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Maintaining Dynamic Content in Neighborhood Networks

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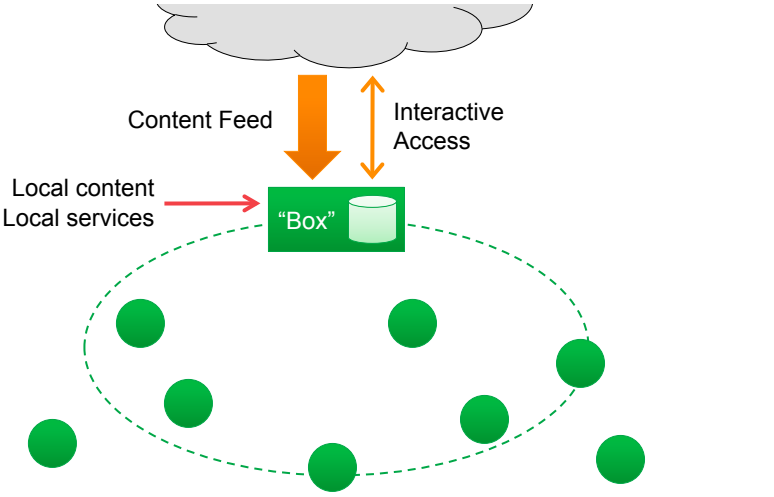
http://www.netlab.tkk.fi/~jo/
4 December 2014

"Internet in a Box"



[Dagstuhl seminar 14471; especially discussions with Gareth Tyson]

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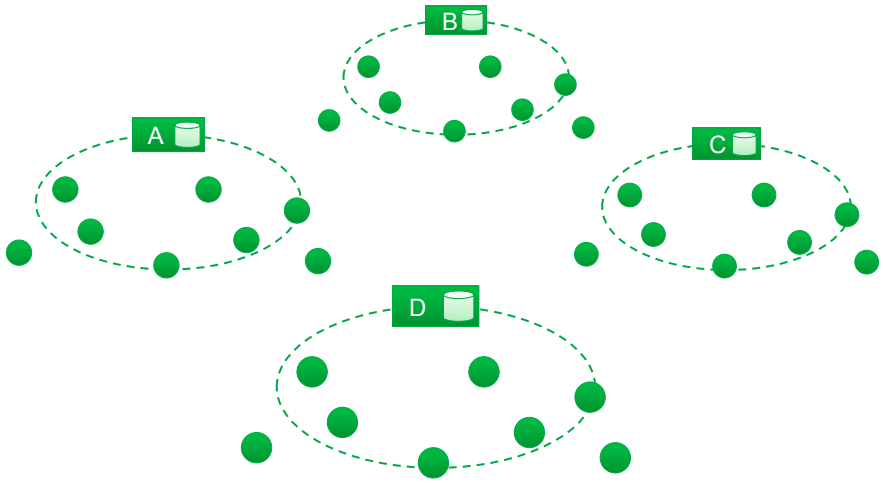
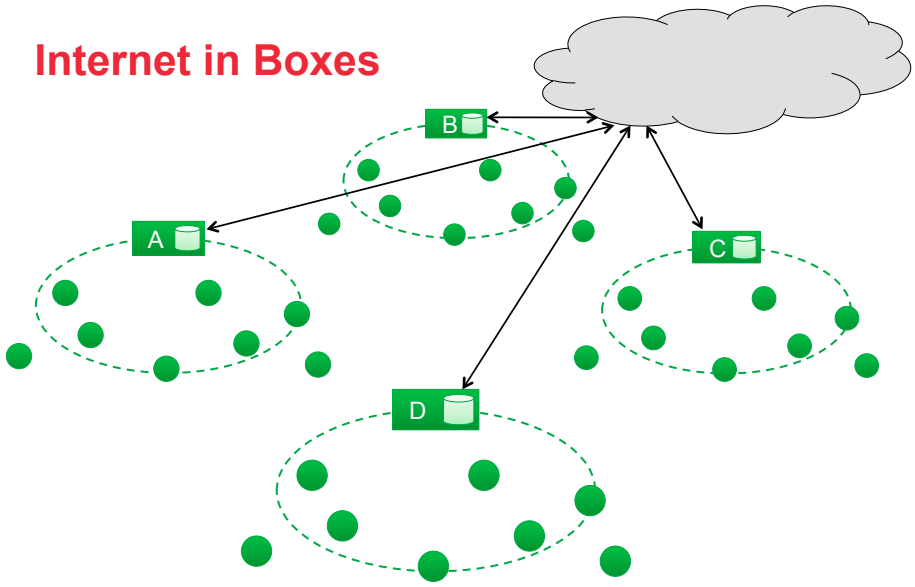
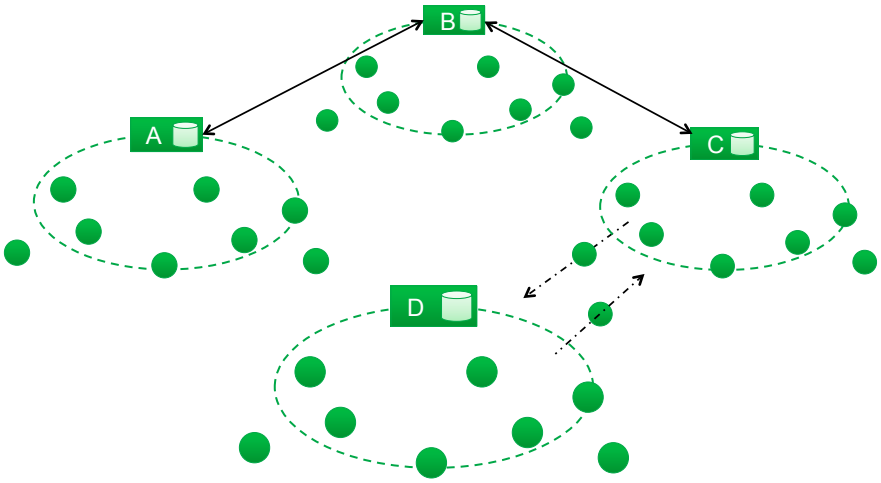
Internet in Boxes



