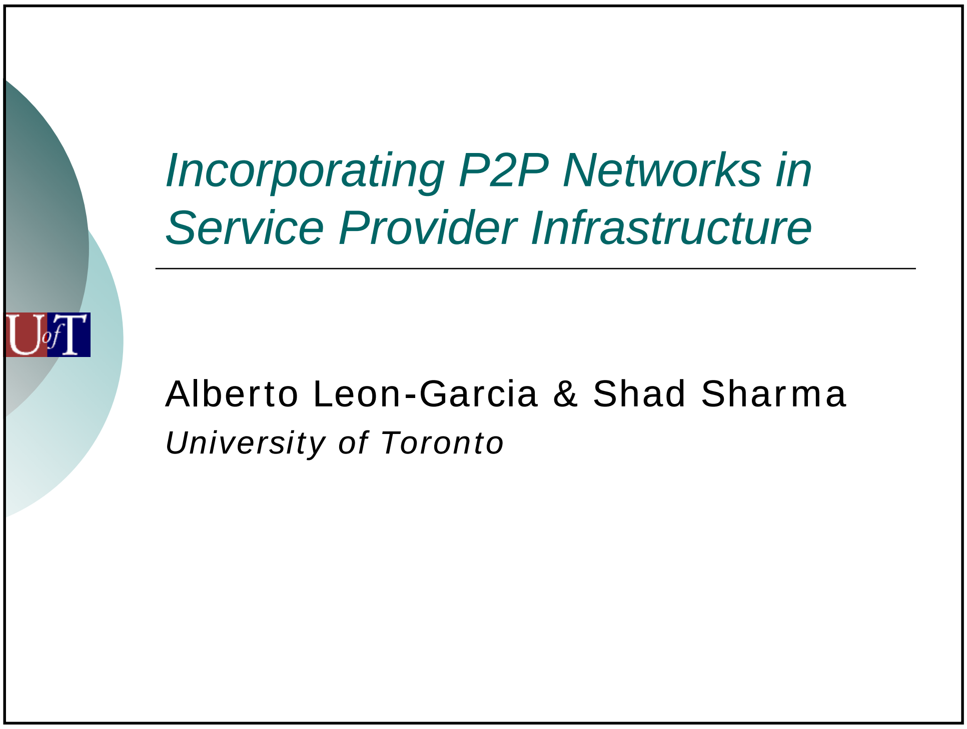

Incorporating P2P Networks in Service Provider Infrastructure

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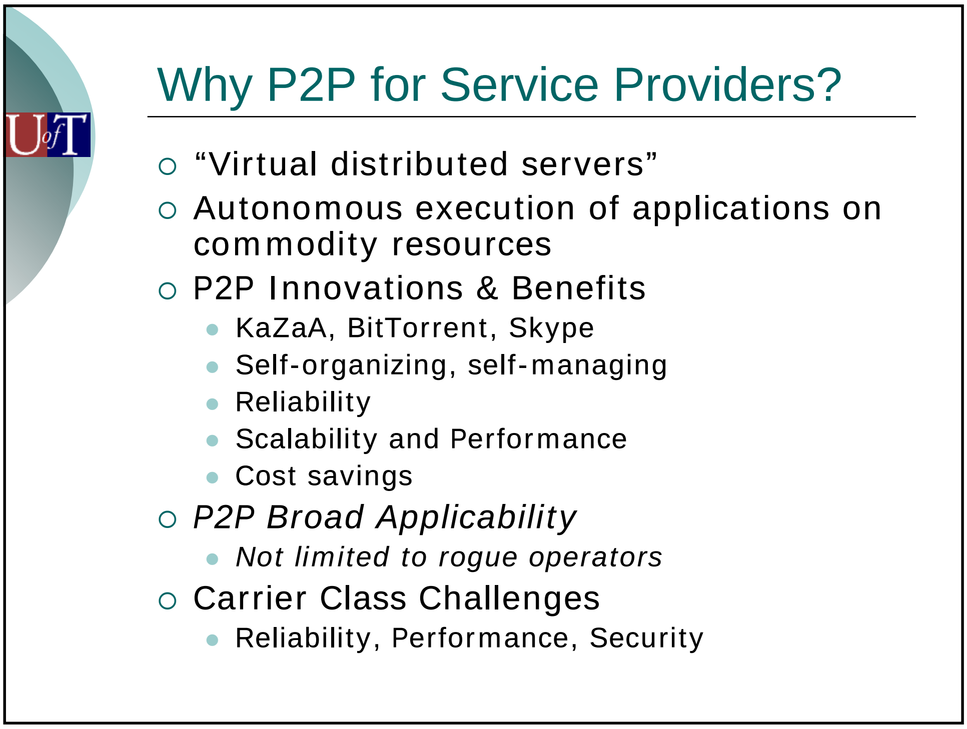
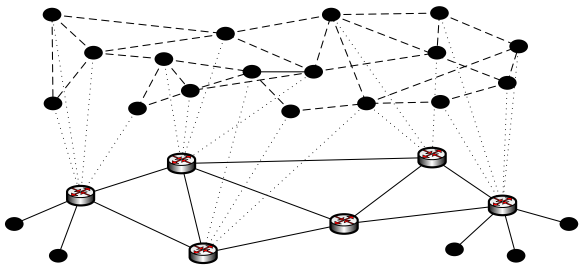


