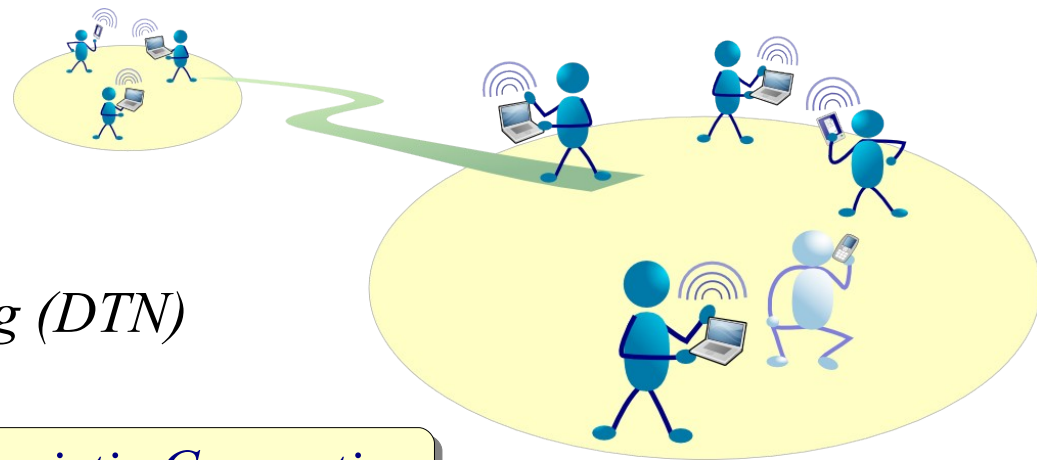
- *Delay/Disruption-Tolerant Networking (DTN)*
 - ↳ Application to MANETs ~ 2003-2004



When a MANET becomes disconnected...

- Each mobile host can...
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- *Delay/Disruption-Tolerant Networking (DTN)*

↳ Application to MANETs ~ 2003-2004

- *Opportunistic Networking & Opportunistic Computing*

Terminology issue...

Delay-Tolerant Networking

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

∪

Disruption-Tolerant Networking

Focus on transmission-link disruptions

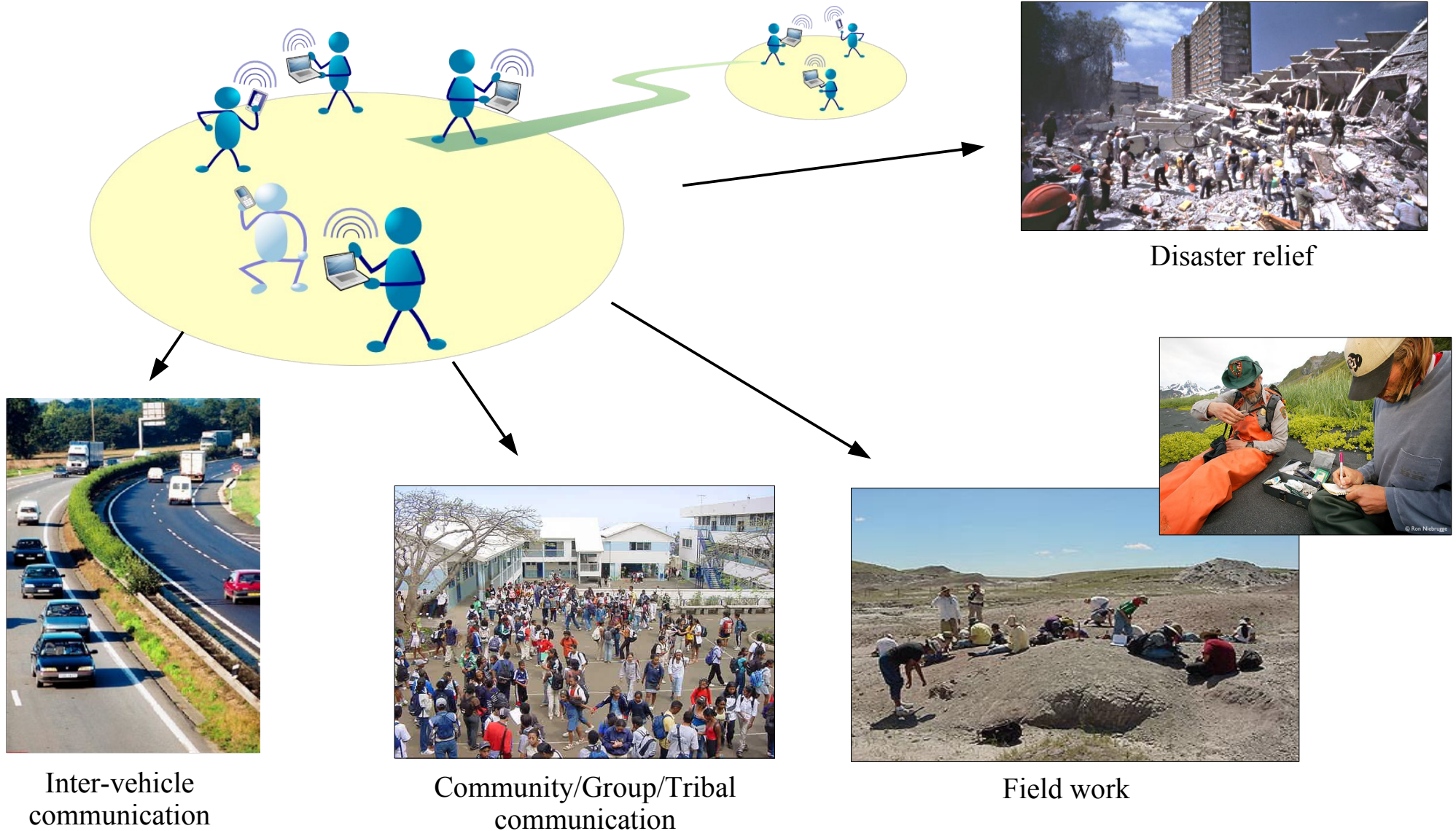
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Opportunistic Networking