Internet in Boxes



Internet in Boxes



Neighborhood Networking: Localizing Content Sharing

- Keeping content that matters where is matters
- Limiting third party dependencies
- An intuitive understanding of the sharing context: “What is said in the room stays in the room!”

1) Our Boxes: Liberouters
2) Mutable Content
3) Access Control

Do-It-Yourself Networking

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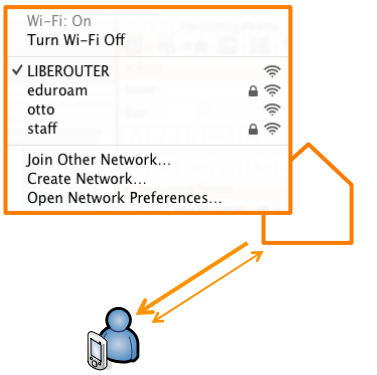
Liberouter

- Basic features
  - WLAN access point
  - Captive portal
  - SCAMPI router
  - Storage node
  - Can mesh with other liberouters
- Applications
  - Android liberouter distribution
  - Native SCAMPI (Java) applications
  - HTML5 applications (SCAMPI-enabled)



Teemu Kärkkäinen, Jörg Ott: Liberouter: Towards Autonomous Neighborhood Networking. Proceedings of IEEE/IFIP WONS, March 2014.

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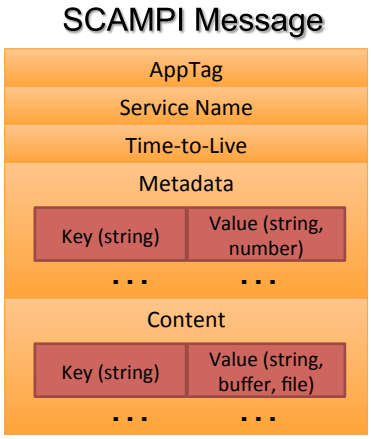
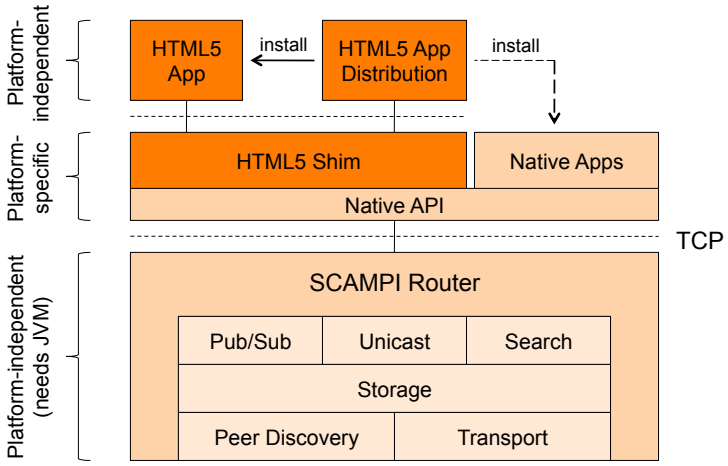
SCAMPI Networking Platform

