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# Virtual Private Ad Hoc Networks

## Next-generation network communication

Jeroen Hoebeke, Ingrid Moerman, Piet Demeester



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# Internet evolution

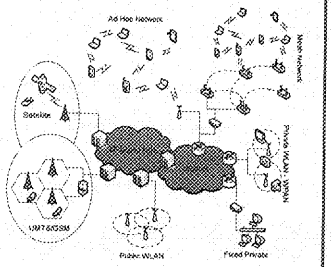
*The Internet is not for sissies.* (Paul Vixie)

*You can't trust the internet.* (Nicolette Sheridan)



## Internet evolution: the network

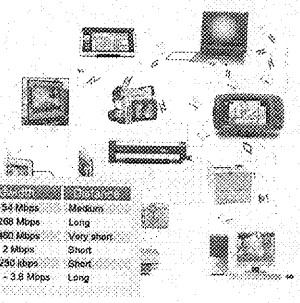
- **4G communication networks**
  - Evolution towards a "network of networks", integrating different technologies (WLAN, UMTS, Ad Hoc, cellular…)
  - Characteristics:
    - **IP-based**
    - **Broadband**
    - **Support of mobility**
    - **Heterogeneous**
    - …






## Internet evolution: the devices

- **Device evolution**
  - More and more networked devices
  - Convergence of network devices and consumer electronics (eg. cameras, TV…)
  - Trend towards mobile and wireless access

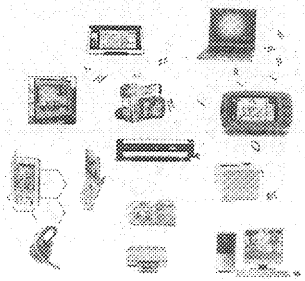


| Technology | Data Rate | Range |
|---|---|---|
| 802.11a, b and g (Wi-Fi) | Up to 54 Mbps | Medium |
| 802.16e and a (WiMAX) | Up to 268 Mbps | Long |
| UWB (802.15.3) | Up to 480 Mbps | Very short |
| Bluetooth (802.15.1) | Up to 2 Mbps | Short |
| Zigbee (802.15.4) | Up to 250 kbps | Short |
| UMTS | 384 kbps - 3.8 Mbps | Long |



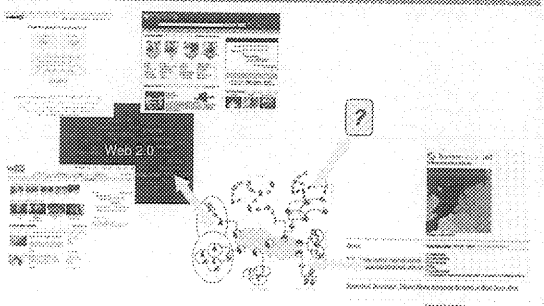
## Internet evolution: consequences

- **Consequences**
  - Connectivity anywhere, at any time and from any device
  - More and more networked devices supporting people in their daily life
  - Bigger and bigger (users, devices, services…)
    - Overwhelming
    - Security risks
    - Management
    - Configuration
    - …





## Internet evolution: the services



## Internet evolution: what's next?

- This large network and its services do not meet many of the users' communication needs
  - 1 device -> multiple purposes, multiple devices -> 1 purpose
  - So, communication often takes place within a limited context or scope:
    - Work related communication: projects, customers, students...
    - Personal communication: friends, family...
  - ...involving a limited (dynamic, mobile) subset of devices that communicate
    - in a secure fashion
    - in a self-organising and easy to manage way
  - And goes further than chat, email...
  - Now: we struggle to interconnect all these devices, to keep their data and communication secure and shielded and to get easy access to their data and services, especially when being nomadic...

**New communication paradigm needed!**



## New communication paradigm

- **Trend towards network virtualization**
  - 4G IP network = carrier that provides end-to-end connectivity
  - On top: multiple virtual networks that logically structure the network and its services/resources into small secure communities

+

- **Deployment of ad hoc network techniques**
  - Capable of dealing with the distributed, mobile and dynamic characteristics
  - Self-organizing and self-maintaining properties

= **VPAN (Virtual Private Ad Hoc Network)**



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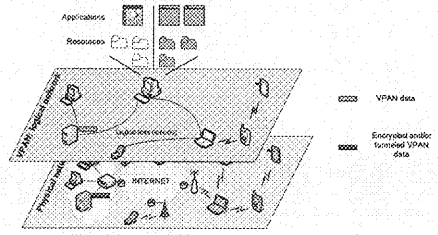
# Virtual Private Ad Hoc Networks

Definition, concept and applications



## VPAN concept and definition

- **Definition**
  - A secure and self-organizing virtual overlay network of distributed nodes deploying ad hoc network techniques and private addressing
  - Secure: both in terms of networking and applications and services