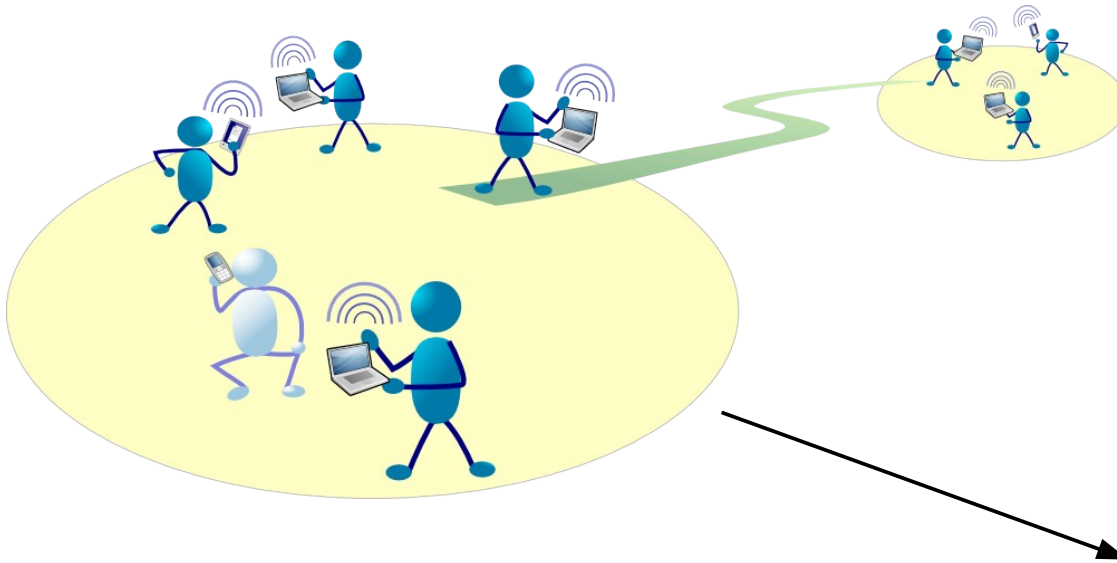
Focus on the transient and unpredictable nature of radio contacts

