Simulating industry-wide IP addressing transition risks & opportunities

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Disclaimer

The author is an External Consultant to the RIPE NCC Science Group. The author gratefully acknowledges the support of RIPE NCC in making this research possible.

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In the Post-Runout Future

- **Regardless of whether they choose to prepare ahead** for these potential IPv6-based opportunities & risks, incumbent IPv4-based operators might also to elect to sell "***transition survival insurance***" **– fee simple IPv4 transfers** – to aspiring new entrants.*
  - For incumbents: IPv4 transfer sales (***100% opportunity!!***)
  - For new entrants: IPv4 transfer purchases (***100% requirement!!***)

*Incumbents may directly impact the balance of IPv6-related opportunities & risks in five ways: ***sell IPv4***, ***buy IPv4, offer IPv6 access***, ***offer IPv6 transit,*** and/or ***offer IPv6 peering***.

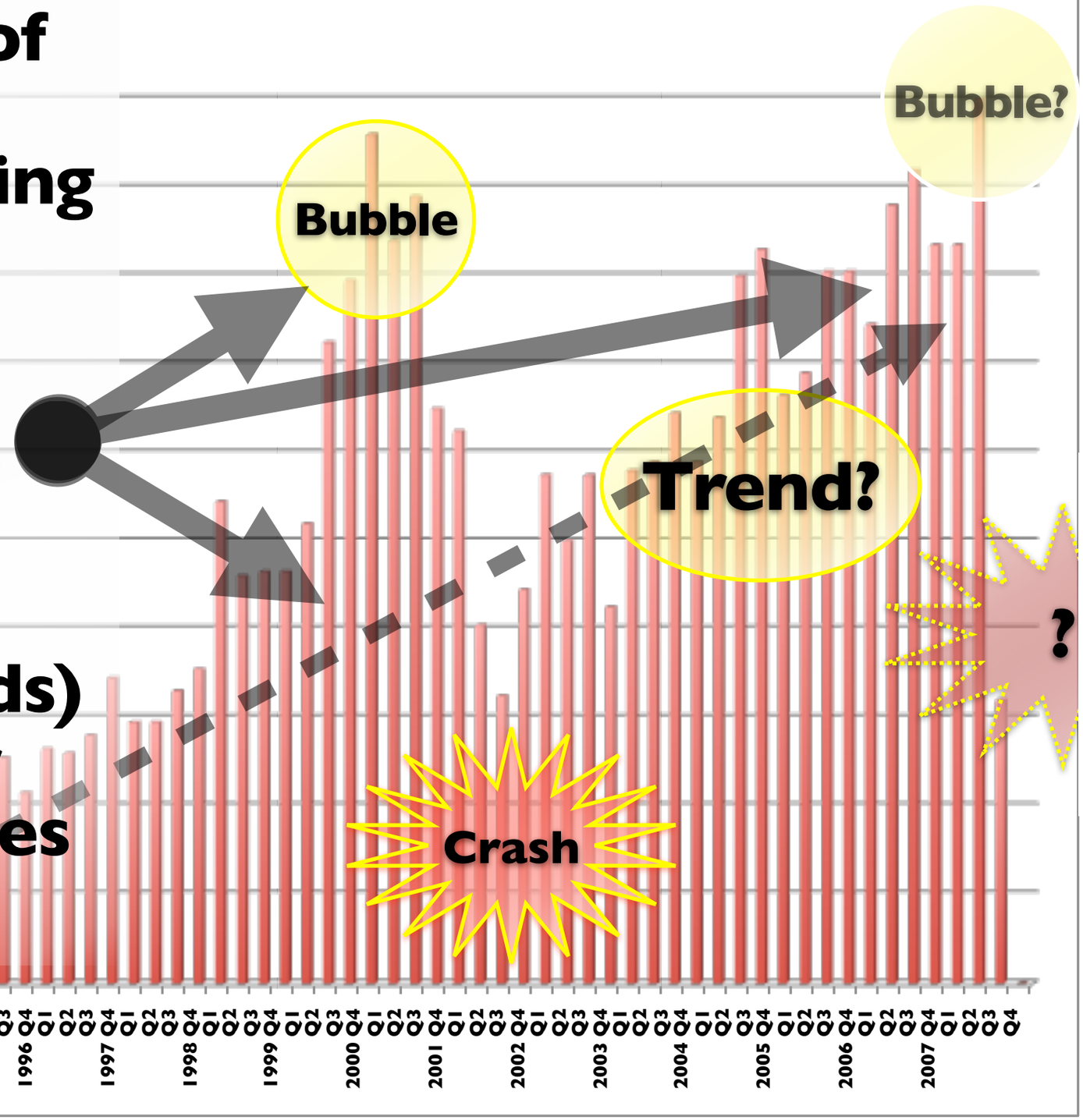
In the Post-Runout Future

- IPv6-based services ***might become important*** to commercial growth for incumbent IPv4-based operators...
  - *New customers (**opportunity?**); lost connectivity (**risk?**)*
- IPv4 ***will remain*** absolutely indispensable to market entry for future IPv6-based routing service providers* for a long time...
  - *No customers, no connectivity (**existential risk!!**)*