- Message-based interactions
  - Self-contained ADUs (arbitrary size)
  - Metadata
  - Lifetime
- Unicast / multicast / broadcast
  - Messaging + real-time streams
- Publish / subscribe
- Search using metadata
- Geo-based content sharing (Floating Content)



SCAMPI Platform and Apps

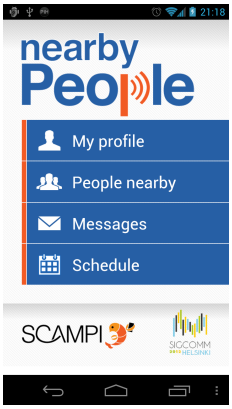


Deploying applications

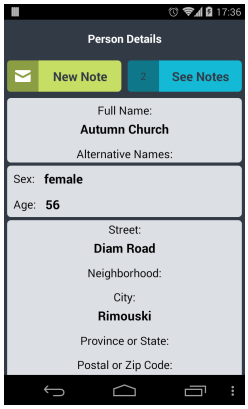
- Liberouter bootstrapping: Web-based download
  - Bootstrapping router code installation to mobiles
  - Native and HTML5 apps
- An app is essentially a (signed) bag of bits
  - Use messaging for distribution
- Distributed instance of an app store: SCAMPI apps
  - Liberouters for storage and replication, web-based access
  - HTML5 app for the devices

Some Apps

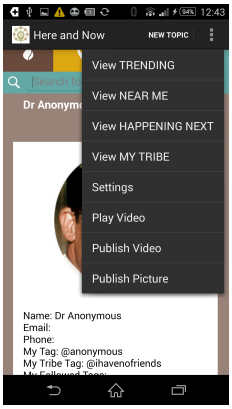
Instant Social Networking



Distributed "People Finder"



Here & Now Experience Sharing



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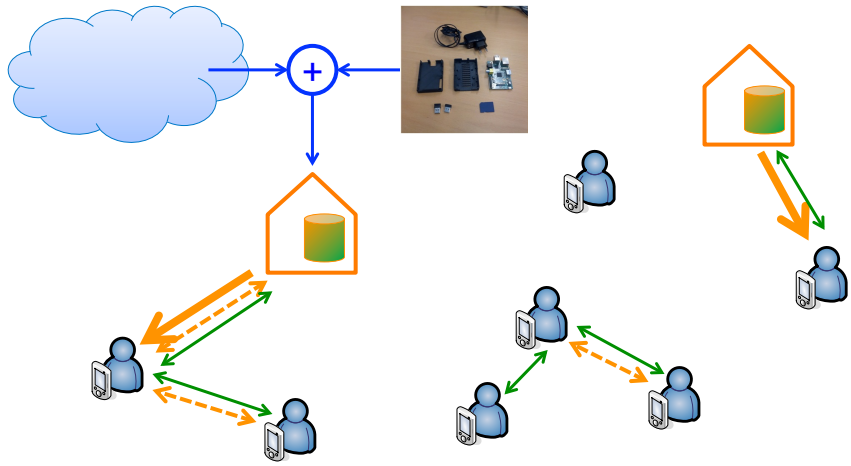
What we have now…



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1) Our Box: Liberouter
2) Mutable Data
3) Access Control

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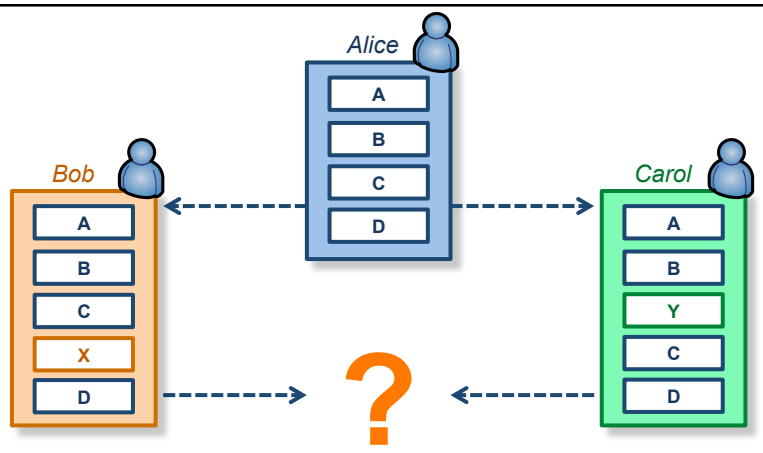
Mutable Data

