Evaluations of Growth-based Address Partitioning (GAP) Algorithm with Real Data

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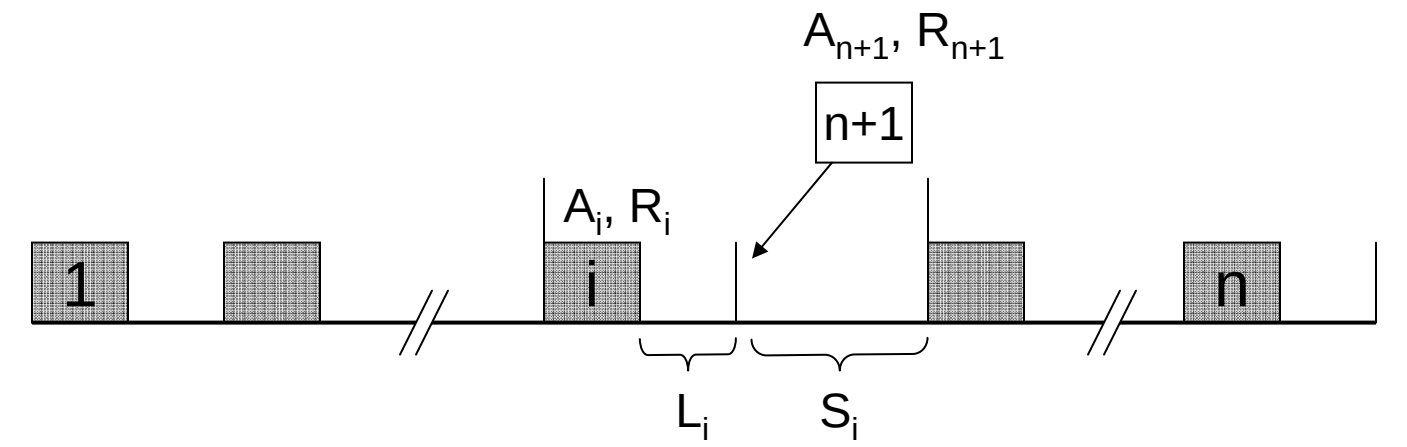
Outline

I. Problem definitions
II. Performance results
III. Allocation software demo
IV. Further work

I. Problem Definitions

- Research shows that address allocation is key to the routing table size and structure, thus, the routing efficiency and scalability of the network
- Need an optimal solution
  - Less fragmentation ➔ smaller routing table size ➔ scalability
  - Many variables play a role: limited address space pool available, customer request sizes and frequencies, growth rates…
  - Need a systematic method to guide address allocation in practice, applicable at all levels.
  - Online optimal is hard, find a solution that balances being simple and close to optimum.
- We proposed a new algorithm GAP: Growth-based Address Partitioning towards this goal

Growth-based Address Partitioning (GAP)

