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Beyond ad-hoc networking. Self-configuring Networks and Terminals

Virtually every device
and appliance in the
future will have
network capabilities
No-one (well, almost)
will be able to
manage the huge
amount of diverse
networks of the future



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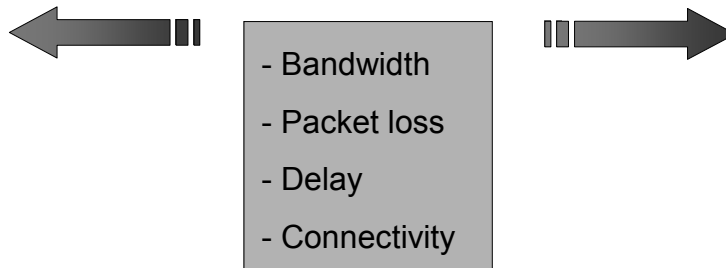
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Network Diversity increases



Wireless networks
Mobile nodes and networks
Ad Hoc networking
Overlaid virtual networks

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Terminal Diversity



- Processing
- Size and cost
- Mobility
- Pervasive



Carried personal devices
Embedded everywhere, available anytime
Demand first class Internet citizenship
Massive sensor networks

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User Diversity



- Internet literate
- Applications
- Privacy and security



Large parts of the worlds population
More networks than individuals
**Average user not inclined to become
network manager**

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Networking Everywhere

- One major obstacle on the road to *The Ubiquitous Internet / Pervasive Computing* is the need for human interaction during network:
 - Installation and organization
 - Configuration
 - Management
- Manual configuration is error prone!

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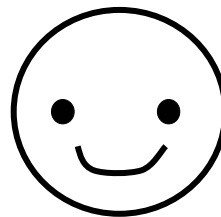


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Long term vision - The Invisible Internet

Network connectivity should ideally
be like electricity

- no installation
- no configuration
- no management
- no nothing
- just plug in and use.



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Network Formation - issues

Discovering neighbours, forming domains and establishing connectivity:

- Multiple wireless access technologies
- Roaming of smaller networks within larger networks
- Overlays/groups formed depending purpose
- Resource discovery
- Removal of not used networks – a "Network soft state" would be attractive

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Related Efforts

Sensor Networks

IETF zeroconf (home appliances)

Ambient Networking

Autonomic computing

Pervasive computing

Terminodes project

UCLA Sensing Center

<Your favorite term>

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Three key areas for research

- (1) Network formation and removal
- (2) Security
- (3) Terminal adaptability

Will comment on our ongoing
research in these areas

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Focusing on SelfConfig for "Temporary Networking"

Networks for the "moment"

- Ad Hoc networking
- Mobile IP
- Proxy dynamic set-ups
- Application overlays
- Content Distribution Networks

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Indirection problem of Temporary Networking

IP merges three concepts:

- Identity
- Location
- Access

Being unable to control the indirection of temporary networks is a major problem today

Requires awkward adjustments to the existing underlying (IP) infrastructure.

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Ad Hoc Networking. Self- configuring an Internet gateway

Problems:

- Nodes constantly change their location
- Flat addressing on the Ad Hoc side
- Any address may visit ad-hoc network
- Discover path to gateway node
 - Multi-hop to gateway
- NAT-like gateway common
- No route aggregation in ad-hoc

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Global IPv4 gateway

Mobile IP solution

AODV aware Foreign Agent in Gateway

Uses a default route to gateway

Check first if node is in ad hoc network

Problems to maintain a default route

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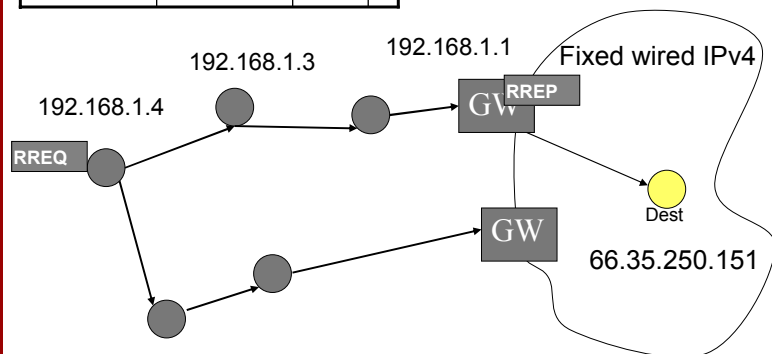
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MANET AODV and Gateways

Destination	Next Hop	Hops	
192.168.1.1	192.168.1.3	3	
192.168.1.3	192.168.1.3	1	



Local node discovery

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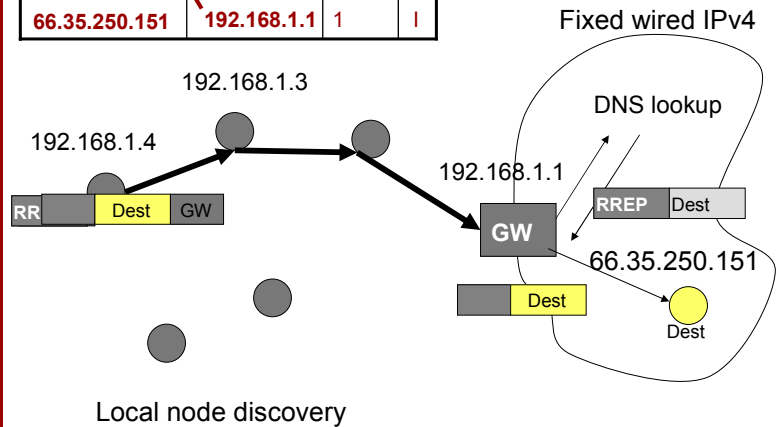
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Tunneling, one virtual hop