## Applications

| | VPAN members |
|---|---|
| Emergency scenarios | ▪ Rescue people (police men, fire fighters...) organized in teams |
| Social networks | ▪ Networks with family, friends |
| Enterprise networking | ▪ VPAN between collaborating people: within a department, within a project, between people at a construction site, monitoring network, virtual service providers, machine-to-machine networks... |
| Personal networks | ▪ Personal networks: overlay of all your personal devices<br>▪ E-health: health care network |
| Commercial and civilian environments | ▪ Cab network, public transport network, surveillance systems, touristic information, building automation... |
| | ... |

VPAN concept supports these scenarios in a generic fashion!



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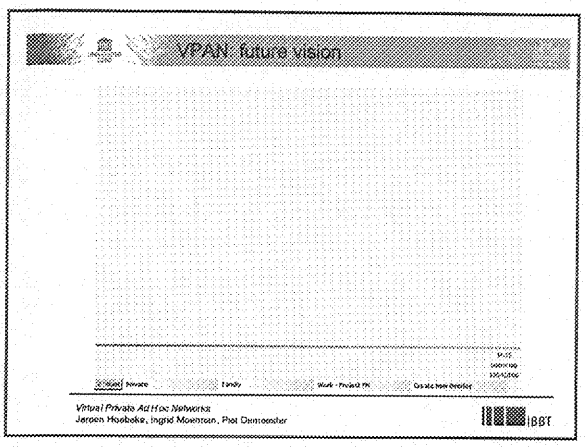
# Virtual Private Ad Hoc Networks

Future vision


VPAN: future vision
Virtual Private Ad Hoc Networks
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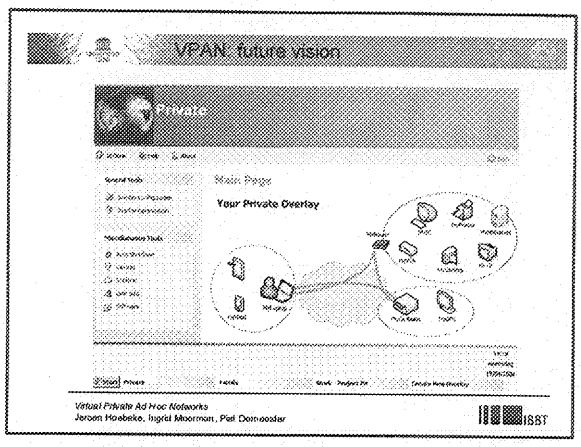
VPAN: future vision
Private
Your Private Overlay
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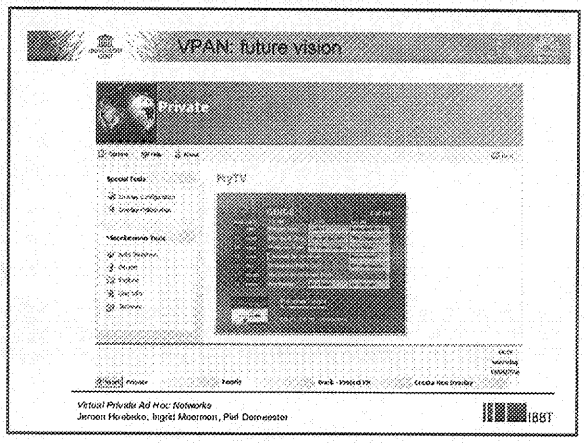
VPAN: future vision
Private
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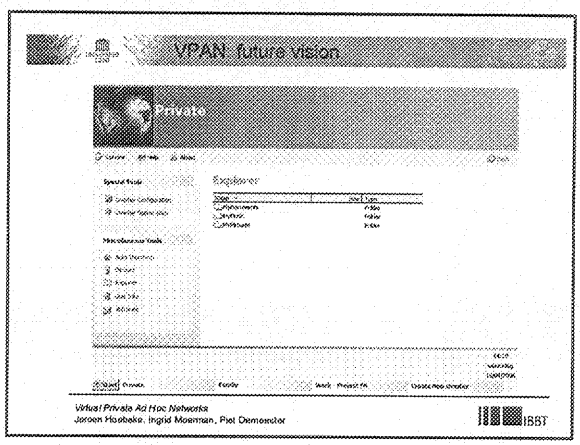
VPAN: future vision
Private
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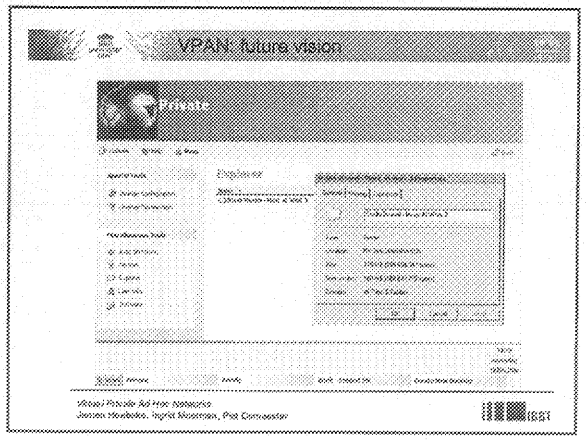
VPAN: future vision
Private
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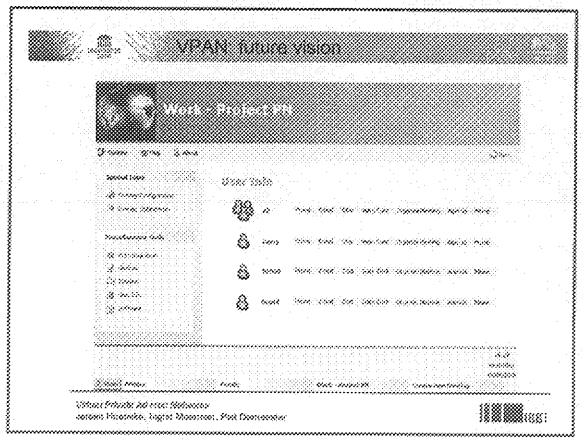
VPAN: future vision
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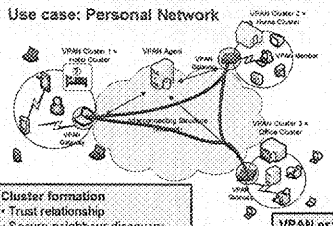
# Virtual Private Ad Hoc Networks