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

Possible application fields for opportunistic communication



Possible application fields for opportunistic communication

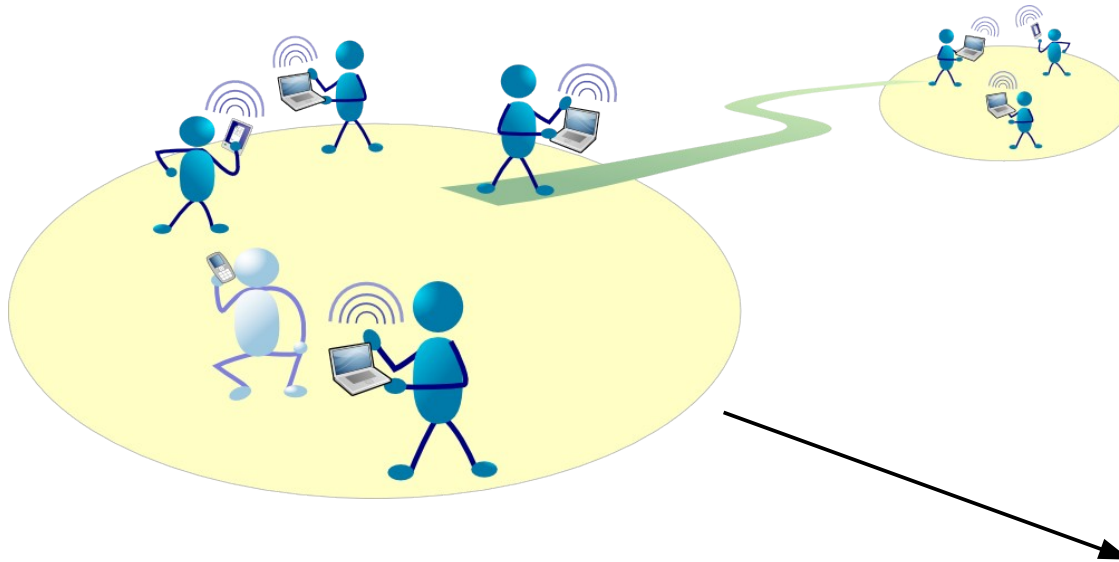


*Egypt, Jan. 2011: Google services inaccessible during 5 days
(source: Renesys + Google Transparency Report)*



*Arab Spring
Tahrir Square, Egypt 2011*

Possible application fields for opportunistic communication



*Egypt, Jan. 2011: Google services inaccessible during 5 days
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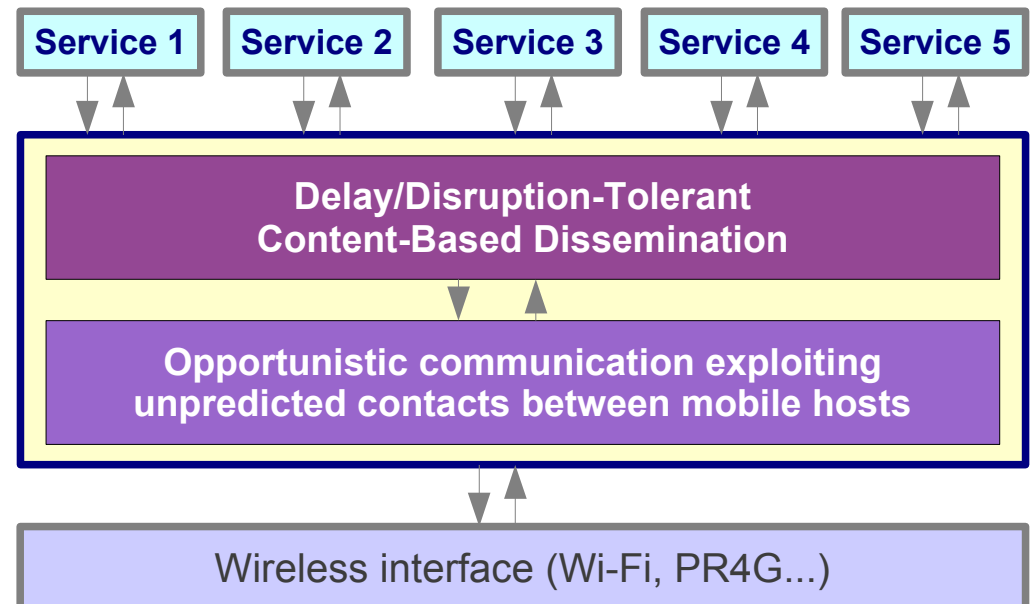
*Arab Spring
Tahrir Square, Egypt 2011*

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>

File Edit View History Bookmarks Tools Help

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

DodWAN Documentation

DoDWAN

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

The DoDWAN platform

Overview

Download

Tutorial

Introduction

Network configuration

Using the DoDWAN daemon

Using the DoDWAN Java API

Reference documents

Java API

Launching the environment

Configuration

Done

Introduction

This tutorial explains how to install the DoDWAN software, gives hints for configuring a network DoDWAN application, and describes how DoDWAN can be used, first through its daemon and then through the Java API. You should read this page entirely before going into the detailed instructions accessible through the links.