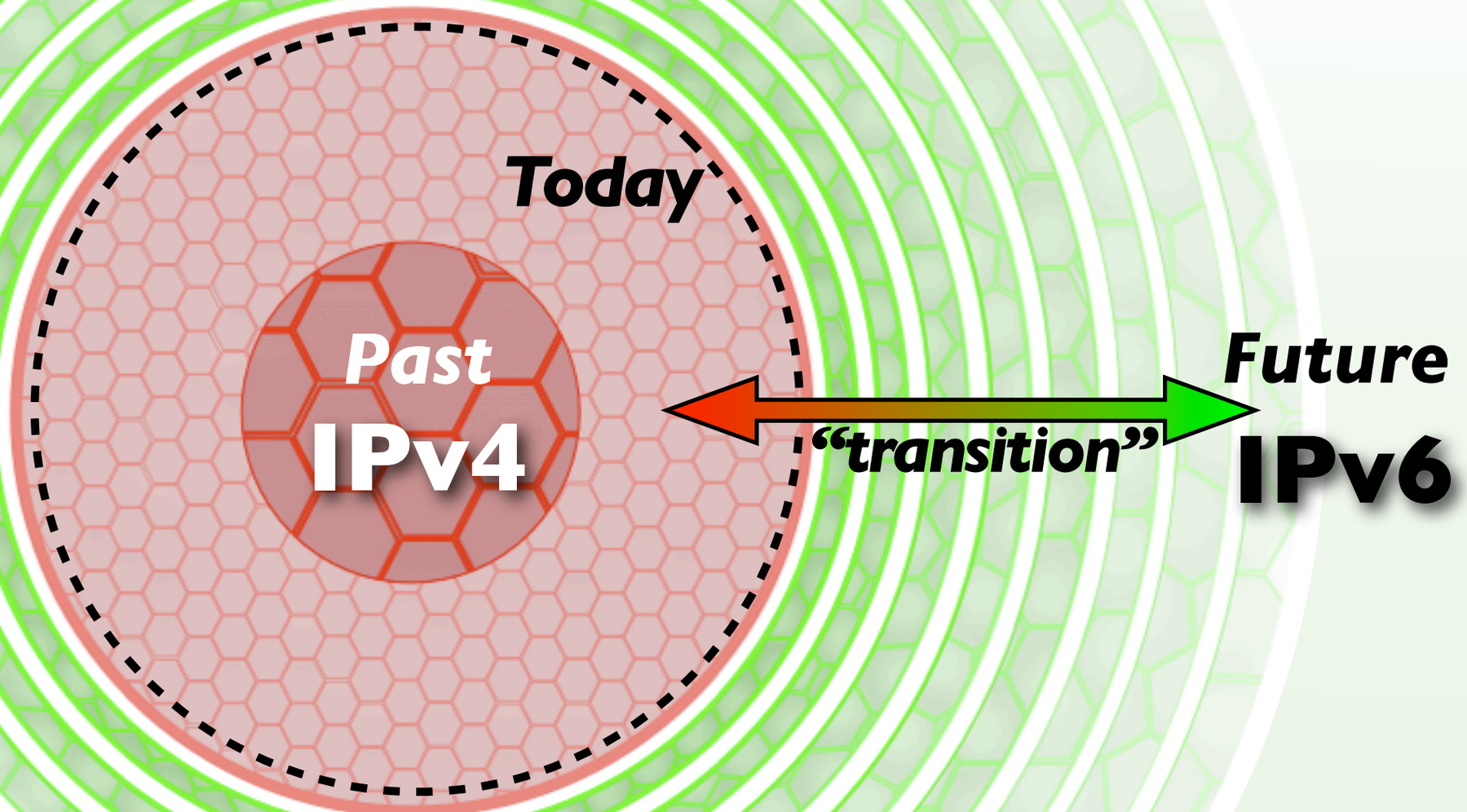
*The routing services provider industry, including self-providers and commercial ISPs; *excludes customers*

