A Backward-Compatible Protocol for Inter-routing over Heterogeneous Overlay Networks

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Problem

Overlay network co-operation

- Overlay networks currently cannot co-operate due to the incompatibilities in topologies, routing algorithms and types of queries.
- Advantages of inter-overlay co-operation: increased search space in file sharing systems, simple localization of participating overlays, and easily achievable content redundancy.

Solution

A super-overlay for enabling co-operation

A small number of peers from each of the standard overlay networks run Overlay Gateway Protocol (OGP), in addition to their native protocols. These peers form a super-overlay (the OGP overlay) equipped with efficient algorithms to perform unicast, broadcast, and multicast of messages from one standard overlay to others. Peers forming the OGP overlay play the role of "gateways" for other peers can reach across standard overlays they are not members of.

System model

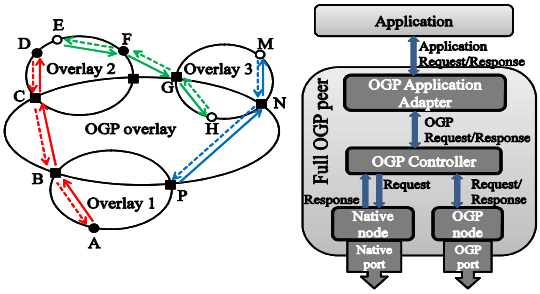

Fig. 1: (a) The OGP Topology (b) A full OGP peer.

Classification of Peers

1. ***Blind peers:*** belong to only one standard overlay, and are not aware of the existence of the OGP protocol.
2. ***Lightweight OGP peers:*** belong only to one standard overlay, but keep a list of full OGP peers.
3. ***Full OGP peers:*** simultaneously belong to one standard overlay and the OGP overlay.

Inter-routing schemes

1. ***OGP Unicast:*** full OGP peers route requests into only one standard overlay different from the one the request originated from.
2. ***OGP Multicast:*** full OGP peers route requests into multiple destination overlays different from the one the request originated from.
3. ***OGP Broadcast:*** full OGP peers route requests into all overlays different from the one the request originated from.

Evaluation setup

- The full OGP protocol has been implemented, and has been deployed on the French Grid5000 platform.
- The broadcast routing scheme is used.
- The full and lightweight OGP peers periodically looked up a random piece of data on any of the standard overlays. The blind peers periodically looked up data existing on their standard overlays.

Three experimental scenarios

- The first and the second scenarios evaluate the metrics of the OGP protocol when performing data lookup with only one and several kind of standard overlays, respectively while the third serves to evaluate the metrics of the lightweight OGP protocol in performing data lookup with only one kind of overlay.
- The values of experimental parameters in three scenarios are described in three columns in the Table 1 below respectively.

	Scenario 1	Scenario 2	Scenario 3
% of OGP peers	6, 10, 20, 30, 40	6, 10, 20, 30, 40	10, 20
% of Light OGP peers	Not applicable	Not applicable	10, 20, 40, 60
Lifetime mean (s)	900, 1800, 3600	900, 1800, 3600	1800
Type of overlays	Chord	Chord, Kademlia, Gnutella	Chord
No. of overlays	20	20	20
No. of nodes per overlay	50	50	50

Table 1: Values of experimental parameters in the three experimental scenarios

Results

Successful operation: show how well the full OGP peers and lightweight OGP peers perform their lookup activity.

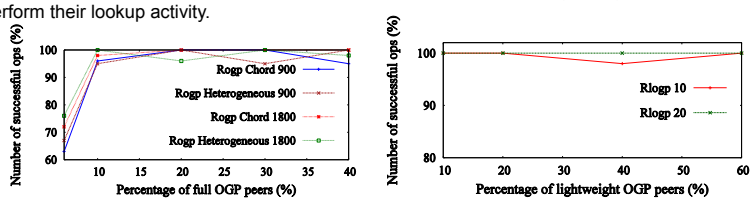

Fig. 2: Ratio of successful hops of a full OGP node (left) and a Light OGP node (right).
Both full OGP peers and lightweight OGP peers gain high ratio of successful operation, larger than 95%, when the percentage of full OGP peers per overlay larger than 10%.

Generated traffic: show the traffic generated by a full OGP peer and a lightweight OGP peer.

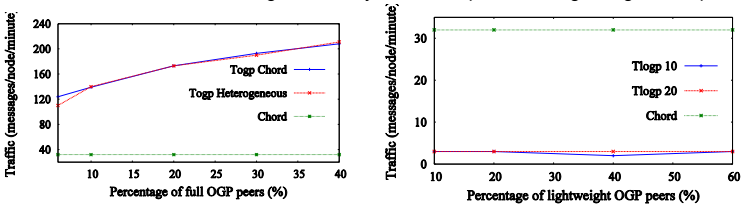

Fig. 3: Traffic of a full OGP node (left) and a Light OGP node (right) on the OGP overlay.
The traffic generated by a full OGP peer is quite large while the traffic generated by a lightweight OGP peer is very small, only 3 messages/node/minutes.

Latency: show path length that request and response cover over the OGP overlay in the successful lookups.

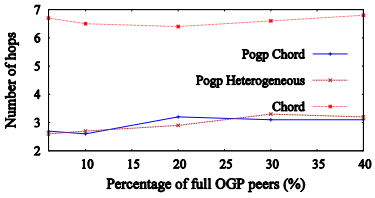

Fig. 4: Path length on the OGP overlay in a successful lookup performed by a full OGP node. The path length slightly increases, from about 2:6 to about 3:3 as the percentage of full OGP peers rises from 6% to 40% in the inter-connecting system with 20 overlays, each contains 50 nodes.

Conclusions

- Having only 10% of peers as full OGP peers is sufficient for achieving a success ratio of round trip inter-overlay routing operations larger than 95%.
- Both full and lightweight OGP peers are proven to be efficient in terms of the path length needed for data lookup.
- A lightweight OGP peer generates the traffic nearly as same as that generated by a standard peer. The traffic generated by a full OGP peer on it is considerably larger than the traffic generated by a standard peer.
- Further work: thorough investigation of the efficiency of the OGP protocol on larger systems.