Package installation

After having downloaded the latest DoDWAN binary package from the [CASA web page](#), the package file `dodwan-1.0.1-1.zip` in the directory of your choice, for example, in your home directory, you should extract the package contents in the following way:

DoDWAN console commands

DoDWAN console

It is possible to associate an instance of DoDWAN with a console that allows to control its behaviour. This console interprets commands that are received on TCP sockets. Two server threads give access to the console through TCP session on dedicated ports. The first one maintains a connection on port `console_port` for a stream of commands until a quit command is issued. It is typically accessed via a telnet client for interactive control of DoDWAN. The second server thread opens a new connection on port `console_port + 1` for a single command. It is typically accessed via a client like [ncat](#).

The value of `console_port` is given a Java property (see page [Configuration properties](#)). The default value of `console_port` is 8500.

The TCP console is available when launching DoDWAN through the [DoDWAN daemon](#). The DoDWAN Java API also permits the use of a console. A simple instantiation of class `TCPDoDwanConsole` creates a command interpreter and the two server threads accepting commands on the two dedicated TCP ports.

Using the DoDWAN daemon

The DoDWAN daemon is provided mainly for test purposes. It allows the DoDWAN features to be used easily, without writing Java code. Instead, the user can control DoDWAN behaviour through a text console attached to the DoDWAN daemon.

Test scenario

In order to test DoDWAN middleware you need at least three devices, named here A, B and C, configured as presented in the [Network configuration](#). The scenario described here aims to show the publish/subscribe paradigm and the delay-tolerant propagation of messages.

Step 1: Content-based Publish/Subscribe

Subscriber

DoDWAN 1.0.1 API Specification

Document is the API specification for version 1.0.1 of the DoDWAN middleware platform.

Description

Package	Class	Tree	Index	Help
wan.config	Provides classes related to the configuration of DoDWAN.			
wan.docware	Provides classes for manipulating documents.			
wan.message	Provides classes for manipulating DoDWAN messages.			
wan.pubsub	Provides the API for accessing the publication/subscription service of DoDWAN.			
	Provides classes for running the DoDWAN top-level service and			

