



## Dynamic and Automatic Interworking between Personal Area Networks using Composition

Rui Campos, Carlos Pinho, Manuel Ricardo and José Ruela

### Outline



1. Introduction
2. Ambient Network and Network Composition
3. Case Study – Interworking between PANs
  1. Using Legacy Technology
  2. Using Legacy Technology with Composition
  3. Comparison between 1 and 2
4. Future Work within AN project
5. Conclusions
6. Commercial/Industrial Interest



## Introduction



- Past/Current Communications Scenario
  - Multiple technologies deployed independently; optimized for specific services  
(GSM networks → voice-oriented; IP networks → data-oriented)
  - Handover/roaming between technologies unfeasible
  - User's devices work independently
- Paving the way towards B3G Networks
  - Preliminary solutions supporting 3G/WLAN interworking already available
  - Users' devices can form small incipient cooperative networks (Bluetooth)



## Introduction



- Future Communication Scenario (B3G)
  - Plug & Play is a MUST
  - Users owning/carrying small moving networks (PAN, BANs)
  - Cooperation required between multiple users' networks
  - Technology adapting to the user needs – Ambient Intelligence
  - Multiple networking technologies integrated → seamless handover



## Ambient Network



- Set of devices sharing a common control plane – *Ambient Control Space*  
(sensor device, laptop, BAN, PAN, LAN)
- Ambient Network characterized by
  - Identity
  - Ambient Control Space (ACS)
    - Control plane functions, named Functional Areas (FAs)
  - Ambient Resource Interface (ARI)
    - Communications with connectivity resources (routers, radio equipment)
  - Ambient Network Interface (ANI)
    - Communications with other networks
    - Negotiation of composition agreements; transfer of control information between networks
  - Ambient Service Interface (ASI)
    - Communications with user applications requesting end-to-end connectivity



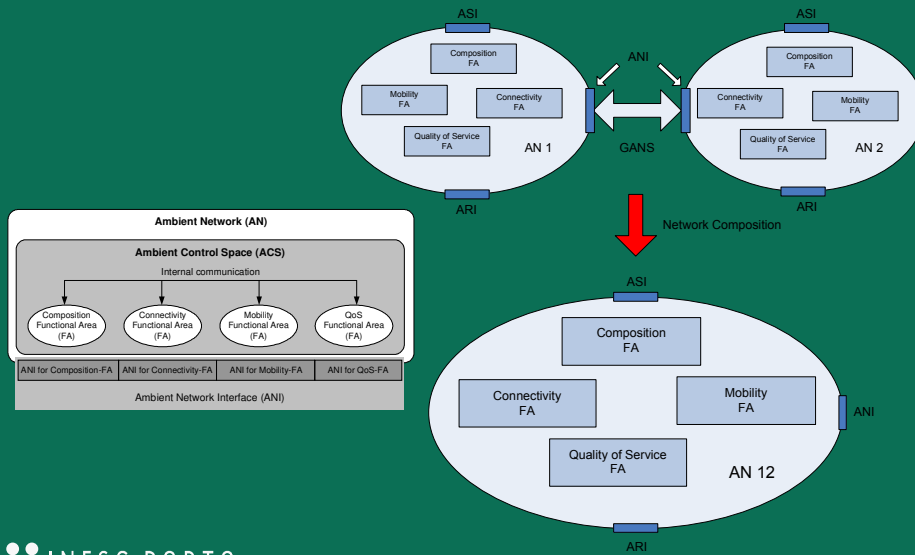
## Network Composition



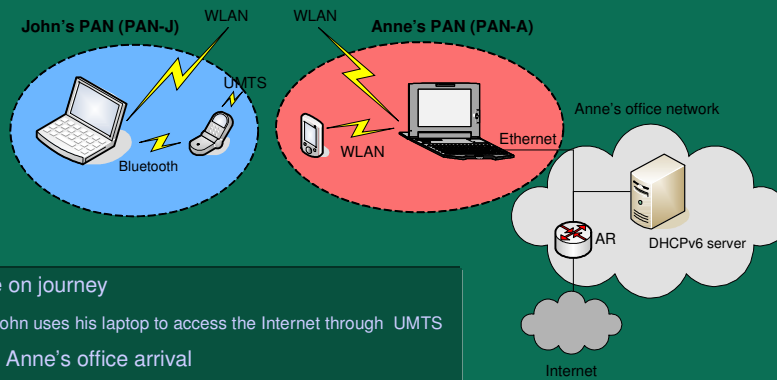
- Enables
  - Plug & Play of networks; integration of heterogeneous technologies
  - Internetworking transparent to the user; on-the-fly negotiations
- Types of composition between 2 ANs
  - Network Interworking → no new AN created; ANs can communicate
  - Control Sharing → ANs share control functions. Security handled by AN1; QoS by AN2
  - Network Integration → new AN created, which integrates resources from composed ANs
- Signalling carried out using the GANS protocol, through the ANI
  - GANS – Generic Ambient Network Signalling; based on NSIS
  - Negotiation of Composition Agreements
- Composition orchestrated by the *Composition Functional Area*



