ICN Mobility: Overview, Discussion and Challenges

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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
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• 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