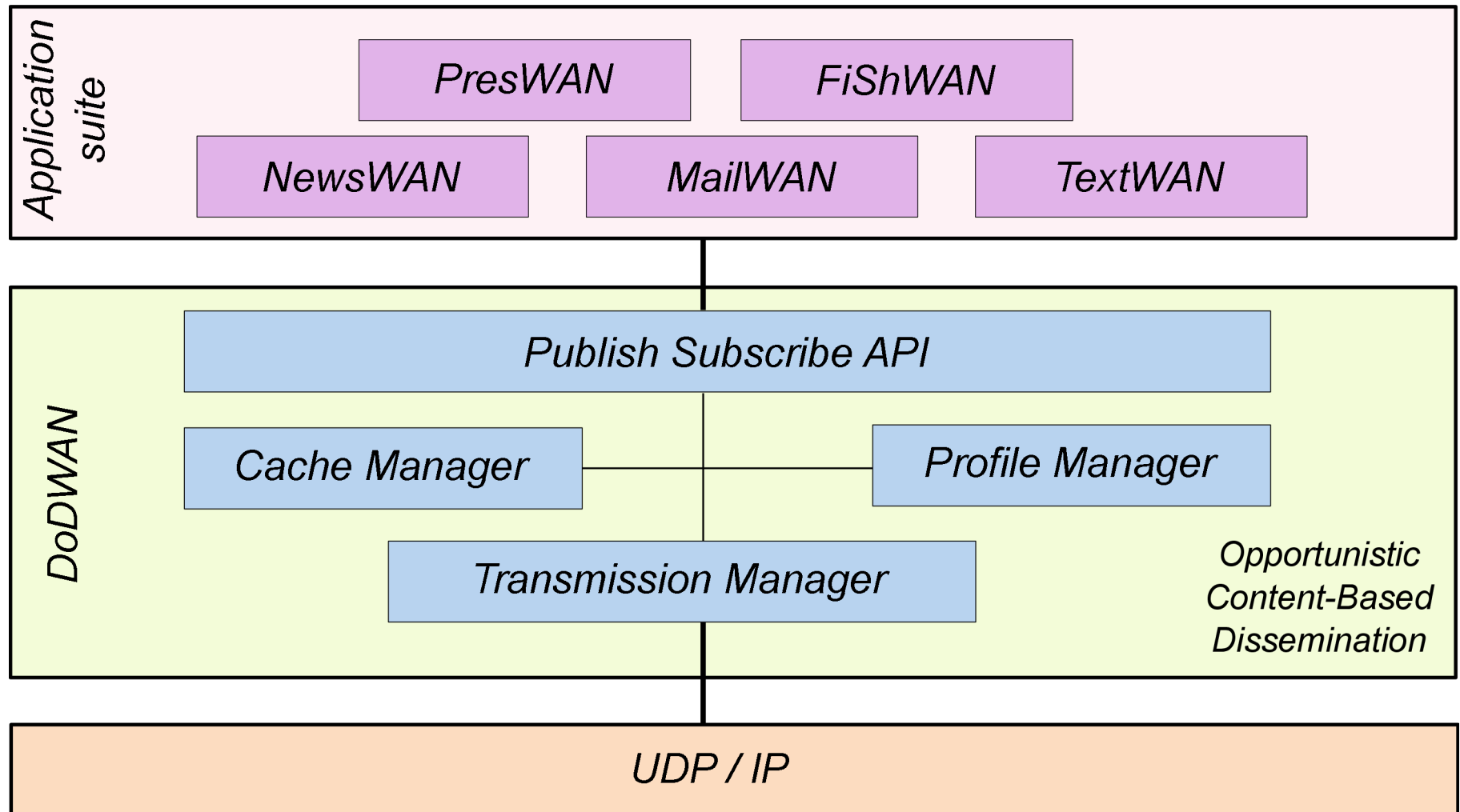
Done

zotero

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

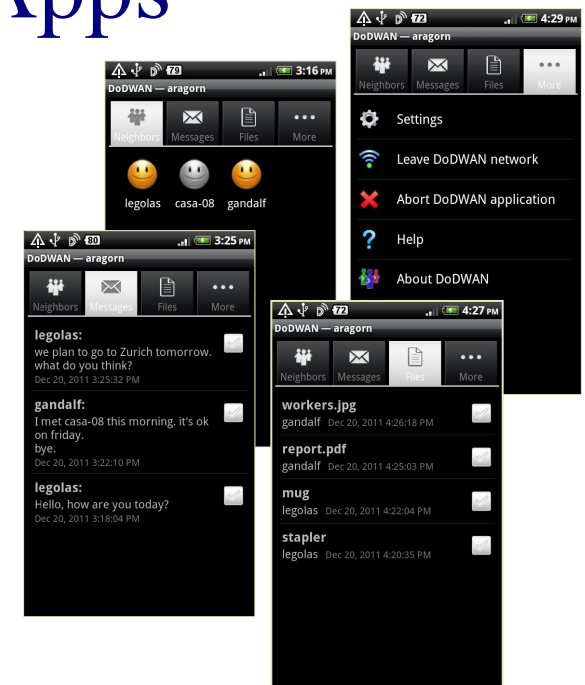
- Motivation
 - Running protocols in simulators can bring interesting results
 - Running the same protocols in real conditions can bring a lot more results (but it may be a lot more difficult to achieve!)
 - ↳ Need for real users in a real environment
 - Users do not “run” communication protocols or 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

