

ICN Mobility: Overview, Discussion and Challenges

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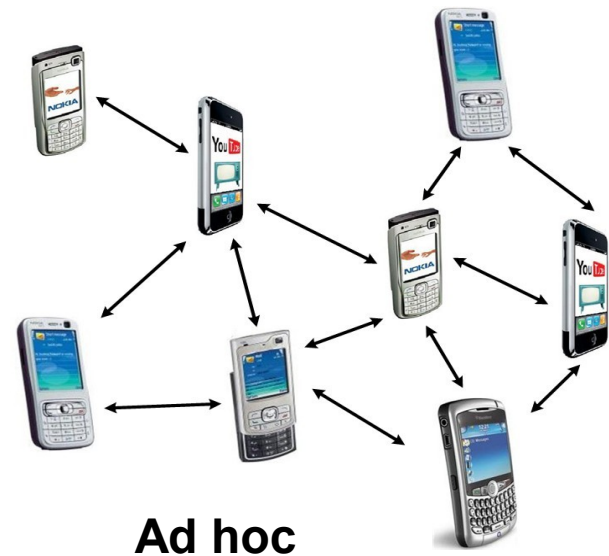
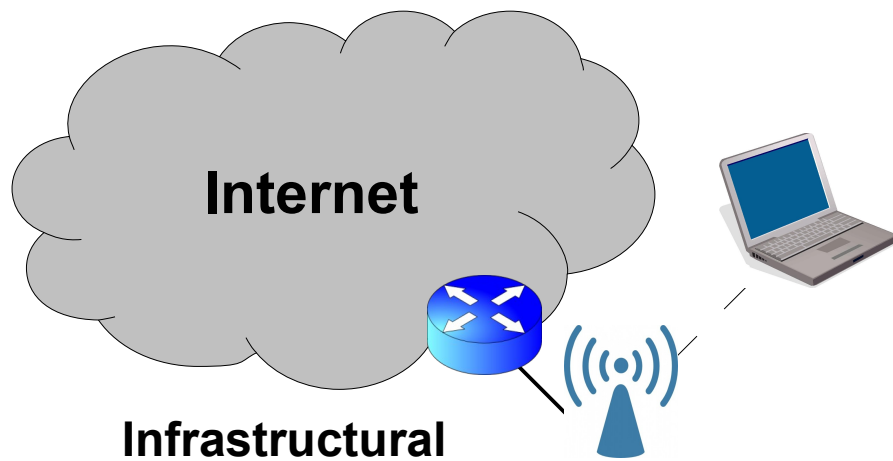
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What is Mobility?

- Allows nodes to move their **physical** location
- Allows nodes to move their **topological** location



Why is Mobility Hard?

- Hosts must be constantly **reachable**
 - Huge **global routing** challenge
- Hosts must maintain seamless **connectivity** between physical **end points** (i.e. TCP sessions!)
 - What if the 'thing' connected to the end point changes?
- Solution: tunnelling or re-binding
 - Slow, unreliable and costly

ICN: The Solution?

- Content is the **addressable** entity
 - Not a host!
- Content is the underlying **routing** target
 - Not a host!
- A content **pub/sub** interface is used
 - Not a socket!
- Content is **secured** independently
 - Not a channel!

ICN: The Solution?

Many problems stem from handing references to (moving) physical hosts

...ICN attempts to remove this need

Host Multihoming

- Host multihoming in TCP/IP difficult
 - TCP connections created between two end points (interfaces)
- ICN detaches itself from this principle
 - Doesn't depend on interface addresses
 - Requests can be **multiplexed over any interface**
- Application hidden from this complexity
 - Never need to know interface addresses

Session/Connection-Orientation

- Majority of IP traffic is connection-oriented
 - Congestion/flow control and reliability
- Mobility therefore requires TCP session maintenance
- Not required in an ICN
 - Congestion control and reliability can be achieved **solely by the consumer**
 - No need to exchange parameters etc.

Resilience During Mobility

- TCP/IP is dependent on host availability
- Mobile networks particularly vulnerable
 - MANETs/DTNs have high churn
- ICN does not statically bind content to locations
- Any source can be used
 - Ubiquitous caching
 - No single point of failure

Abstraction of Network Address

- Some applications use network addresses
 - Registering with BitTorrent tracker
 - Requesting event call backs
- Necessitates a **persistent** address
 - Or IP references can become stale
- ICN detaches applications from this
 - Uses addresses that are already application-layer concept

Inference Scoping

- Information is often interpreted (wrongly?) from host locations
 - E.g. country, optimal source etc.
- ICNs make an explicit **split** between content and location/user
 - Not necessary to interpret information

Mobility Support in ICNs

Mobility Support in ICNs

- Many designs for ICN
 - NDN, PURSUIT, NetInf, CURLING, MobilityFirst, Juno, DONA, CONET (in no particular order!)
- Implicit support
 - Receiver driven, late binding etc.
- Explicit support
 - MANET routing protocols, mobility-aware caches etc.

Important Concepts for Mobility support in ICNs

- Bind time
 - When is an object bound to a location?
- Connection oriented vs Connectionless
 - Must sessions be established?
 - When/if are sessions are bound to locations?
- Object size
 - How large are the addressable units of transfer?

Remaining Challenges

Is everything sorted then?

...no.

Provider Mobility

- We still need global routing information!
 - In fact, much more ($>10^{15}$)
 - What if providers move?
- NDN
 - Difficult to move away from hierarchical location
- PURSUIT, MobilityFirst, Juno, NetInf
 - Resolution service needs updating

Managing Path Information

- We still need physical path information!
 - Breadcrumbs, source routing, IP
 - What if paths change?
- NDN
 - Can leave stale breadcrumbs to false locations
- PURSUIT
 - Changes require path re-computation

Access to Local Replicas

- We still need to discover (off-path) cached replicas!
 - Huge amounts of 'routing' information
- NetInf, DONA, Juno, MobilityFirst
 - Difficult to maintain bindings
 - Resolution service may not be available
- NDN
 - High levels of routing overhead
 - Organisational hierarchy redundant

Real-time Hand-offs

- We still need to achieve (very) fast hand-offs
 - Video and audio content highly prominent
- NetInf, COMET, Juno, MobilityFirst
 - Need very fast resolution updates and re-binding
- NDN
 - Route re-convergence would need to be fast, even during name space de-aggregation

Security and Privacy

- Many remaining security threats
 - Blackhole routing, DoS
- And some new ones
 - E.g. false Interest packet flooding
- Privacy risks
 - Everybody can view requests

Key Future Work

- Mobility a hot topic in ICN
 - Many questions left unanswered
 - Many researchers identified benefits
- Particularly **routing and management**
 - Unstructured (flat), off-path caching, social knowledge, routing localisation

Conclusions

- Discussed mobility in CCN
- Presented some prominent examples
- Explored remaining challenges

**Not necessarily limitations but challenges
that need to be explored**

Gareth Tyson, Nishanth Sastry, Ruben Cuevas, Ivica Rimac and Andreas Mauthe.

Where is in a Name? A Survey of Mobility in Information-Centric Networks.

In Communications of the ACM, Dec, 2013.