Demand for New Entry

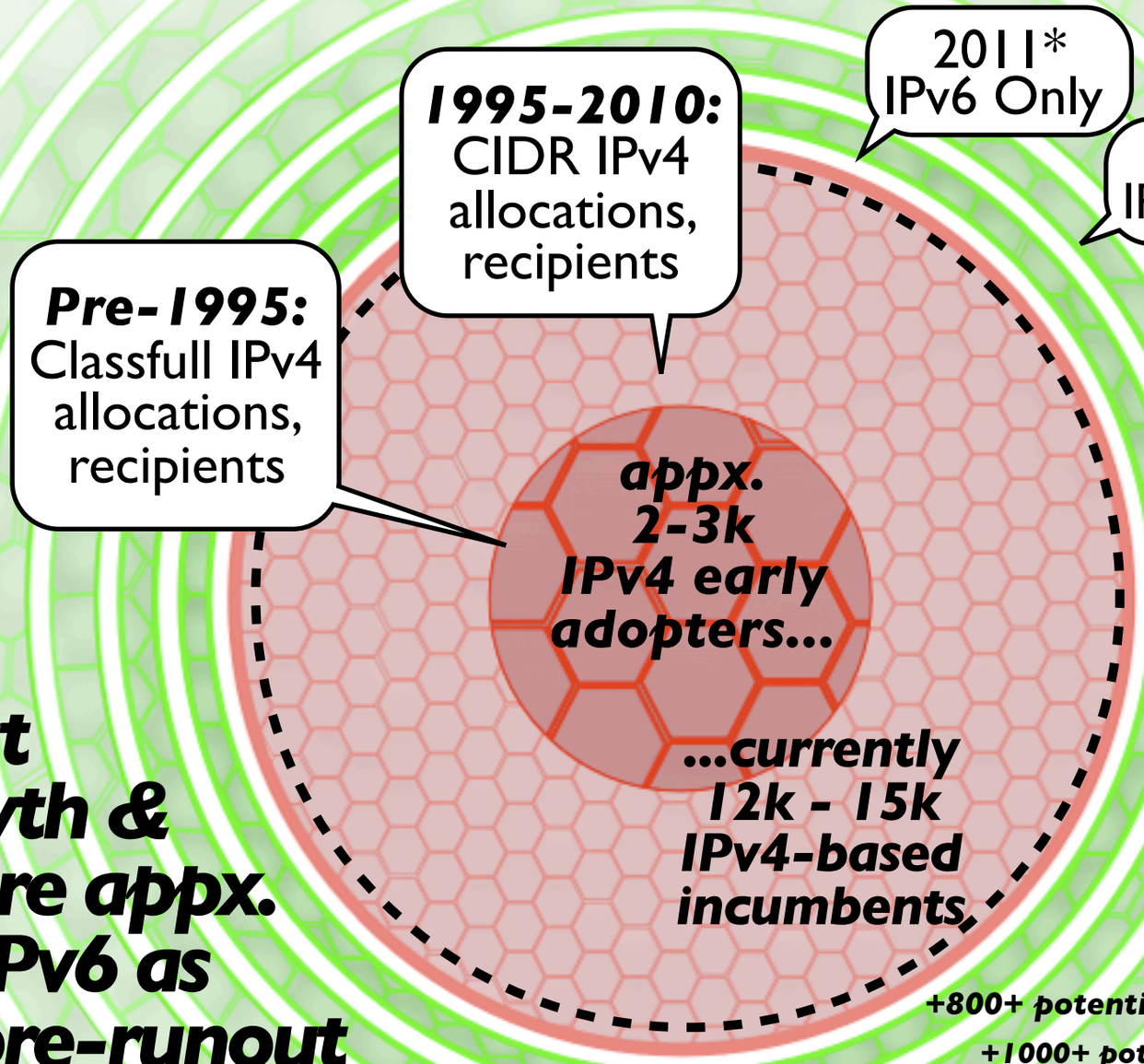
The global rate of demand for *new entry* in the routing services market probably ranges from about 2-3 *initial allocations* per day (during extremely depressed periods) to about 4-6 per day, and continues to rise



Industry participation before & after the IPv4 runout



Transition survival "candidates"



