Analyzing the effectiveness of the CIDR Report

Stephen Woodrow
MIT CSAIL
Outline

• History of the CIDR Report
• Analytical approach
• Results
• Observations about the Report
• Conclusions
What this talk is and is not

• This is specifically about the CIDR Report in the context of deaggregation
• Deaggregation and its causes have been considered before:
  – RAS’ “Inconvenient Prefix”, NANOG 50
  – Cittadini et al. “Evolution of Internet Address Space Deaggregation: Myths and Reality”, IEEE JSAC October 2010
  – ripe-399 RIPE WG on Route Aggregation
History of the CIDR Report

- Initially a tool to promote CIDR aggregation following BGP4 deployment in early-mid 1990s
- Earliest “top 10” list on IETF CIDRD list in 1994
- Appeared on NANOG list in September 1996, and soon evolved into its current format
- Initially launched by Tony Bates & Philip Smith, later transitioning to Geoff Huston in 2002
Initially successful?
Down and to the right

Routing Table Size

[April-July 1994]
Why did it (presumably) work?

• Providing information to the clueless
• Social forces
  – Shame and reputation
  – Peer pressure
  – The CIDR Police (NANOG 27)
Is the CIDR Report still effective?

• “Not anymore, but it worked $N$ years ago” from several people I spoke to
• “Doesn’t matter; Routing table growth isn’t a problem anymore, thanks to Moore’s law”
• No longer needed to promote classful-to-classless transition

• No empirical study?
Defining “effective”

• Hypothesis: If the CIDR Report “works”, it should encourage aggregation in order to reduce one’s ranking. Thus:

Does an AS improve its aggregation behavior after appearing on the CIDR Report?

• Aggregation behavior in terms of:
  – Deaggregation factor (netsnow/netsaggr)
  – Aggregable prefixes (netgain)
Measuring AS behavior

• Archived CIDR Reports are not sufficient
  – Relative ranking—dropping off top 30 is ambiguous: did AS improve, or did others become worse?

• Re-implementing the CIDR Report
  – Data: Route Views RIBs
  – Preprocess to canonicalize AS_PATH
  – Mark prefix aggregable if any RV peer can aggregate
  – Some differences, but generally consistent
Measuring change in AS behavior
Measuring change in AS behavior

• Locate each AS’ first appearance on the Report
• Sample at various periods after appearance

• Establish control group of ASes
  – Same number as in treatment group
  – Randomly selected from ASes never appearing
  – Must advertise at least 10 prefixes
  – Must be visible for full sampling period

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Measures of deaggregation

• Deaggregation factor (DF)

\[
\text{actual number of prefixes advertised by an AS} \div \text{minimum number of prefixes required for AS’ routing policy}
\]

• netgain

  – the number of prefixes advertised by an AS that could be withdrawn without altering routing policy
Deaggregation factor over time

Deaggregation factor (netsnow / (netsnow – netgain))
1 Jan 1998 – 31 Dec 2001
Deaggregation factor over time

Deaggregation factor (netsnow / (netsnow – netgain))
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Deaggregation factor (netsnow / (netsnow – netgain))
1 Jan 1998 – 31 Dec 2001
At first, the top 30 mostly improve, while the control group deaggregates.

Deaggregation factor (netsnow / (netsnow – netgain))
1 Jan 1998 – 31 Dec 2001
Over time, aggregation improvement by top 30 decreases

Deaggregation factor (netsnow / (netsnow – netgain))
1 Jan 2001 – 31 Dec 2003

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Over time, aggregation improvement by top 30 decreases

Deaggregation factor (netsnow / (netsnow – netgain))
1 Jan 2004 – 31 Dec 2006

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Deaggregation factor (netsnow / (netsnow – netgain))
1 Jan 2007 – 31 Dec 2009

Over time, aggregation improvement by top 30 decreases
Interpreting these data

• Control groups are consistent over time
• Improvement in deaggregation factor has decreased over time
• If CIDR Report was source of previous behavior change, it is no longer effective
• Potential confounding factors
  – Selection Bias: Top 30 ASes may be intrinsically different than other networks
  – Regression to the mean

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Why the change? Theories:

- RIB/FIB slots are plentiful — less pain/concern
- Increased need for deaggregation (TE, etc.)
- Change in community response
Observations about the Report

• CIDR Report was initially developed to encourage CIDR-ization

• It has remained essentially unchanged since, while the Internet has grown and changed
With fixed “top 30”, the Report focuses on outlier behavior as Internet grows.

Threshold lines indicating the cut-off point for appearing on the CIDR Report in 1998 and 2011 are indicated. Note that the graph is rescaled; approximately 70% of ASes in the routing table do not advertise any aggregable prefixes.
The top of the Report contains ASes with extreme netgains: hard to displace.
Should we do something about the CIDR Report?

• Unclear whether routing table growth is a pain point right now or in the near future

• CIDR Report would probably not be the best way to deal with painful growth
  – FIB aggregation/compression
  – New interdomain routing architecture (RFC 6115)

• But, if it’s something operators care about, it could probably be improved
  – e.g. focus on more actionable behavior: “low-hanging fruit” or recent offenders
Conclusions

• The CIDR Report appeared effective in its early days (though it’s difficult to establish causality)

• There are a number of potential contributing factors for its decreased efficacy over time

• The CIDR Report has not evolved with the Internet, but it probably could be improved

• Social forces in the operator community may yet have value in solving problems

woodrow@csail.mit.edu