Scalability Analysis of the TurfNet Architecture

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Outline

• TurfNet overview
• Internet-derived model
• scalability analysis
• future work
• conclusion
TurfNet Highlights

• next-generation Internet architecture
• dynamic federation of independent, composable network domains
• identity/locator split with global identities
• inherent multihoming and mobility
• implicit, hierarchical interdomain routing

Turf Components

Turf Control
logical entity for intra-turf control functions and inter-turf communication

Gateway
unique node ID; translates multiple intra-turf protocols

Turf Node
unique node ID; speaks intra-turf protocols
Inter-Turf Communication

A registers with the local Turf Control
TC1 forwards registration to composed turfs, which allocate local addresses for A and install translation state at their gateways.
Inter-Turf Communication

B initiates communication with A by looking up its address
Inter-Turf Communication

B communicates with A end-to-end; gateway adds return translation state for B
TurfNet Hierarchy

- similar to Internet ASs
- dynamic, self-configuring according to interconnect types (customer/provider vs. peering)
- inherent routing
- resolution guarantee
- flexible optimizations

lookup request for $N$
node registration for $N$
Optimizations

• use peer interconnects for registration and/or resolution
• selective registration
• push-down caching
• others – only need to terminate at root
Reality Check

• can TurfNet support very large internetworks?

• how would a very large TurfNet hierarchy look like?

• assumption: similar to the Internet’s AS-level topology, i.e., AS \cong Turf
Modeling a Global TurfNet

• derive AS-level topology from BGP tables

• infer “peering” and “provider” interconnect types

• infer hierarchy levels

<table>
<thead>
<tr>
<th>Level</th>
<th>AS Count</th>
<th>Avg. Distance</th>
<th>Diameter</th>
<th>Avg. AS Degree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>22</td>
<td>1.25</td>
<td>2</td>
<td>15.8</td>
</tr>
<tr>
<td>2</td>
<td>215</td>
<td>3.90</td>
<td>10</td>
<td>5.7</td>
</tr>
<tr>
<td>3</td>
<td>1391</td>
<td>1.98</td>
<td>11</td>
<td>1.0</td>
</tr>
<tr>
<td>4</td>
<td>1421</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>13872</td>
<td></td>
<td></td>
<td>no peering</td>
</tr>
</tbody>
</table>

Communication Assumptions

- Internet-like communication patterns
- 1 billion level-1 nodes ("hosts")
- only hosts communicate
- 0.01 communications/second/host
- all hosts globally reachable

Aggregate Lookup Load

Hierarchy Level

Requests/Second (Millions)

level 0 is “virtual” root

“scope n” = propagate registration request across n peering hops

Scope 0
Scope 1
Scope 2

level 5 omitted (only hosts)
Load Variances

lookups arriving at different level-1 Turfs with scope 2

Requests/Second (Millions)

mean = 1.68e6

Turf Identifier

2828 4565 3320 4200 5650 174 6453 5511 4323 4500 1299 7911 6453 3561 2914 3549 8220 7018 3356 1239 701
Load Variances CDF

Fraction of Turfs at Level [%]

Requests/Second/Turf
Mean Registration
Table Sizes

<table>
<thead>
<tr>
<th>Entries/Turf (Billions)</th>
<th>Hierarchy Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scope 0</td>
<td>0.0</td>
</tr>
<tr>
<td>Scope 1</td>
<td>0.2</td>
</tr>
<tr>
<td>Scope 2</td>
<td>0.4</td>
</tr>
</tbody>
</table>

note: assumption was all hosts globally reachable

here, registrations are forwarded across peering interconnects – can alternatively reduce state by forwarding lookups, increases delay
Recent Results

- enhanced lookup mechanism that intelligently forwards up the hierarchy
- reduces lookup load by up to 80%
- additional analyses, such as mean hop count for successful resolution
Ongoing Work

• prototype implementation
• design and evaluation of mobility mechanisms
• design and evaluation of enhanced registration and resolution mechanisms
• revisiting the assumptions underlying this analysis
Conclusion

- AFAWK first attempt at evaluating the scalability of a next-gen architecture
- calibrated model with Internet characteristics
- TurfNet appears to be technically feasible; more work needed

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