2011* IPv6 Only

2012 IPv6 Only

2013 IPv6 Only

2014 IPv6 Only

2015 IPv6 Only

2016 IPv6 Only

2017 IPv6 Only

2018 IPv6 Only

+800+ potential new entrants*

+1000+ potential new entrants*

+1200+ potential new entrants*

+1500+ potential new entrants*

+1800+ potential new entrants*

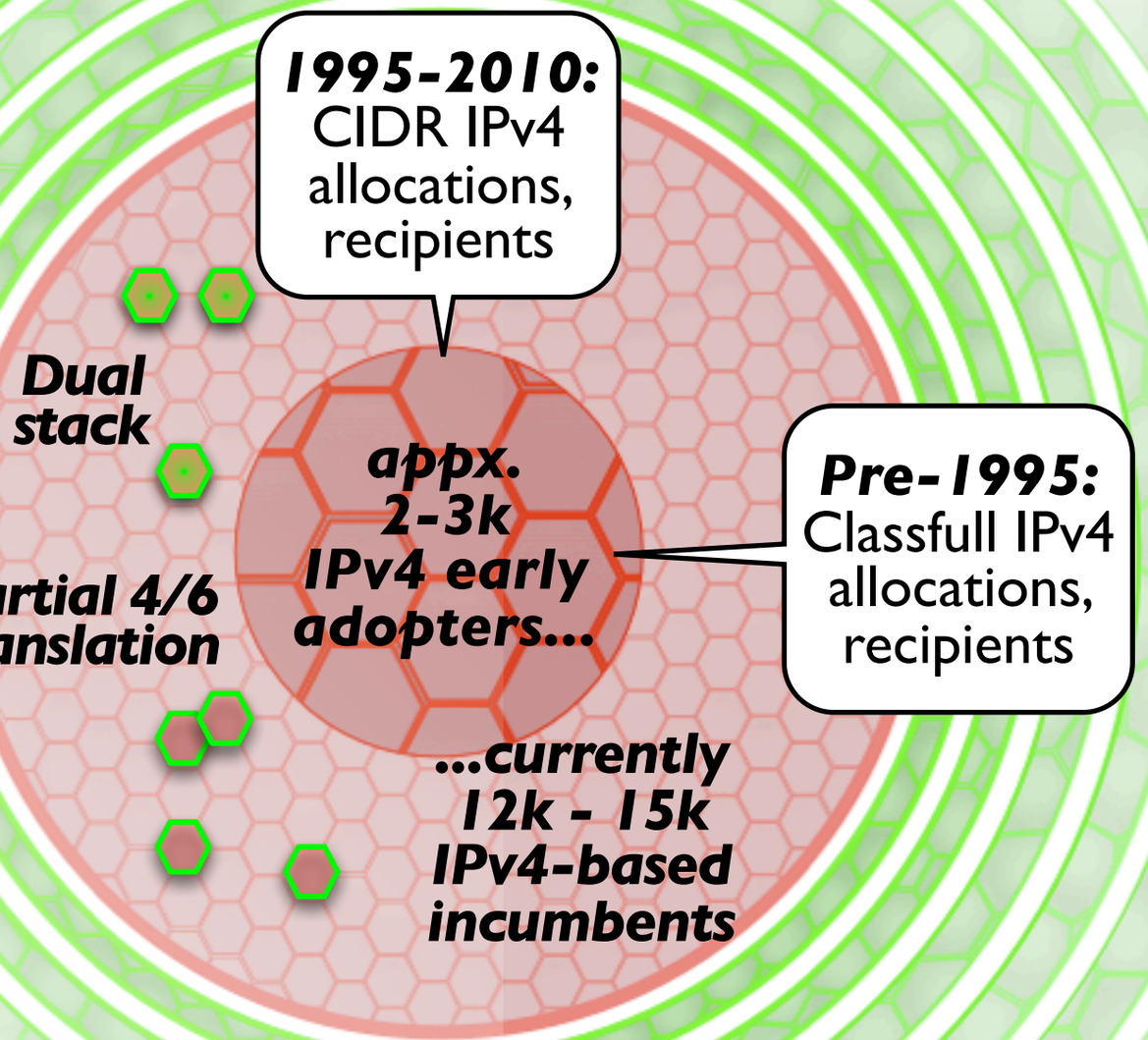
+2000+ potential new entrants*

+2400+ potential new entrants*

Assuming that industry growth & churn rates are appx. same under IPv6 as under IPv4, pre-runout "incumbent" and post-runout "entrant" populations might achieve parity in 15-20 years...

Transition survival "candidates"