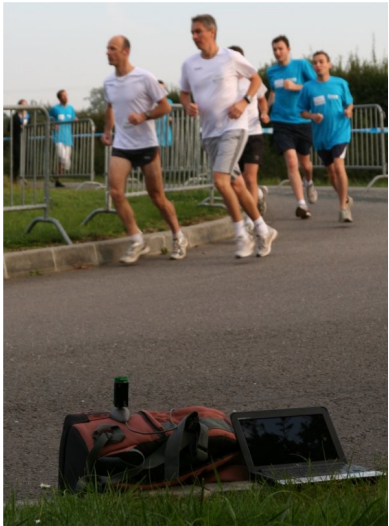
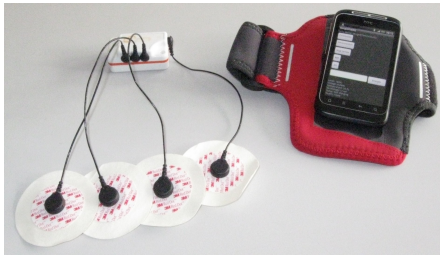
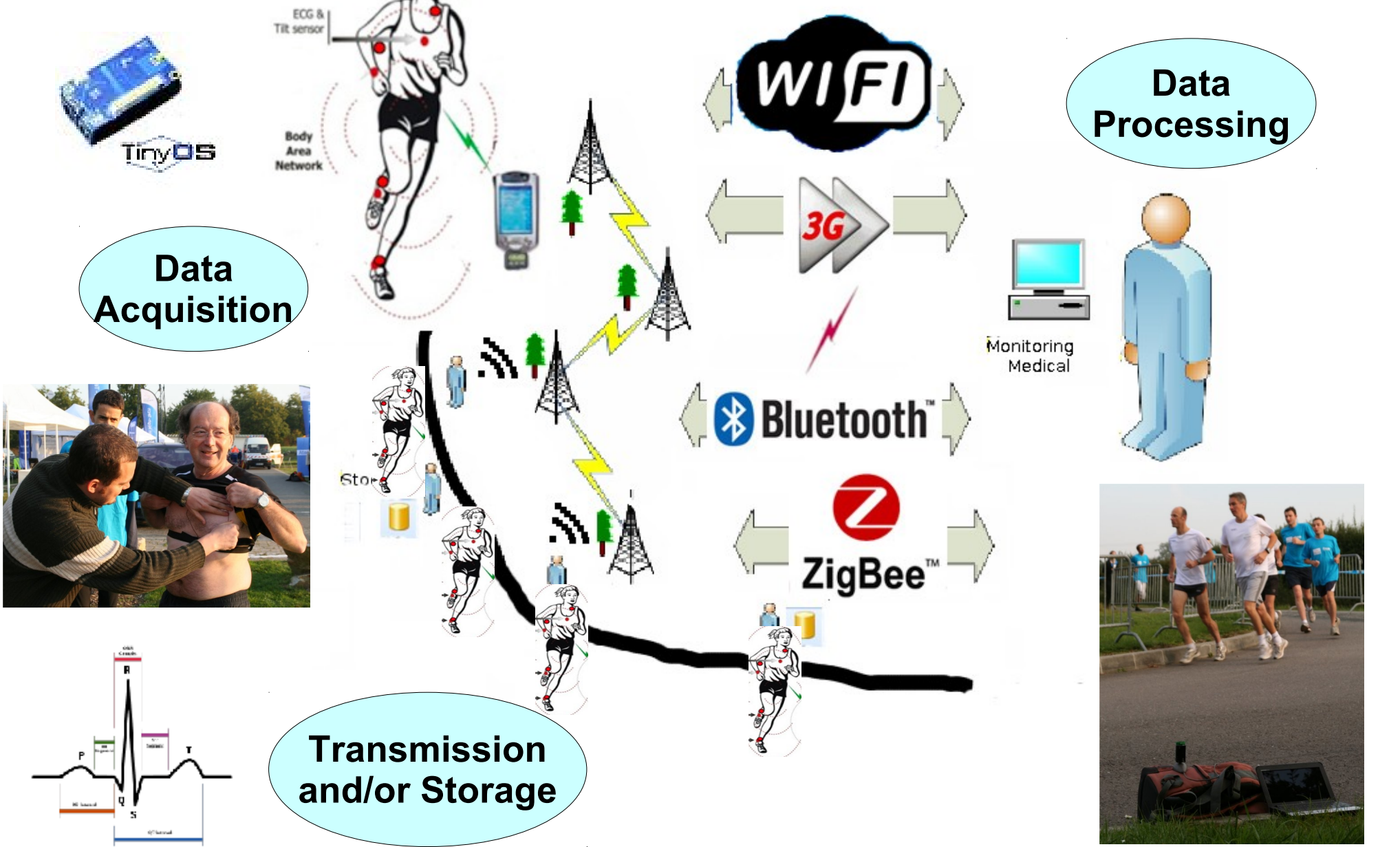


- Motivation
 - Collect communication traces and user inputs
 - Observe how DoDWAN's protocol performs in real conditions
 - Observe how users behave in real conditions(!)