- DTN and ICN research has focused on routing and caching.
  - Sender + receiver(s) + immutable message
- Arises naturally from numerous applications
  - "Classic" applications: sensor data, bulk data, IPN
  - "Opportunistic" applications: photo sharing, music sharing, messaging
  - "Multimedia" applications: media streaming, a/v messaging
- Leaves out a whole class of applications based on mutable content.
  - Wikis, Google Docs, forums and message boards

How would you build an opportunistic Wikipedia?

Teemu Kärkkäinen, Jörg Ott: Shared Content Editing in Opportunistic Networks. (concise contribution)
Proceedings of the ACM MobiCom CHANTS workshop, September 2014.



1. Pick one, discard one

"Adoption"

2. Create a combination

"Merging"

Adoption

- Pick one of the versions, discard the other
  ⇒ Both nodes will continue on with the same version.
- Multiple possible strategies for making the choice
  1. Pick the larger message
  2. Pick the message with more recent changes
- Pros
  - Simple to implement.
  - No knowledge of content structure.
  - Cannot lead to conflicts.
- Cons
  - Modifications from the discarded version are lost.

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Merging

- Apply a merging algorithm to combine the versions.
  ⇒ Both nodes will continue on with the same version.
- Multiple possible merging algorithms.
  - We use three-way merge, popular in software version control.
- Pros
  - Can retain changes from both versions.
- Cons
  - Can lead to unsolvable conflicts.
  - Might need user intervention.

Some evaluation observations

- Connected vs. opportunistic vs. communities
- Simple adoption strategies work surprisingly well
- Ability to solve conflicts is necessary when using merging
  ⇒ Hybrid strategy: use adoption if conflict can't be solved
  ⇒ UX problem to ask users to solve
  ⇒ Heuristic based automatic solving
- Future Work
  - Solving the conflicts (in the context of applications)
  - Hybrid strategies
  - Specific applications (and editing behavior)

1) Our Box: Liberouter
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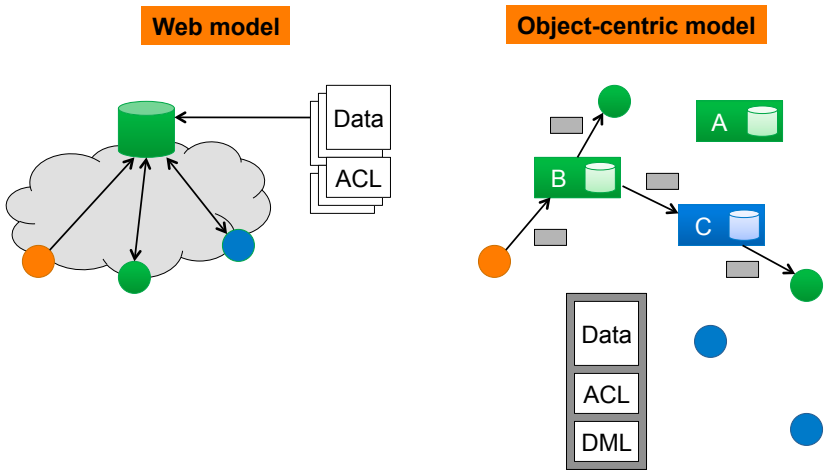
Managing Permissions for Mutable Data



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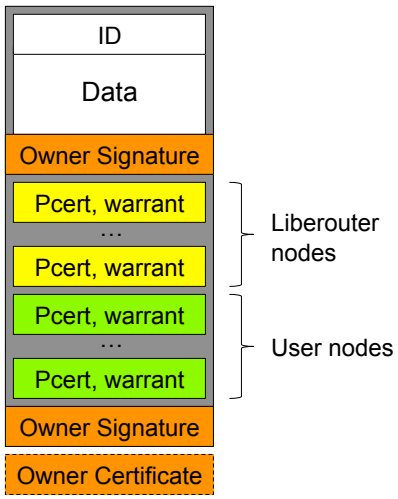
Certificates and Proxy Signatures