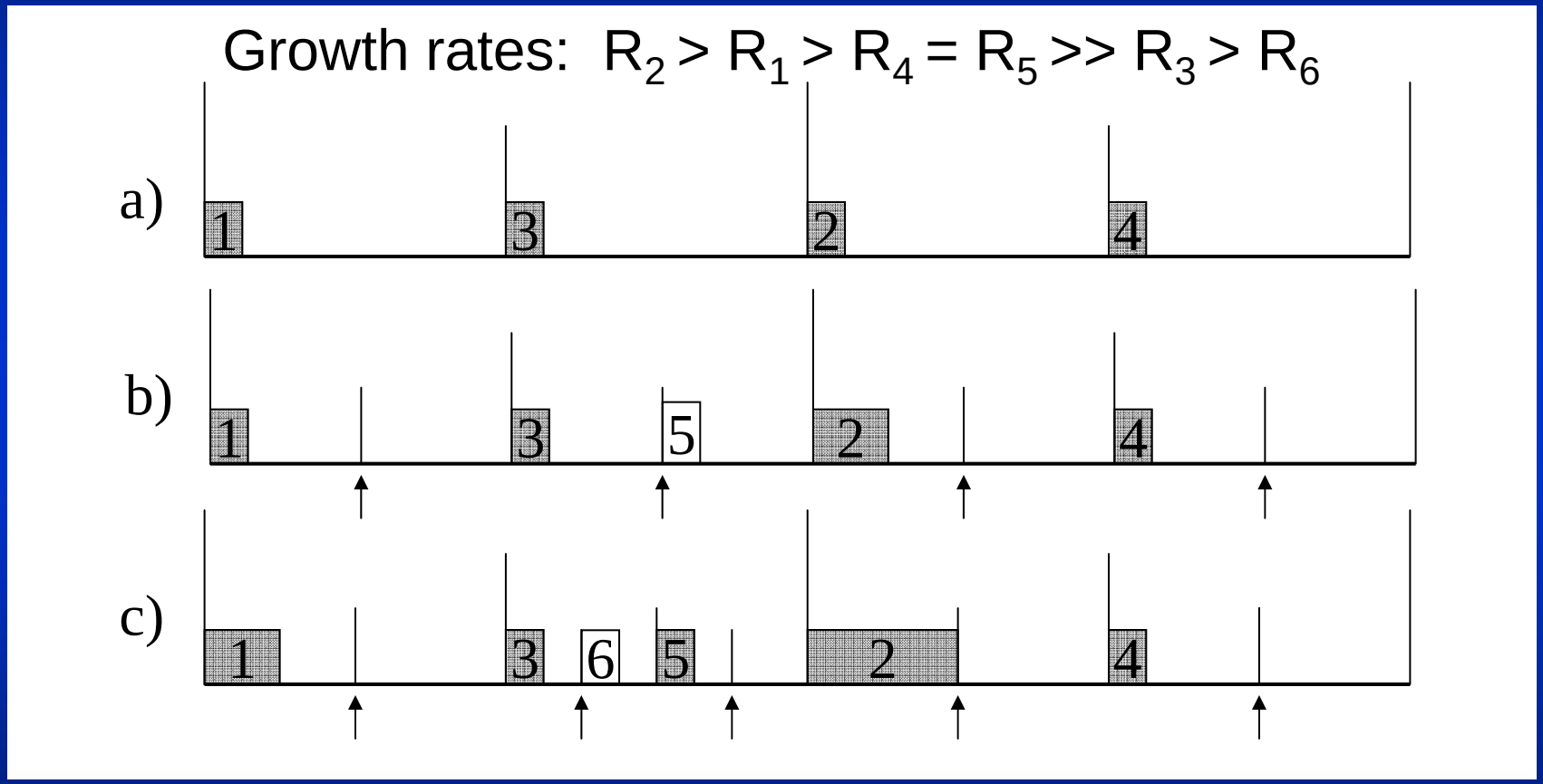


$$\max\{\min[t(L_i, R_i),\ t(S_i, R_{n+1})],\ \ i = 1,\ldots,n\}$$

- Treat each address assignment uniquely by allocating according to its size and potential speed of its expansion
- For the new coming customer with growth rate R_{n+1}, find a slot that maximizes the time it takes before a collision. Collision is a cause of fragmentation

$\max\{\min[t(L_i, R_i),\ t(S_i, R_{n+1})],\ i = 1,...,n\}$

Growth-based Address Partitioning (GAP) -- Example



Allocate addresses according to growth-rates.