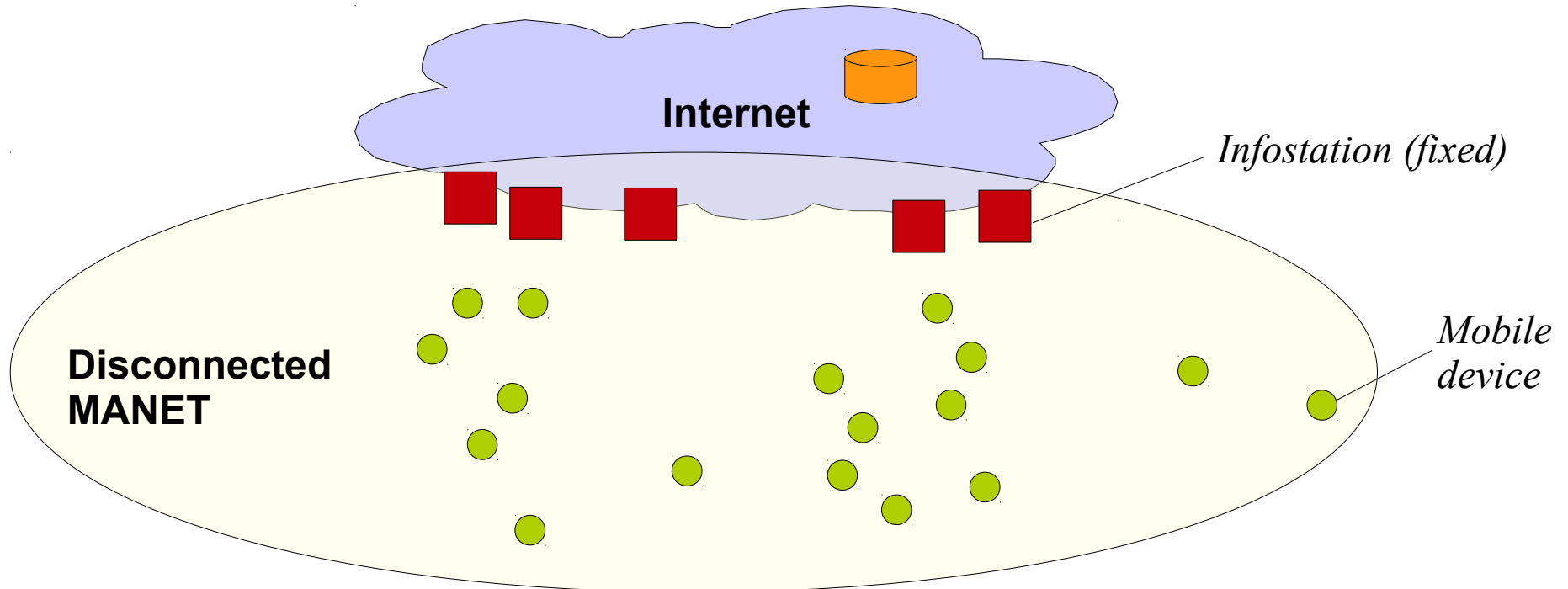
Project CoMoBioS

(Communicating Mobile Biometric Sensors)



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)



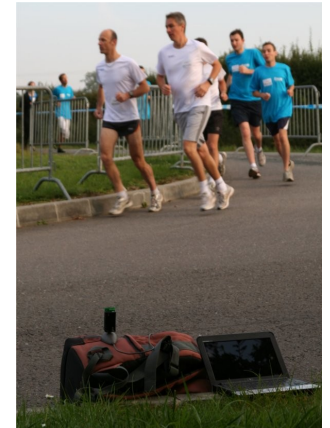
High-level Programming Abstractions for Opportunistic Computing