- Assumption: at least one local certification authority
  - Low volume certificate + CRL distribution via messaging
- Objects (documents) are signed by the “owner”
- Proxy signatures
  - Owner entitles other nodes to perform actions on its behalf (read: perform content modifications)
  - Liberouters: designate who may carry out content updates (adoption or merge operations)
  - Users: designate who is allow to submit content update requests (add/delete/edit parts)

A Sample Object



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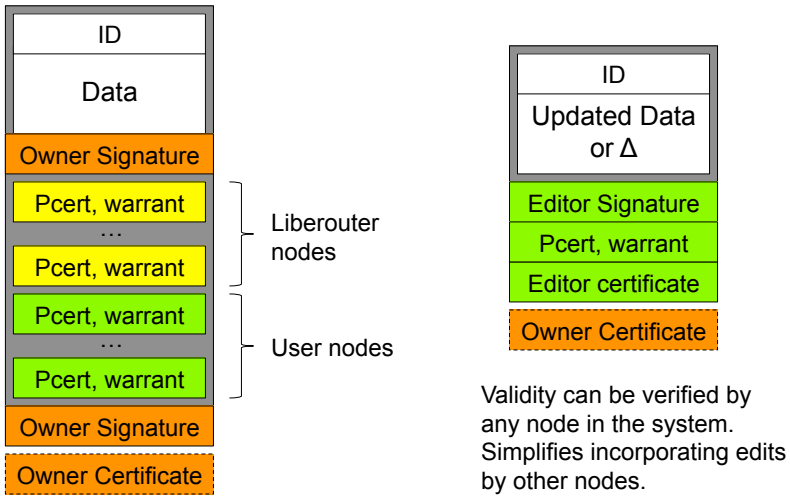
A Sample Object: Modification Request



Validity can be verified by any node in the system. Simplifies incorporating edits by other nodes.

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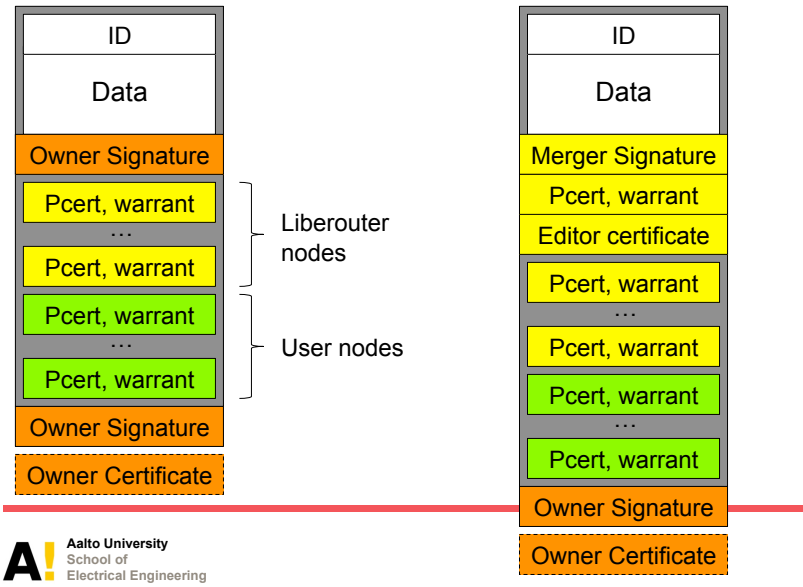
A Sample Object: Merged Edits



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Evaluation in Progress

- Implemented a distributed “Google Docs”-style application
- Quantitative evaluation in progress
  - Different editing models
  - Different classes of community mobility

Arseny Kurnikov, Teemu Kärkkäinen, Jörg Ott: Data to the People. (poster paper)
Proceedings of the ACM MobiCom CHANTS workshop, September 2013.

Conclusion

- Don’t consider just *the* Internet
  - Local interactions matter
- Allow for dual operation
- DIY networking with minimal dependency on the Internet
- Creating a somewhat autonomous ecosystem
- Exploit the existence of local communities for security
- Lowering the barrier for participation: web browsers

Marcin Nagy, Teemu Kärkkäinen, Jörg Ott: Enhancing Opportunistic Networks with Legacy Nodes.
Proceedings of the ACM MobiCom CHANTS workshop, September 2014.

http://www.ict-scampi.eu/results/scampi-liberouter/

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