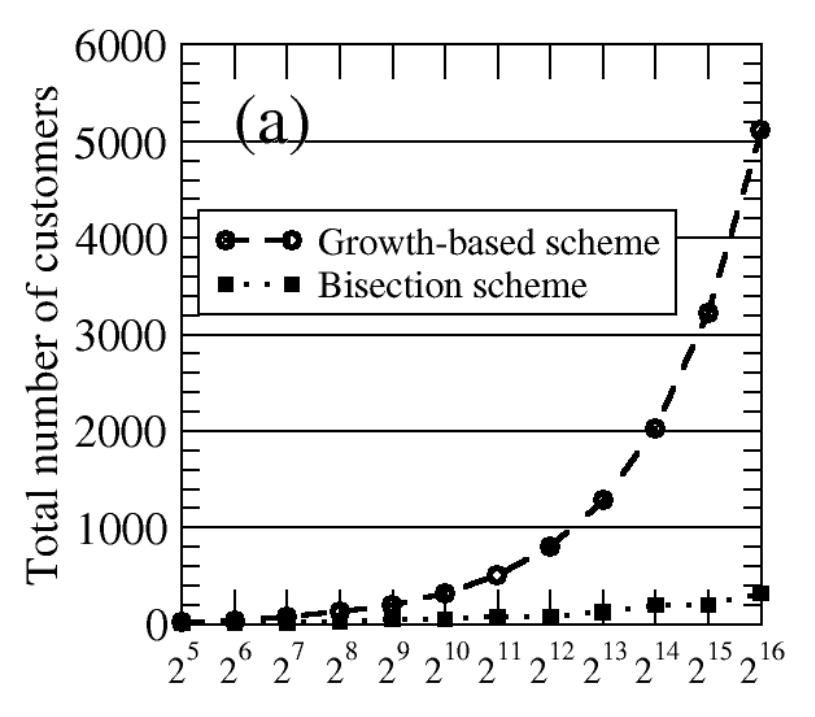
II. Performance Results

- Theoretical analysis (Done, presented before)
- Simulations (Done, presented before)
- Experiments with real data

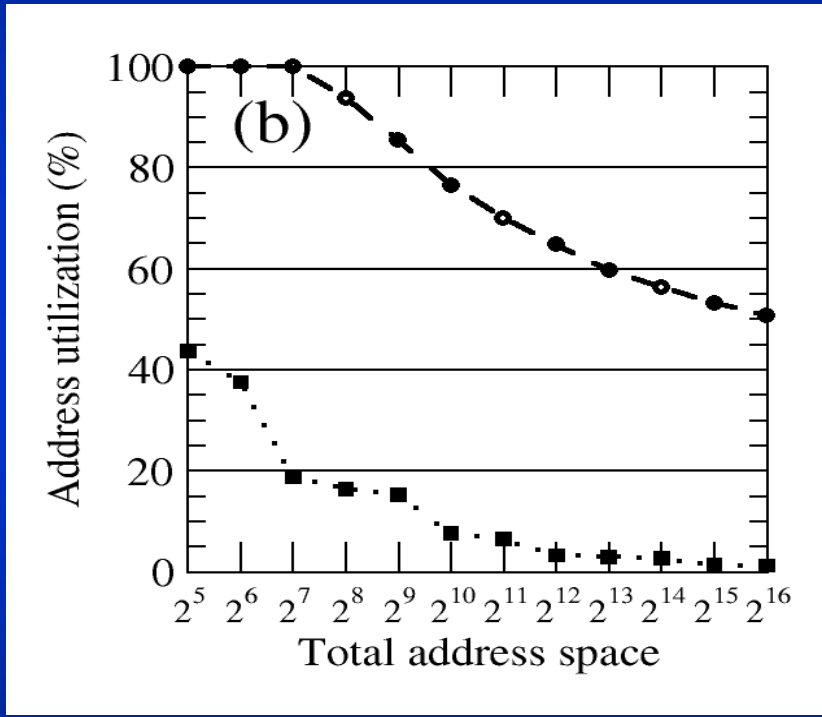
  (Latest development, today's focus)
  - APNIC data
  - CNNIC data