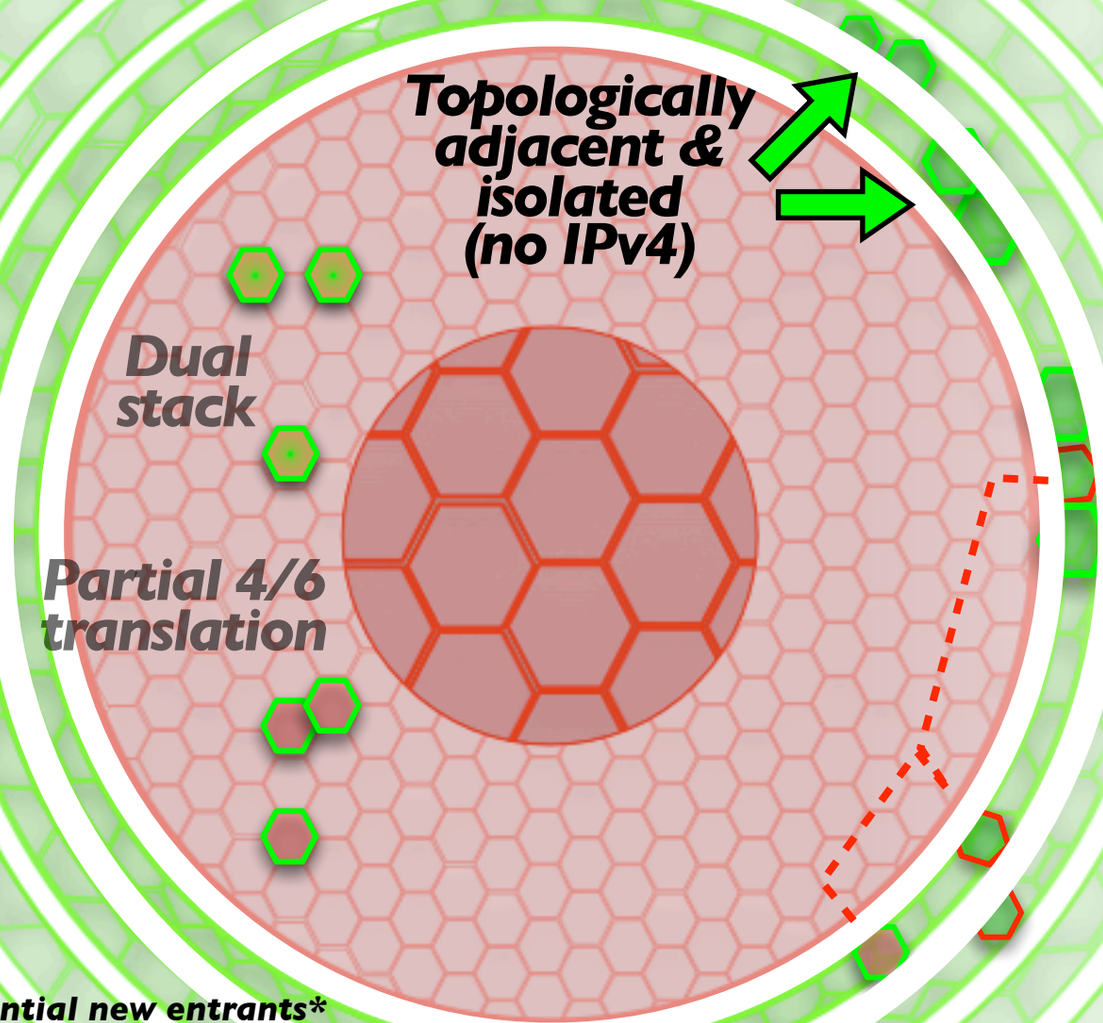
IPv4-based incumbents are at extremely low risk of transition-related failure; to date few have bothered to secure any kind of insurance against the possibility of an IPv6-based future



Their risk will remain *very low* until the preponderance of new interconnection and traffic exchange opportunities are IPv6-based

However, that risk is directly & *exclusively* determined by the form and levels of incumbent participation in an IPv4 transfer market...

Transition survival "candidates"



IPv6-based new entrants are at *absolute* risk of transition-related failure (i.e., non-emergence); their only means of achieving *reachability* with the rest of the Internet is to secure some IPv4 addresses