Why P2P for Service Providers?

- "Virtual distributed servers"
- Autonomous execution of applications on commodity resources
- P2P Innovations & Benefits
  - KaZaA, BitTorrent, Skype
  - Self-organizing, self-managing
  - Reliability
  - Scalability and Performance
  - Cost savings
- *P2P Broad Applicability*
  - *Not limited to rogue operators*
- Carrier Class Challenges
  - Reliability, Performance, Security

Introduction

- Overlay Topology
  - Application layer routing
  - Nodes maintain logical neighbours to whom they forward messages
- P2P Applications
  - Content Delivery
  - Lookups and Search
  - Service Virtualization
    - E.g. P2P HTTP server



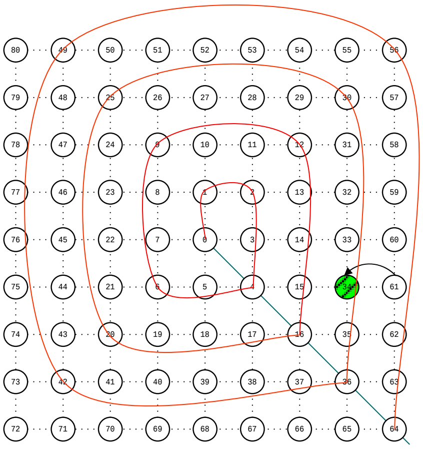
Distributed Hashing

- Hash table
  - Defines set of buckets that hold objects
- Hash function
  - Distributes *objects* into *buckets*
  - Objects distributed “uniformly” among buckets
- Distributed Hash Table
  - Nodes are the buckets that store objects
  - Objects: files/resources/things you want to find/store
- Structured overlays well suited to providing DHT services
  - Predefined positions assigned to peers
  - Peers assigned hash values (buckets)

Introduction

Unstructured Overlays + Robust, reliable, fast insertion and removal – Broadcast based search O(m^th^ root(n)) search time O(m x n) search messages	Newscast Epidemic protocol based on gossiping Montressor Dual layer approach: Newscast substrate
Structured Overlay + Fast & efficient DHT search $O(\log_B(n))$ search time $O(\log_B(n))$ search messages Routing table maintenance required – Not robust under churn	Chord Structured DHT capable overlays Rigid finger tables Kademlia Loosely consistent DHT overlay Relaxed finger tables
Hybrid Overlay + Fast & efficient DHT search + Robust, reliable, fast insertion and removal + Resilient to churn	TrebleCast

TrebleCast (1)

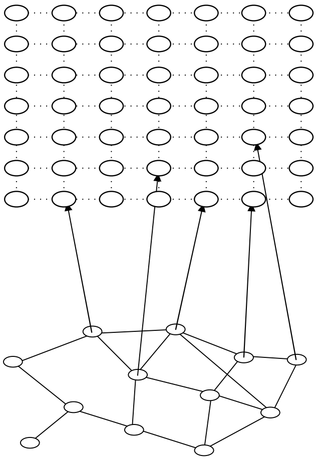


80	49	50	51	52	53	54	55	56
79	48	25	26	27	28	29	30	57
78	47	24	9	10	11	12	31	58
77	46	23	8	1	2	13	32	59
76	45	22	7	0	3	14	33	60
75	44	21	6	5	4	15	34	61
74	43	20	19	18	17	16	35	62
73	42	41	40	39	38	37	36	63
72	71	70	69	68	67	66	65	64