Simulation Results Review – Space

Number of customers served



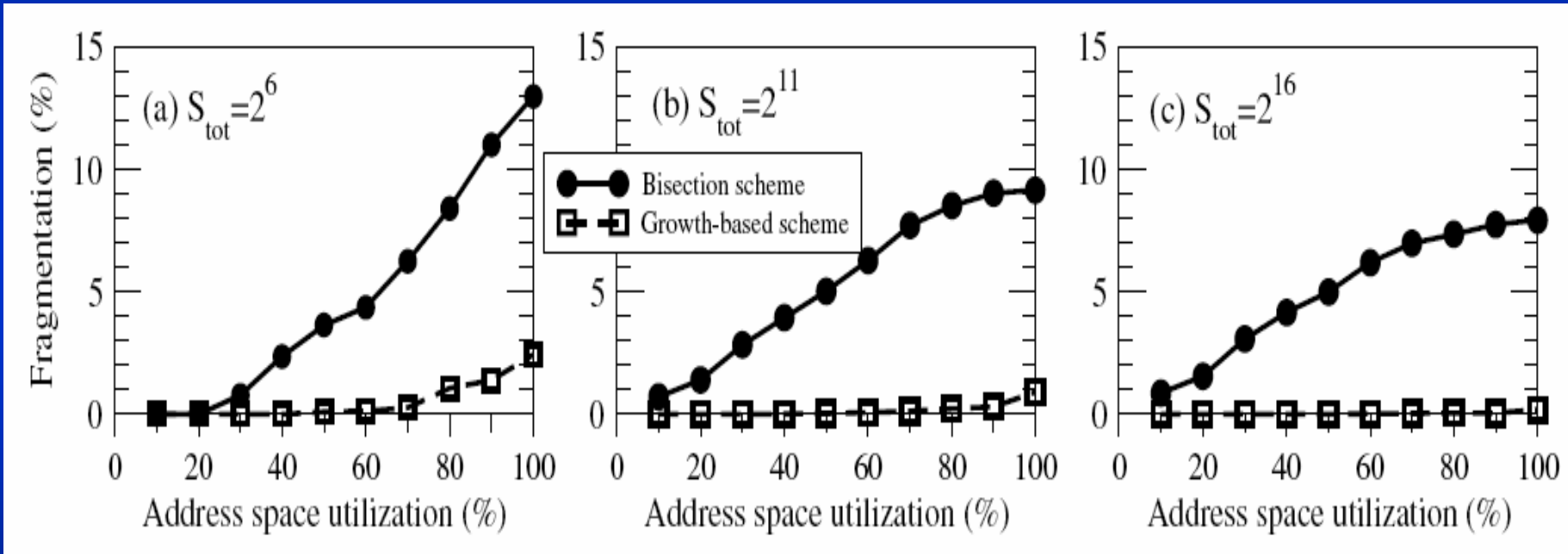
Address space occupied



The more number of customers served and the more address space is allocated without fragmentation, the better the allocation algorithm is.

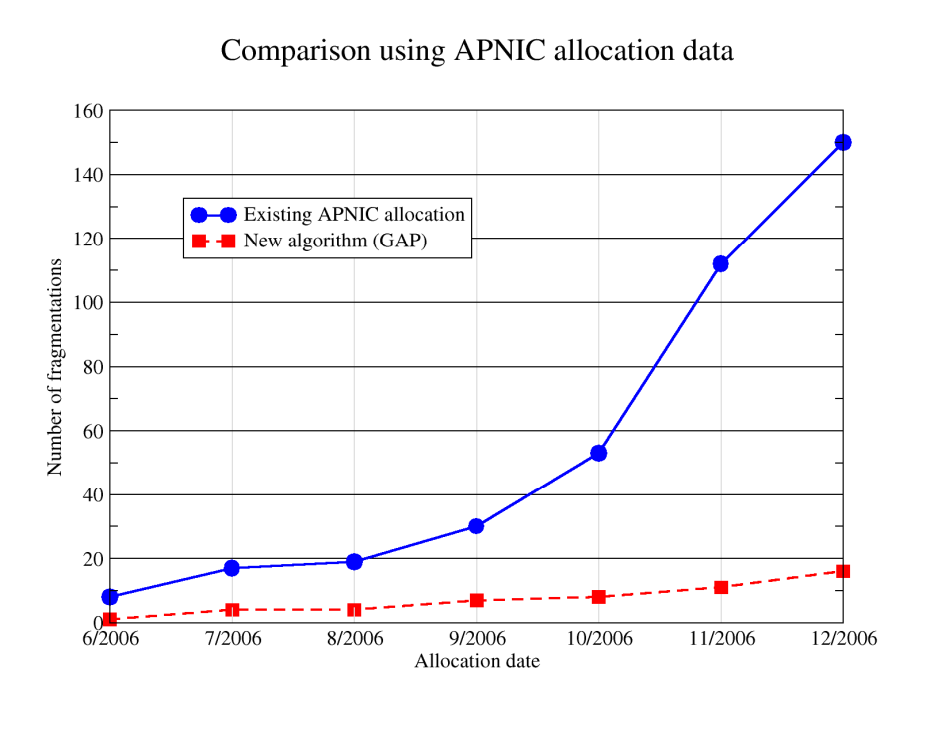
Simulation Results Review--Fragmentation