Topologically isolated except via IPv4 gateway

+800+ potential new entrants*

+1000+ potential new entrants*

+1200+ potential new entrants*

+1500+ potential new entrants*

+1800+ potential new entrants*

+2000+ potential new entrants*

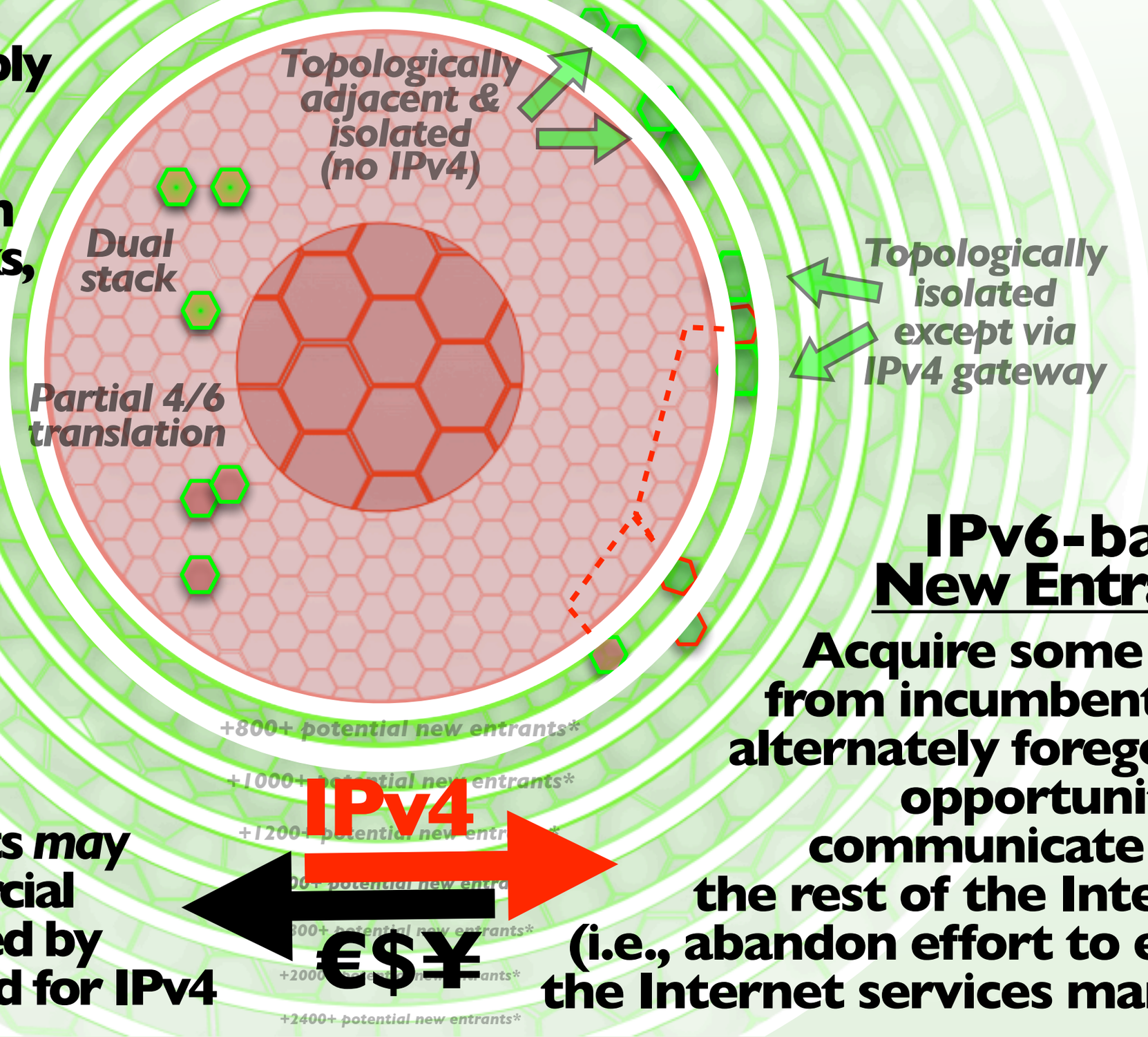
+2400+ potential new entrants*

Their risk will remain *absolute* until the preponderance of new interconnection & traffic exchange opportunities are IPv6-based; *without IPv4 most will not even be able to exchange traffic with each other...*

Transition Survival Requirements

IPv4-based Incumbents

Incorporate (or simply *prepare for*) some mechanism to exchange traffic with IPv6-based networks, and *perhaps* also to eventually add new IPv6-based customers...