Network solution



## VPAN network implementation

- Use case: Personal Network




**Service discovery and service use**
- selection of shared services
- service announcements
- service use

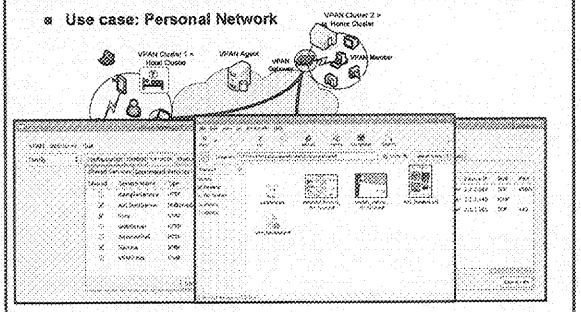
**Cluster formation**
- Trust relationship
- Secure neighbour discovery
- Automatic VPAN IP address assignment
- Intra-cluster ad hoc routing
- Universal convergence layer + interface management

**VPAN establishment**
- Secure registration
- Dynamic tunneling (NAT bypassing)
- Inter-cluster ad hoc routing
- Mobility management
- Broadcasting support



## VPAN network implementation

- Use case: Personal Network



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# Virtual Private Ad Hoc Networks

Existing technologies? - Deployment – business opportunities



## Limitations of existing technologies

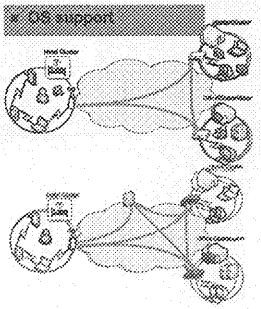
| | Main shortcomings |
|---|---|
| VLAN | ▪ Limited to Ethernet systems (layer 2 solution)<br>▪ No application, mobility or security support |
| VPN / Dynamic VPN | ▪ Mainly static (predefined endpoints)<br>▪ Limited mobility support<br>▪ Security only between tunnel endpoints<br>▪ No application support, no cluster self-organisation |
| P2P overlays / service overlays | ▪ Limited flexibility: too tightly coupled with specific applications<br>▪ Not shielded at network layer, more complex mobility management<br>▪ Assumes underlying connectivity platforms: no cluster self-organisation, no interface management |
| Mobile IP, HIP, ... | ▪ Only deal with isolated aspects such as mobility management<br>▪ VPAN provides an integrated solution |



## Deployment – current/future status

- PCs, PDAs
  - Linux proof-of-concept
  - Windows, Mac OS-X port
- Access points/routers
  - Alix PC engine
- Other devices
  - Camera, printer
- VPAN supporting Routers
- Virtual machines
- Sensors

- OS support



## Business opportunities - thoughts

- **VPAN providers**
  - Sell VPANs: VPAN certificates, name, addressing space...
  - Offer web-based VPAN creation and participation functionality
  - Deploy VPAN Agentservers
- **Billing, service models, QoS**
  - With VPAN supporting Routers or VPAN-aware networks
    - **Different cost models for Internet and VPAN traffic**
    - **Different VPAN establishment and use policies (flat fee, per use, proactive, reactive...)**
    - **QoS guarantees**
      - Many applications requiring high bandwidth and/or low delay e.g.: video streaming, video conferencing, remote editing of files, well performing use of remote services
- **Virtual devices**
  - Offer customers virtual machines that can be added to their VPAN and that offer value-added services
- ...