- Peers inserted in order in spiral-like fashion
- Spiral - Notion of layers:
  - Provides data redundancy
  - Data stored at each layer
- Peers maintain 4 neighbours:
  - In, out, left, right
- Successor:
  - Peer responsible for replacing a failed peer
  - Successor moves “inwards” (closer to core)
- Layer indicative of peer reliability
  - Peers closer to core considered more reliable

TrebleCast (2)

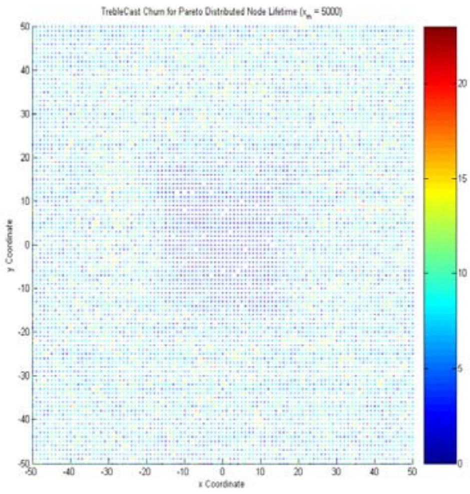
- Dual layer approach:
  - Newscast substrate
  - Grid superstructure
- Adaptable to churn:
  - Superstructure repaired through gossip messages exchanged at Newscast substrate
- Fast adaptive search:
  - Search messages exchanged at superstructure layer
  - Lookups under static conditions: O($\log_B(n)$)
  - Graceful search degradation under increasing churn
- Flexible data storage policy:
  - Choose location of stored data (at core for instance)
  - Permits flexibility allowing data redundancy and load balancing
- Robustness and reliability:
  - Build overlay around core of reliable server-like peers



Implementation

- TrebleCast implemented in Java
- Currently used for SIP virtualization
  - May implement any <key, value> pair storage based mechanism
  - Register, store, retrieve, delete: O(log(n)) time
- TrebleCast simulator implemented in Java
- P2P Monitor implemented in Java
  - Monitors peers in a P2P network
  - Allows basic interaction with peers through virtual console