Fragmentation Percentage



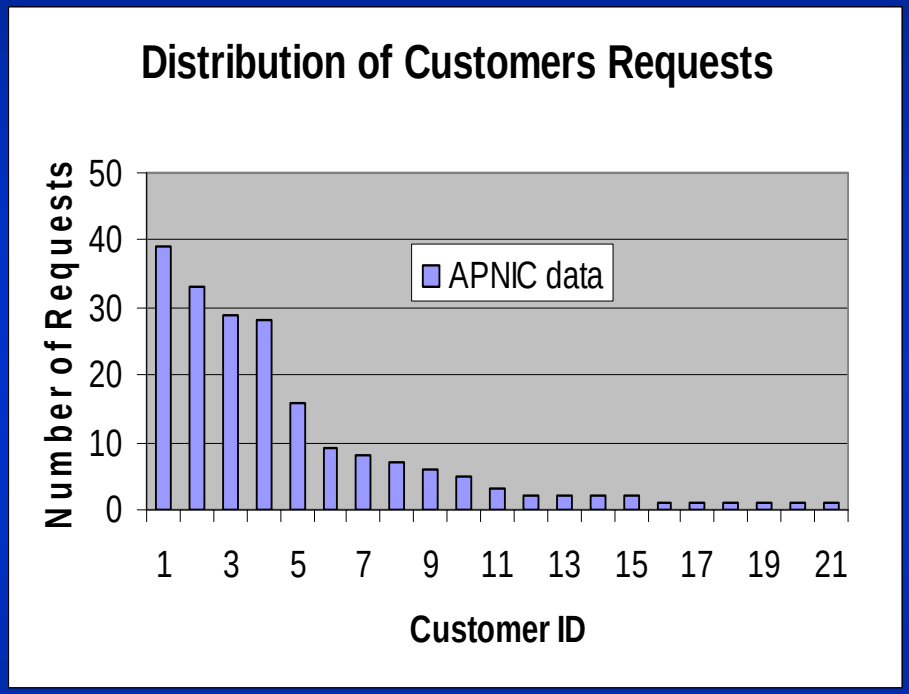
GAP dramatically reduces fragmentation compared to bisection scheme for any percentage of address space utilization.

