Introduction

• What is Mobility? Why is it hard?
• ICN: The Solution?
• Mobility Support in ICNs
• Remaining Challenges
• Conclusions
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 change?
• 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 the use of individual interfaces
  • Requests can be **multiplexed over any interface**
• Application hidden from this complexity
  • Never need to know interface addresses
Connection-Oriented Sessions

- 95% of IP traffic is connection-oriented
  - Congestion/flow control and reliability
- Mobility therefore requires TCP session re-establishment
- Not required in an ICN
  - Congestion/flow 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 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  • Or applications can become out-of-date
• ICN detaches applications from this
  • Uses addresses that are already application-layer concept
Content Scoping

• Information is often interpreted from host locations
  • E.g. country, optimal source etc.
• ICNs make an explicit **split** between content and location
  • Not necessary to interpret information
  • E.g. seamlessly route to newly available sources
Mobility Support in ICNs
Mobility Support in ICNs

• Many designs for ICN
  – CCN, PURSUIT, NetInf, CURLING, Juno, DONA, CONET (in no particular order!)

• Implicit support
  – Receiver driven, late binding etc.

• Explicit support
  – MANET routing protocols (e.g. Slinky), 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?
Mobility Approaches in ICN

- **CCN/NDN**: late binding routing infrastructure
- **DONA**: late binding request passing infrastructure
- **NetInf**: request-time binding resolution infrastructure (local or infrastructure)
- **Pursuit**: request-time binding rendezvous infrastructure
Remaining Challenges

Is everything sorted then?

...no.
Provider Mobility

• We still need global routing information!
  • In fact, much more ($>10^{12}$)
  • What if providers move?

• CCN
  • Difficult to move away from hierarchical location

• PURSUIT, Juno, NetInf
  • Resolution service needs updating
Maintaining Path Information

- We still need physical path information!
  - Breadcrumbs, source routing, IP
  - What if paths change?
- CCN
  - 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
- Juno, NetInf, DONA
  - Difficult to maintain bindings
  - Resolution service may not be available
- CCN
  - High levels of routing overhead
  - Organisational hierarchy redundant
Security and Privacy

- Many remaining security threats
  - Blackhole routing, DoS
- And some new ones
  - False Interest packet flooding
- Serious privacy risks
  - Everybody can view requests
Key Future Work

• Mobility a hot topic in ICN
  • Many questions left unanswered
• Many researchers identified benefits
  • MANETs: Slinky, Ditto, STEAM
  • DTNs: Haggle, TACO-DTN, PodNet
• Particularly routing
  • Unstructured (flat), off-path caching, social knowledge
Conclusions

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

Not necessarily limitations but challenges that need to be explored