Pareto Turnover

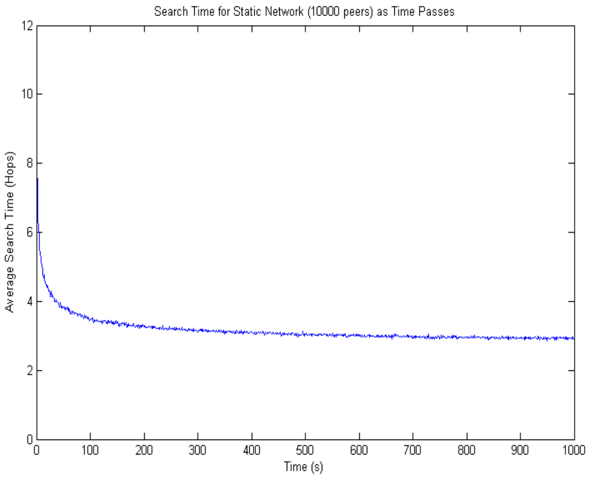


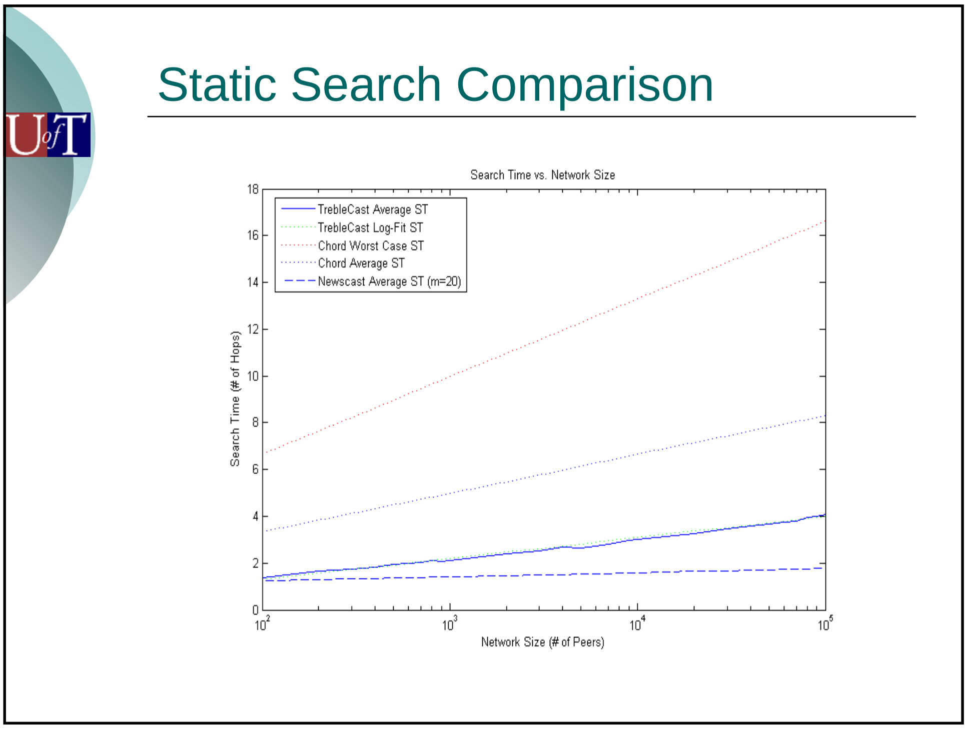
High Death Rate

- Reliable peers move to overlay core
- Core "protected" from churn
- Improved search time (less routing table maintenance)