# Ambient Network and Network Composition



# Case Study: Interworking between PANs



- While on journey
  - John uses his laptop to access the Internet through UMTS
- Upon Anne's office arrival
  - John triggers his PAN to associate with Anne's PAN for file sharing and for benefiting from the Internet access offered by that PAN
  - John decides to switch off UMTS connection

## Using Legacy Technology



- Offline negotiations and manual configurations required
- Steps performed
  1. PAN-A sends beacon frames announcing the SSID of the WLAN in ad-hoc mode
  2. **Anne informs John** that she can offer Internet access free of charge through her PAN
  3. **John configures** his laptop's WLAN interface in ad-hoc mode in order to detect PAN-A
  4. **Anne configures** her laptop as a bridge between the WLAN and Ethernet link
  5. The laptop of PAN-J receives PAN-A beacon frames through its WLAN interface, and John is informed about the presence of PAN-A
  6. PANs perform mutual authentication based on certificates, assigned by a trusted third party
  7. The laptop in PAN-J autoconfigures a global IPv6 address based on the Router Adv messages sent out by the local AR; further configuration information may be retrieved from the local DHCPv6 server
  8. **John switches** from UMTS to WLAN access



## Using Legacy Technology with Composition



- User intervention in the configuration process is minimized
- User needs to define a profile in advance
  - High-level policies governing the compositions with other ANs
  - Translation into lower-level policies used by C-FA to perform compositions automatically
  - In principle, user involvement is limited to the definition of this profile
- PANs are ANs; no new composed AN is created
  - Type of composition: Network Interworking



## Composition Procedure



Composition Framework	Detailed Procedures (From PAN-J point of view)
<b>AN Discovery</b>	<ul style="list-style-type: none"> <li>• ANs (PANs) advertise their identity to the outside</li> <li>• Connectivity-FA (Cn-FA_J) detects Adv messages of PAN-A, and informs Composition-FA (C-FA_J)</li> </ul>
<b>AN Authentication</b>	<ul style="list-style-type: none"> <li>• C-FA_A requests authentication from C-FA_J</li> <li>• C-FAs of each PAN perform mutual authentication using certificates</li> </ul>
<b>CA Creation</b>	<ul style="list-style-type: none"> <li>• C-FA_A gets a locally stored Composition Agreement (CA)</li> </ul>
<b>CA Negotiation</b>	<ul style="list-style-type: none"> <li>• C-FA_A starts CA negotiation by sending the locally stored CA as a first proposal</li> <li>• C-FA_J receives the CA proposal and finds out that peer AN offers Internet access service; the process is transferred to Cn-FA_J</li> <li>• Cn-FA_J analyzes the CA from the connectivity viewpoint considering local policies</li> <li>• Cn-FA_J finds the current AN suitable to create a composition and informs C-FA_J</li> <li>• C-FA_J agrees with the CA proposal and sends back a confirmation accepting it</li> </ul>
<b>CA Realization</b>	<ul style="list-style-type: none"> <li>• C-FAs transfer the process to Cn-FAs</li> <li>• Cn-FA_A configures Anne's laptop as a bridge</li> <li>• Legacy technologies are used to autoconfigure connectivity parameters</li> <li>• Each C-FA informs the user that the composition is established</li> <li>• Cn-FA_J switches from UMTS to WLAN access, according to the connectivity policy defined by the user</li> </ul>



## Comparison between Procedures



Actions	Only Legacy Technology	Legacy Technology + Composition
<b>Service Advertisement</b>	User-user communication	Automatic
<b>Negotiation</b>	User-user communication	Quasi-automatic (user intervention to define policies governing the negotiation)
<b>Configuration of resources</b>	Manual (may involve networking expertise)	Automatic
<b>Selection of the proper network access</b>	Manual	Automatic (possibly based on policies)



## Future Work within AN project



- Further investigation on Composition
  - Design and specification of the signalling protocol for Composition
  - Better understanding of the concept
- Scalability and signalling overhead analysis
  - GANS Transport Layer
  - Analysis on Network Composition postponed to Phase 2
- CA Framework improvement
- AN Advertisement and Discovery
- Intra-AN communication



## Conclusions



- Ambient Network and Network Composition – solution for B3G networks
  - Plug & Play operation
  - Automatic and dynamic negotiation of CAs
    - Easy and dynamic adaptation to rapidly changing network contexts
  - Enabling new business models
    - Users acting as operators of small networks, e.g., PANs.
  - But, further research is required
- Our Case study puts ANs in a real scenario
  - Comparison between the two procedures highlights composition advantages
  - Contributes to a better definition of the innovative AN concepts



## Commercial/Industrial Interest



- Key European manufacturers and operators strongly involved in the AN project
  - Ericsson AB, Siemens, Nokia, NEC Europe, Motorola, Alcatel, France Telecom, Vodafone, ...
  - AN project reuses concepts also very discussed in USA Universities
- If the AN concepts succeed
  - New communications paradigms will emerge
  - Existing communication equipments will need to be changed
  - New Network Elements will be required
  - Revolutionary business models will emerge
- Portuguese manufacturers and operators must be aware of it!
  - By deploying small testbeds
  - By installing/reusing our prototypes which will enable them, in advance, to
    - Evaluate the value of the new concepts
    - Identify the edges between new and existing networks / network elements / business models



Thank you!

Questions?