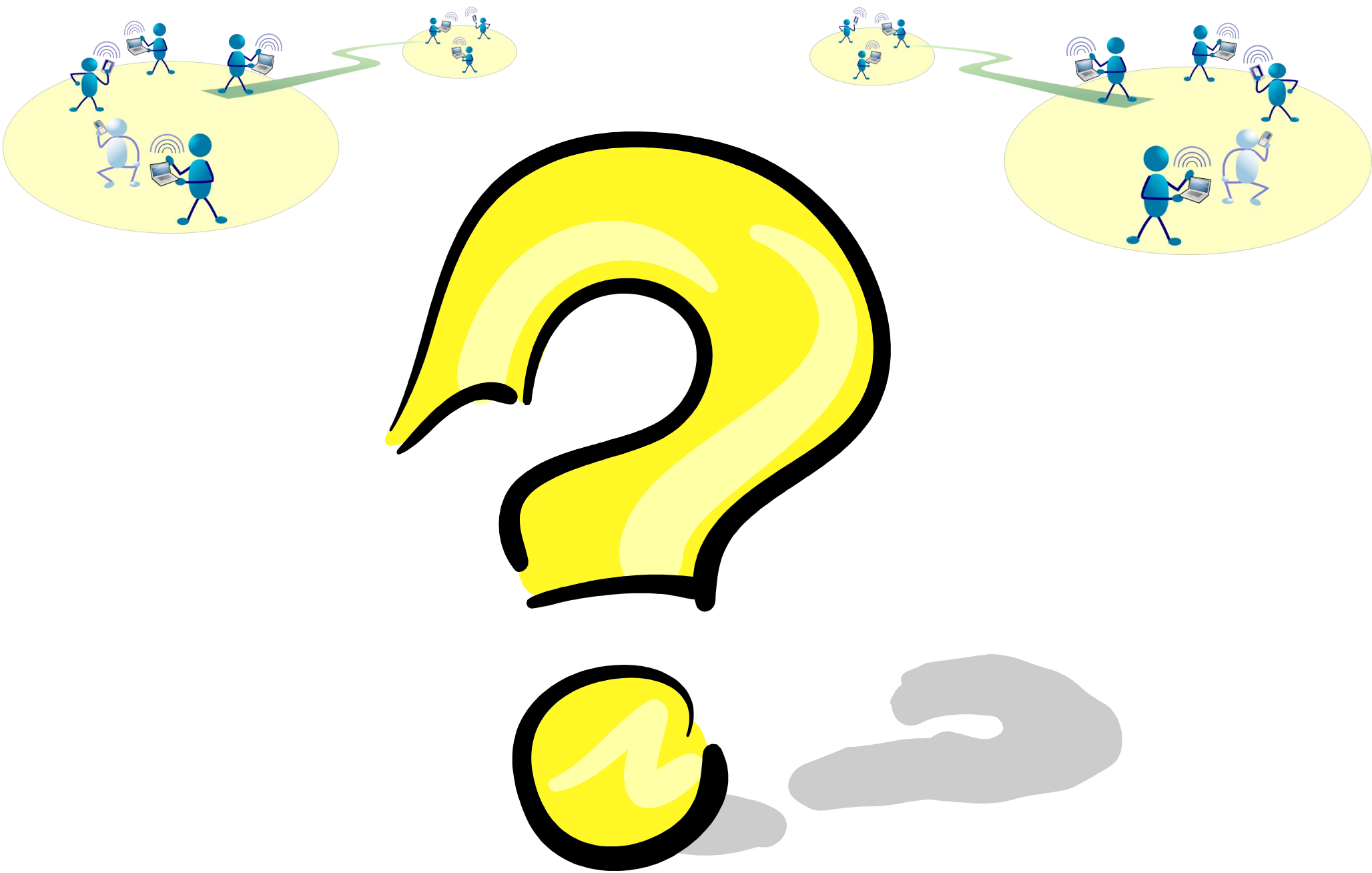
- The development of distributed applications for D-MANETs requires elaborate programming tools (beyond the *send/receive* and *publish/subscribe* primitives)
- Need to account for the constraints inherent to opportunistic communication
 - (Highly!) asynchronous
 - *Best effort*
- Investigating abstractions 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
 - Negotiations in progress
 - IXELEK, NKE, Navix...





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