ComputerScience

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Supporting Predicate Routing in DTN over MANET

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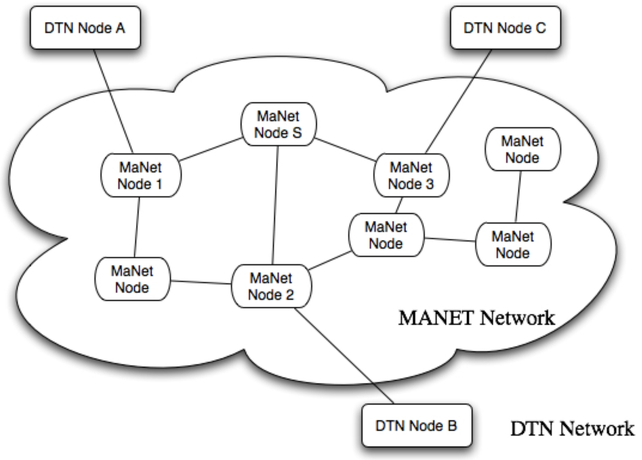
Abstract:

Predicative routing allows Delay Tolerant Network users to declaratively express high-level policy constraints on the routing in the underlying MANET network, e.g. direct all images captured by camera X attached to a MANET-only node S to DTN node B for pre-processing and authorization before sending them to the user at DTN node C. In order to evaluate efficiency of the mapping between high-level constraints of DTN nodes to low-level routing predicates within the MANET nodes for different use cases, we implemented a testbed. This testbed uses a Linux system architecture with a User-Mode-Linux (*UML*) to emulate every node with the AODV routing protocol at MANET level and with or without a DTN Reference Implementation code. The network simulator *ns-2* (ns-emulation version) is used to simulate the mobility of both DTN and MANET nodes.



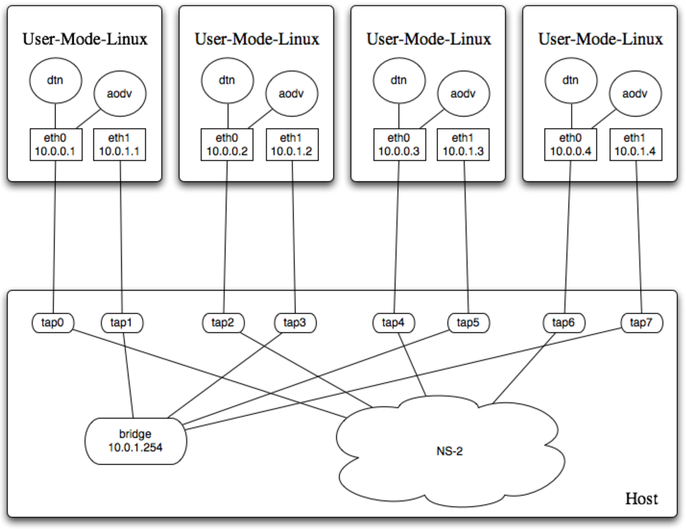
Scenario:

Integrating DTN and MANET with a new convergence layer: Predicate Routing is implemented using efficient data structures storing firewall-style rules.

Predicate Routing in Action:

Direct all images captured by camera X to DTN node B for pre-processing and authorization before sending them to the user at DTN node C.

- Propagate this high-level constraint down to the MANET-level in the network.
- The developed system ends up installing at all nodes the MANET-level forwarding rules shown in Table 1.
- First rule: All S -traffic destined to C but not yet pre-screened at B directed to B.
- Second rule: Forward pre-screened traffic directly to C.



Proposed testbed:

Each emulated node has an AODV daemon running; some of the emulated nodes are DTN nodes running a DTN reference implementation. A machine hosts *ns-2* to simulate wireless connectivity and mobility of emulated nodes. A control network is also established to remotely control the application on the emulated nodes during scenario execution.

Predicate	Next Hop
src = S and dest = C	To B
src = B and dest = C	To C

Table 1: Direct Traffic Originating from a pure MANET node (S) to an intermediate DTN node (B).

Predicate	Next Hop
src != B and dest = C	To B
src = B and dest = C	To C

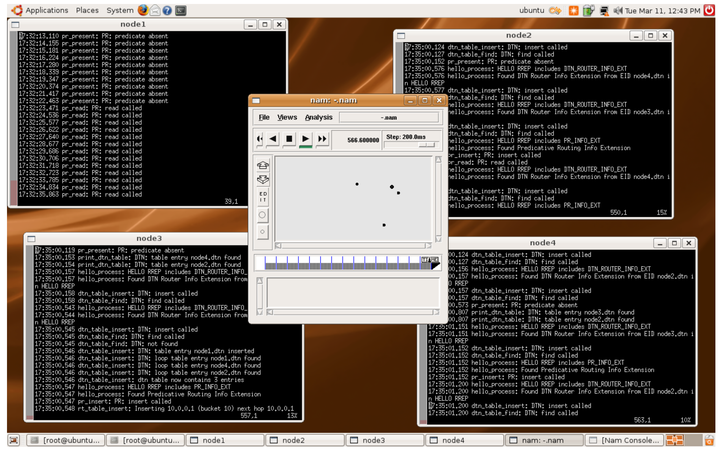
Table 2: Direct all traffic to an intermediate DTN Node (B).

Contribution:

- Integration of two different network architectures: DTN content-aware and the underlying (often resource-constrained) MANET substrate.
- A convergence layer to map DTN-level requirements to low-level routing within the MANET nodes.

Implementation of an efficient predicate-based processing at the MANET-level. To this end, the following issues are addressed:

- DTN Neighbor Discovery mechanism (partially addressed in [1]).
- Propagation of constraints at the DTN down to the MANET level through AODV-like HELLO messages.
- Installation of routing rules using Linux *iptables* facility.



Testbed Trial:

All the nodes are active: when node 1 reads the predicate, it floods it piggybacked on the AODV HELLO messages. At the end of the simulation all the other nodes have the predicate stored. Mobility is simulated with ns-2.

Predicate Propagation:

The central window (ns-2 GUI) shows the mobility. The lowerleft window shows at simulation time 17:35:00:547 the HELLO message when the predicate is recived at node 3. The same happens also for node 2 and node 4 (for the latter, at simulation time 17:35:01:152). The predicate is correctly installed in every node.

References:

[1] J.Ott, D.Kutscher, and C.Dwertmann. Integrating DTN and MANET Routing. 2006 SIGCOMM Workshop on Challenged Networks, p. 221–228, New York, NY,USA, 2006. ACM.

[2] G.Ferrari Aggradi, F.Esposito and I.Matta. Predicate Routing for DTN over MANET. 2008 Boston University Technical Report.