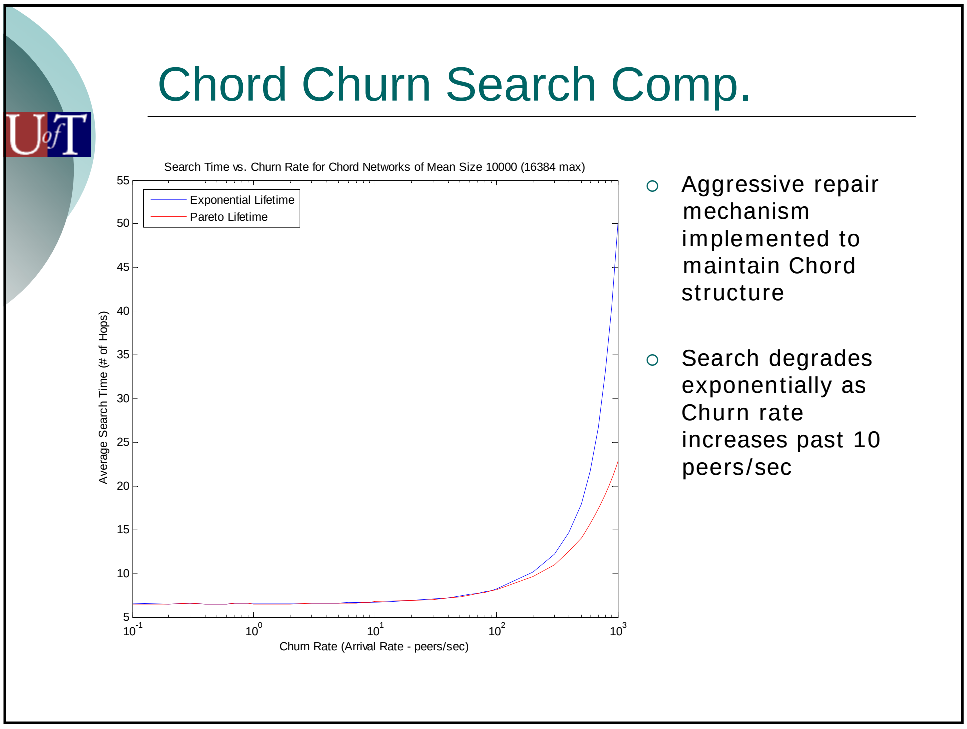
Low Death Rate

Fast Adaptive Search



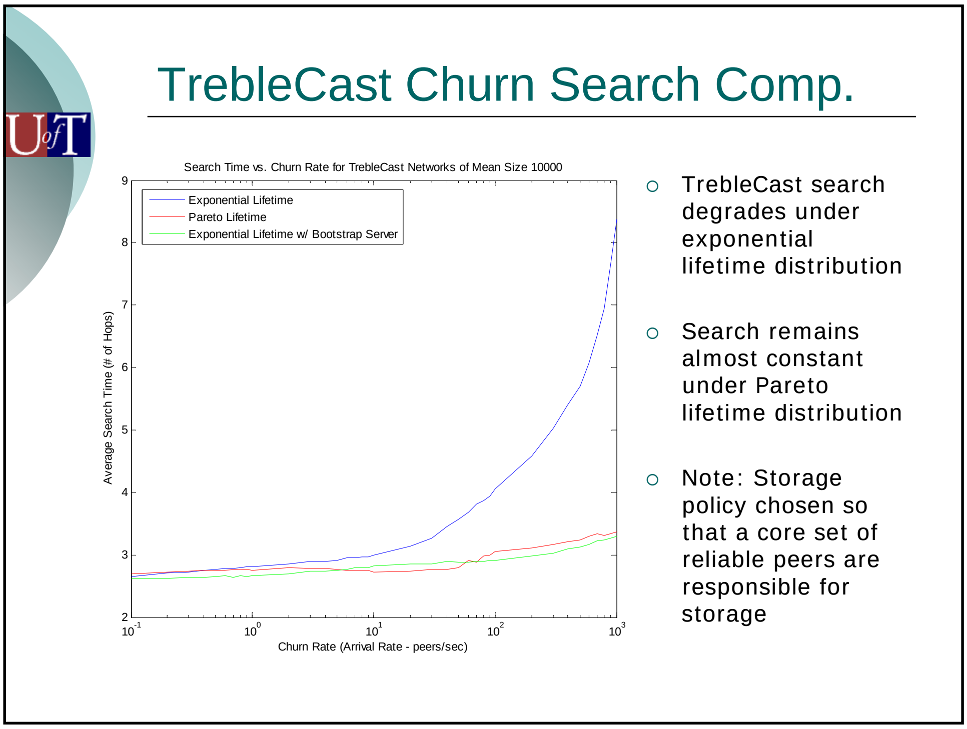


Static Search Comparison



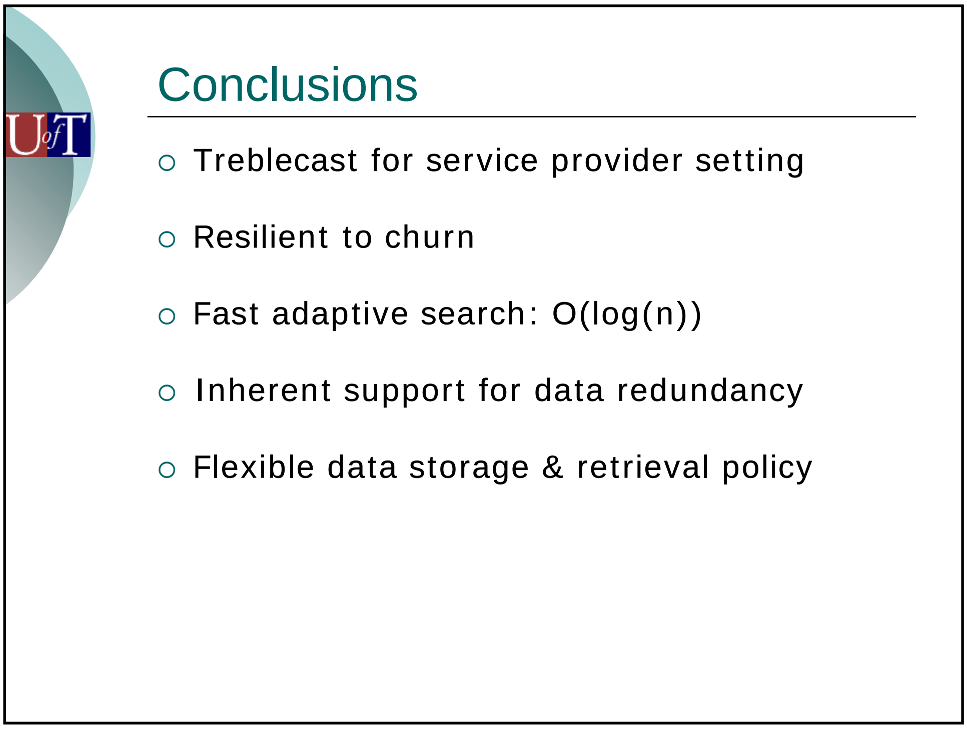
Chord Churn Search Comp.

- Aggressive repair mechanism implemented to maintain Chord structure
- Search degrades exponentially as Churn rate increases past 10 peers/sec



TrebleCast Churn Search Comp.

- TrebleCast search degrades under exponential lifetime distribution
- Search remains almost constant under Pareto lifetime distribution
- Note: Storage policy chosen so that a core set of reliable peers are responsible for storage



Conclusions

- Treblecast for service provider setting
- Resilient to churn
- Fast adaptive search: O(log(n))
- Inherent support for data redundancy
- Flexible data storage & retrieval policy