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# Virtual Private Ad Hoc Networks

Conclusion



## Conclusion

- **VPAN concept**
  - Keywords:
    - **Network virtualization + ad hoc networking = secure and self-organizing overlay networks**
  - Tackles communication needs not addressed by current/future broadband Internet and its services
  - Generic support for many scenarios
  - Implemented proof-of-concept network solution
  - Many possible business opportunities
  - VPAN = "Beyond Connectivity", mapping digital life to easy-to-use virtual networks



## More info?

- **PhD book**
  - Contact: jeroen.hoebeke@intec.ugent.be
- **Projects where VPAN concept or ideas are applied**
  - IBBT TranseCare:
    health-care networks for elderly
  - IBBT VIN:
    virtual individal networks
  - IBBT SPAMM:
    VPAN of busses + backbone
  - IST MAGNET and IST MAGNET Beyond:
    Personal Networks and Personal Network Federations
  - ITEA2 Usenet:
    Machine-to-machine communication
- **IBCN testlab**
  - Permanent proof-of-concept demonstrator
- **Questions?**

# Presentation

### Virtual Private Ad Hoc Networks

The Internet is evolving towards a large 'network of networks', where users can enjoy interactive, multi-media driven content. However, many scenarios require secure communication between a limited number of possibly distributed and mobile devices and for a variety of services and applications. Virtual Private Ad Hoc Networks (VPAN) offer a solution to this complex problem by creating virtual networks on top of the existing network infrastructure. As such, in the future, users will not be restricted to work on a single device, but their device will act as a portal to a number of secure self-organising

## Part of session:

6A - Who cares? – User network issues

See session details

## Related Documents

Download Slides
(5 MB)

network environments.

## Speakers

Jeroen Hoebeke, IBCN - INTEC - IBBT

## Authors

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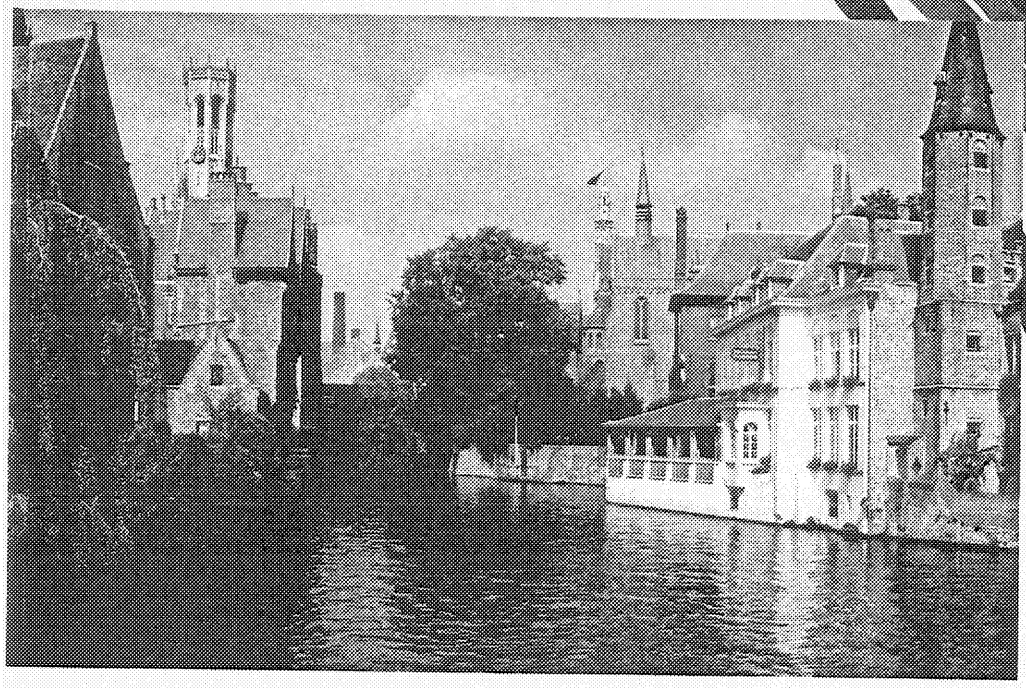

# PROGRAMME

## TERENA NETWORKING CONFERENCE 2008

**19-22 May**

'Oud Sint-Jan' Conference Centre

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