Destination	Next Hop	Hops	
192.168.1.1	192.168.1.3	3	
192.168.1.3	192.168.1.3	1	
66.35.250.151	192.168.1.1	1	!



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Underlay Networks

Layer *underneath* the IP stack

User controlled *indirection pointer* is used to resolve location.

- De-couple identity from location
- Cope with mobility without changing identity

Similar to i3 indirection. Instead of using IP addresses as the target we propose to use separate local name space for labeling pointers

Provides the ability to create a network for a specific purpose AND to get rid of it easily.

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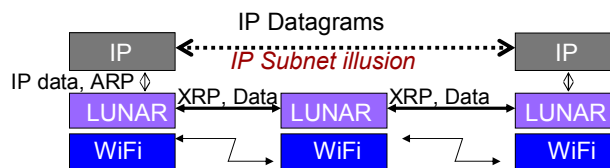


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LUNAR = “Lightweight Underlay Network Ad hoc Routing”



- Works below IP, routing at L2.5
- IP selfconfig (addr, gateway, NAT)
- Simple, although well performing
- μLUNAR: Lego Mindstorm, 3.3 KBytes, footprint



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Adaptable self-configuring terminals

One terminal – multiple usage

- Context and environment dependent
- User controlled
- Secure and privacy

Carried, with limited capabilities

Idea: Device comes with a “Network Butler”

- Context software download
- Proxy/agent support

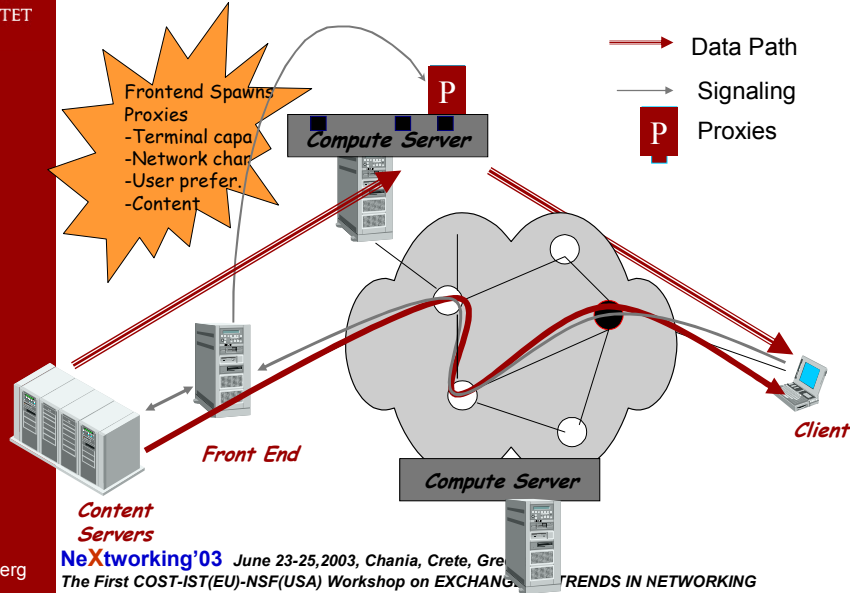
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Personalized Session Overlays



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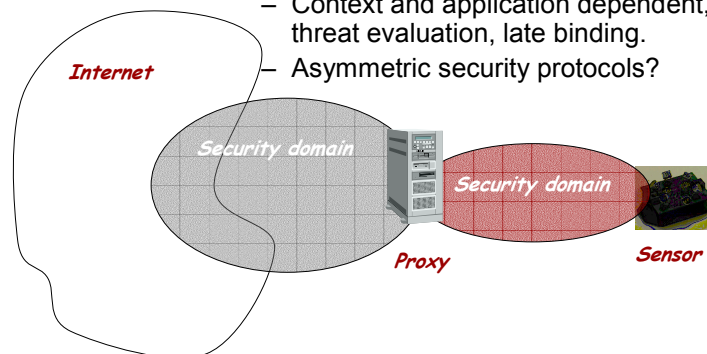
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Proxy support for security

Idea - Off-loading tiny devices heavy Internet security processing

Security proxy – more powerful

- What can be off-loaded?
- Context and application dependent, threat evaluation, late binding.
- Asymmetric security protocols?



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PAN security support

Clouds of devices are likely to move around and join/leave with other groups and the fixed infrastructure.

We need efficient join/leave of groups instead of individuals. Issues:

- Group recognition.
- Build agreements between groups.
- Federations of groups that agree on security.

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More information

<http://www.it.uu.se/research/group/core/>

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