***Optional*: Incumbents *may* also pursue commercial opportunities created by new entrant demand for IPv4**

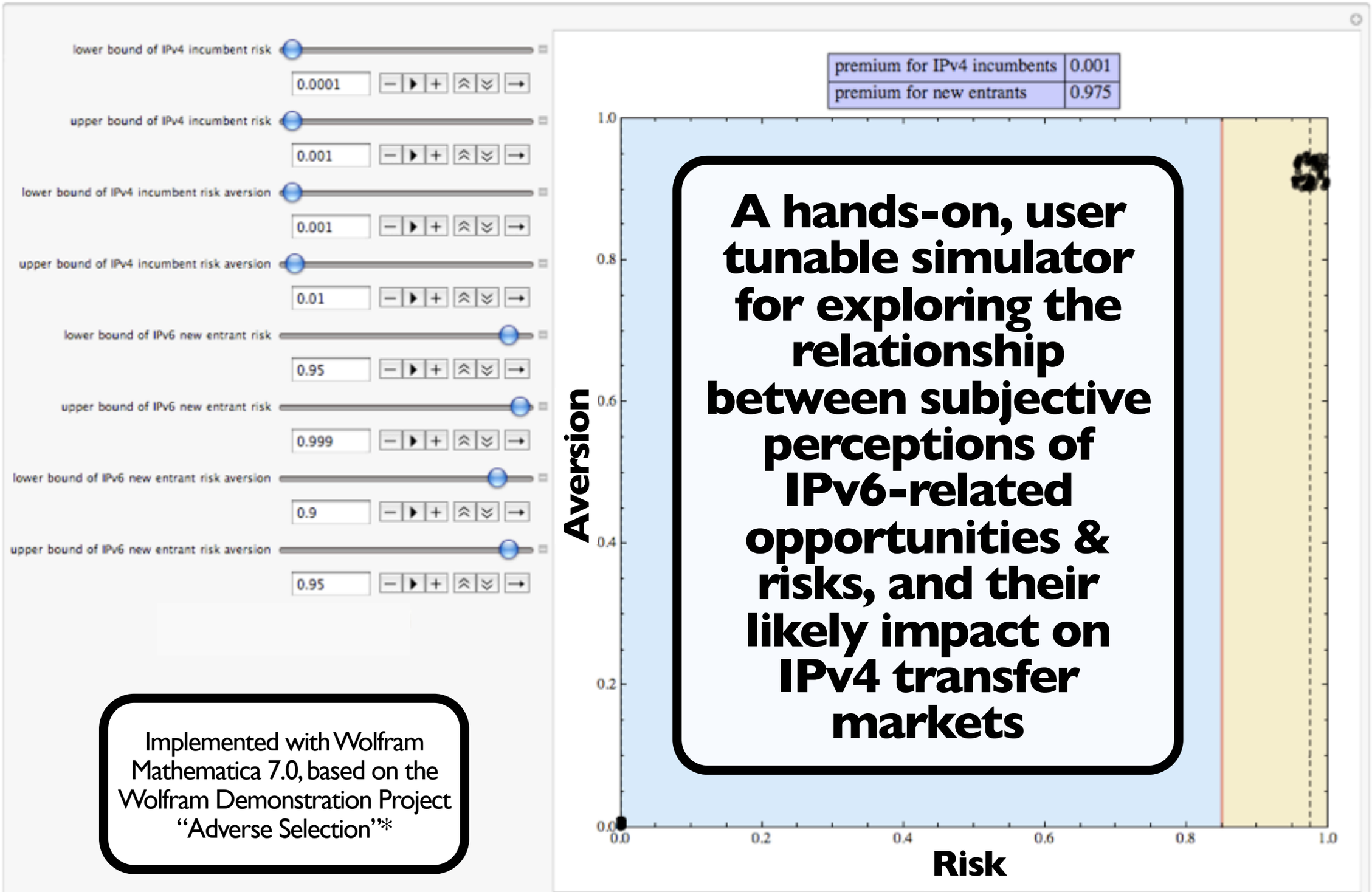
IPv6-based New Entrants

Acquire some IPv4 from incumbents, or alternately forego the opportunity to communicate with the rest of the Internet (i.e., abandon effort to enter the Internet services market)

Structure of the Situation

- Rate of market entry* by IPv6-based operators will be largely determined by incumbent rate of participation in the transition
- Participation in this transition survival strategy by one group (incumbents) will determine the maximum supply and minimum price of survival opportunities available to another group (new entrants)
- Both groups are thus members of the same ***insurance pool... but one group (incumbents) also plays the role of insurance provider***