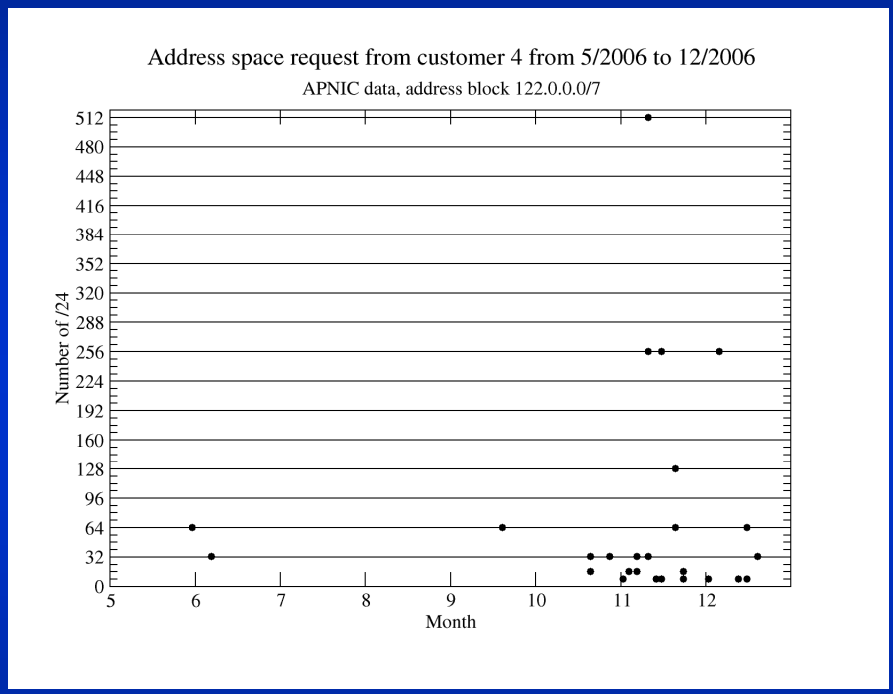
Real Data – APNIC IPv4



- Fragmentation is reduced from 150 to 16 using GAP compared to existing allocation.
- No additional input was required.
- Larger enhancements can be accomplished if customers provide growth-rate estimations..

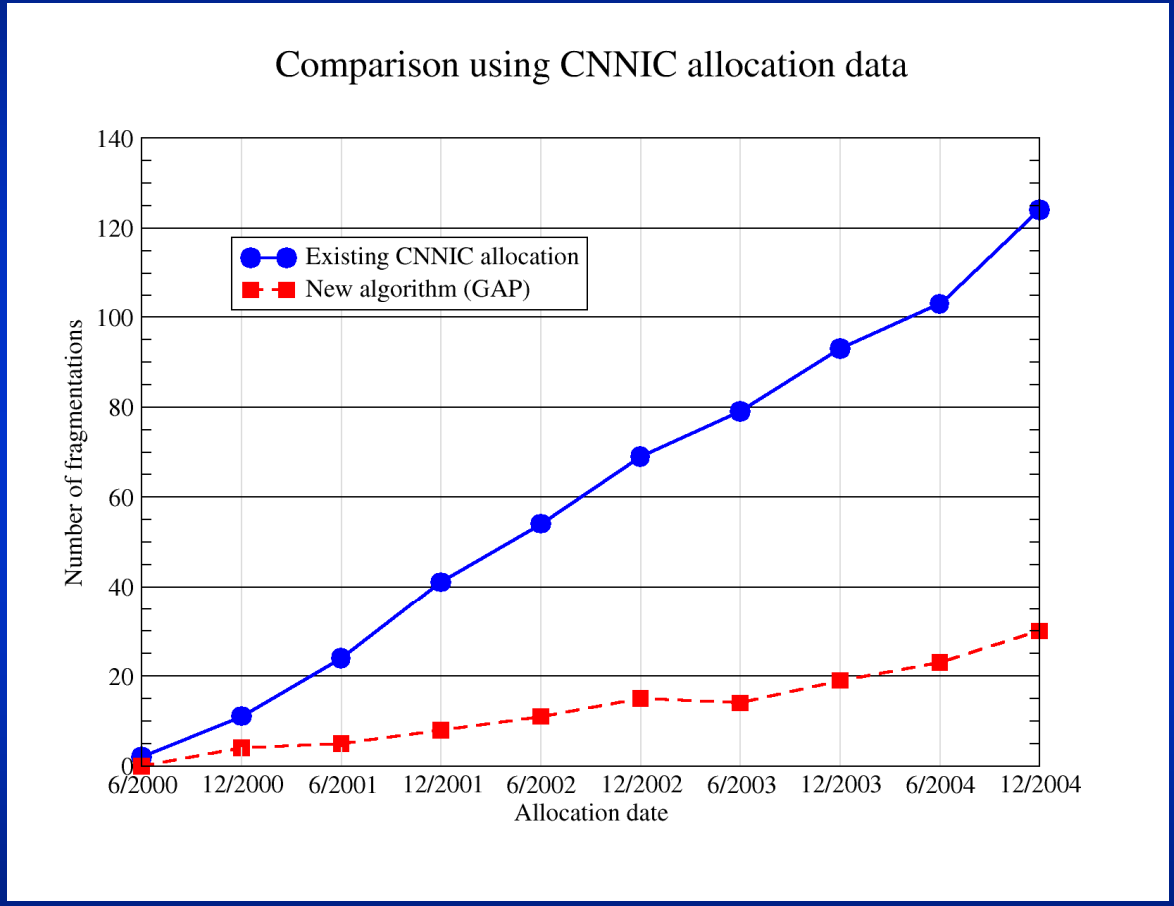
Statistics on APNIC Data





- Number of customers is 21
- Address space is 2^14
- Number of requests is 197

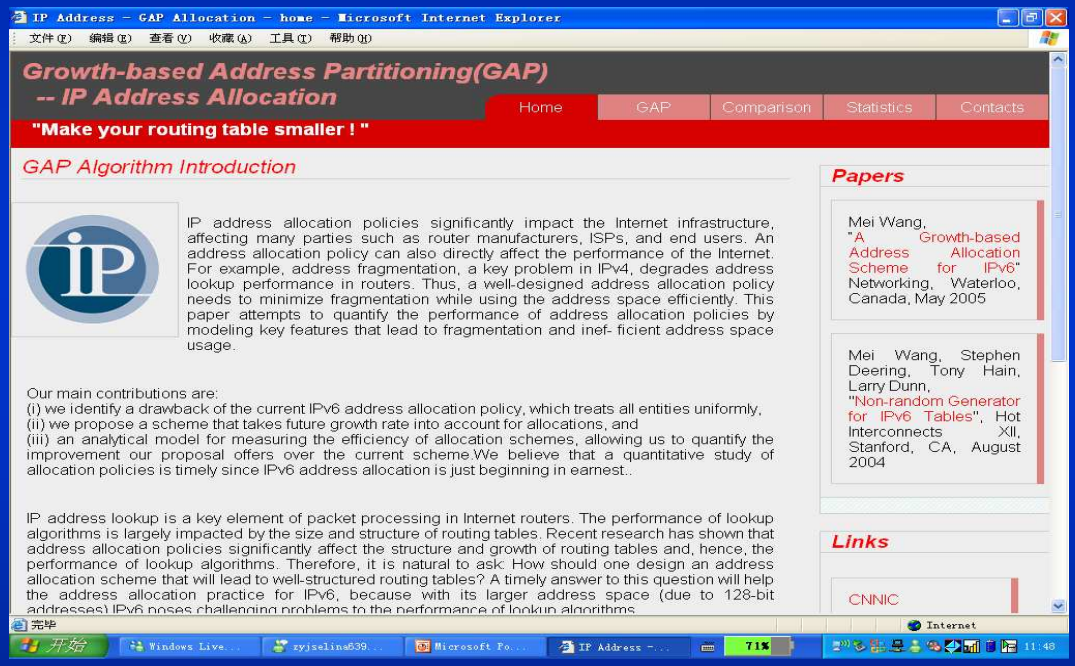
Real Data – CNNIC IPv4



Fragmentation is reduced from 124 to 30 using GAP compared to existing allocation

Software Tool for Address Allocation

http://gap.asrc.cn



- Being jointly developed by CNNIC and Cisco
- Provides a platform for more studies, experiments, and real allocations in the future

Summary of Address Allocation Methods

- Sequential
  - Given fixed sizes without growth, this is the best fit.
- Bisection
  - Provide each customer the max space to grow.
- GAP: Growth-based Address Partitioning
  - Leverage customer growth-rates, balance performance and simplicity.

Further Work

- Get your participation, stimulate more interests in IPv6 address allocation, a working group?
- Joint efforts on reaching a balanced optimum solution
  - Good performance
  - Simple and practical
  - Different requirements
- Further studies and verifications using real data
- Implement and provide a working system for efficient address allocations in the real world
- Make address allocations more systematic, efficient, consistent, and easier across all layers

Thank You

Q&A

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