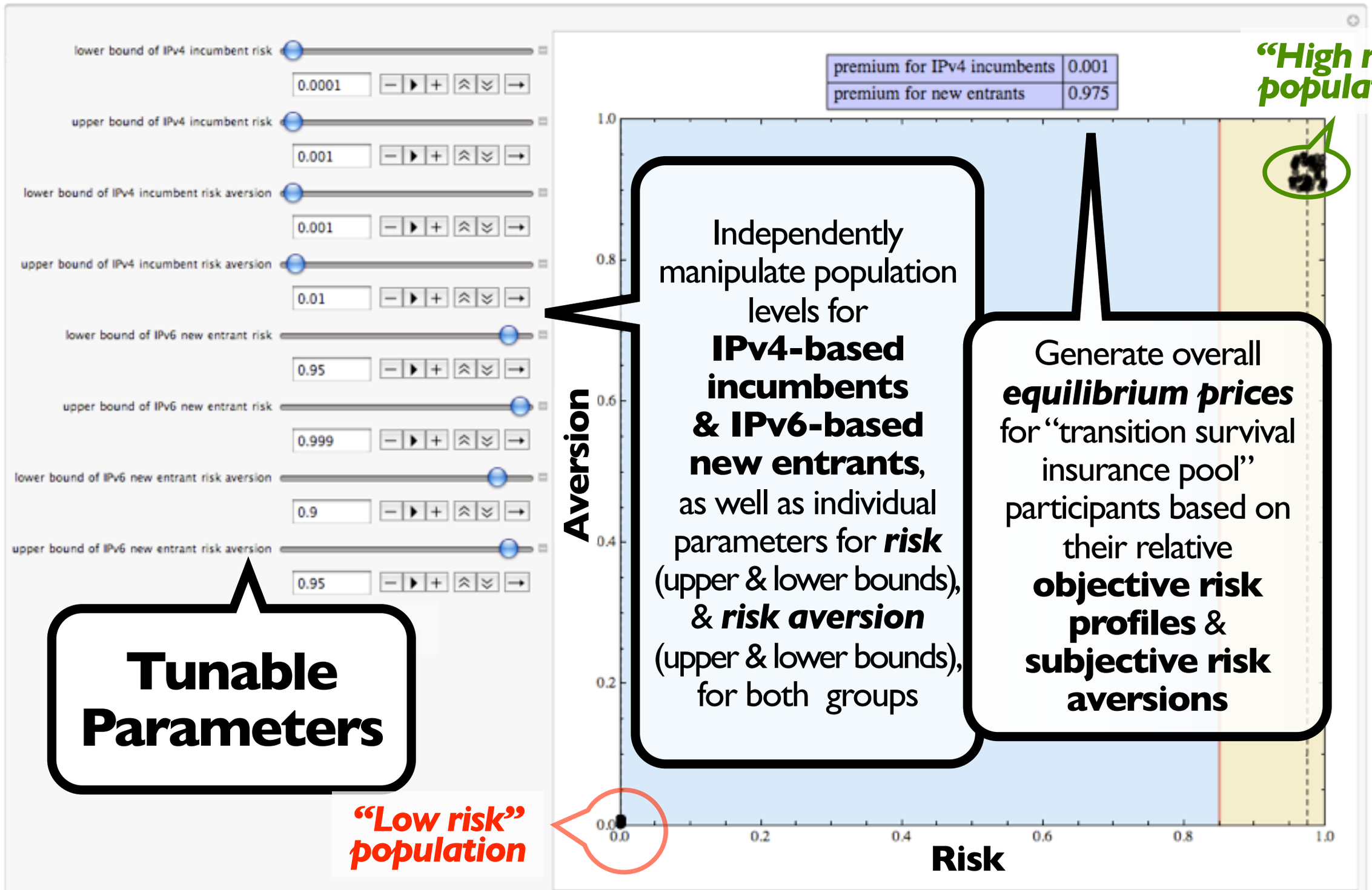
Transition Risk Pool Simulator



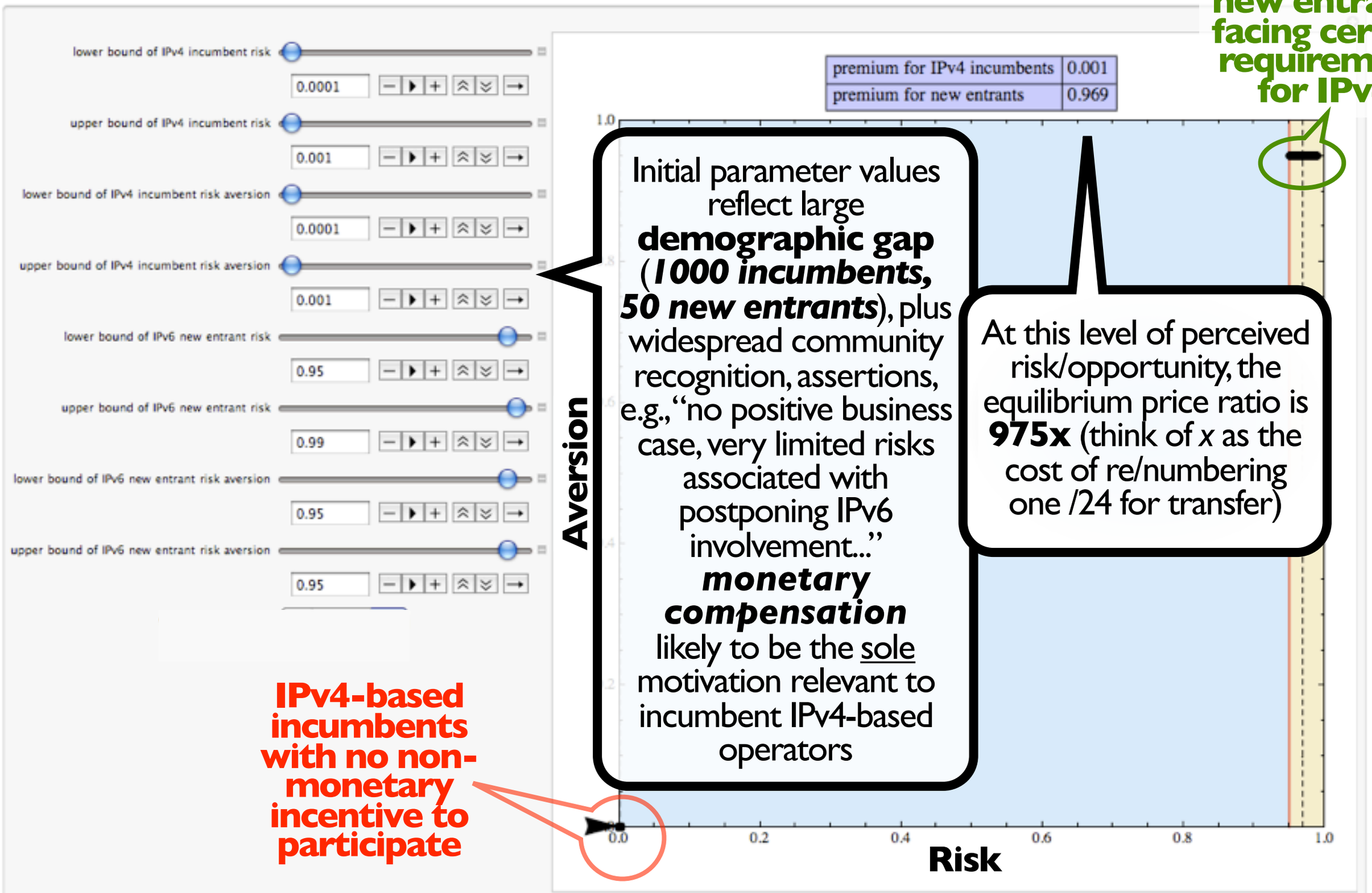
Implemented with Wolfram Mathematica 7.0, based on the Wolfram Demonstration Project "Adverse Selection"*

*http://demonstrations.wolfram.com/AdverseSelection/

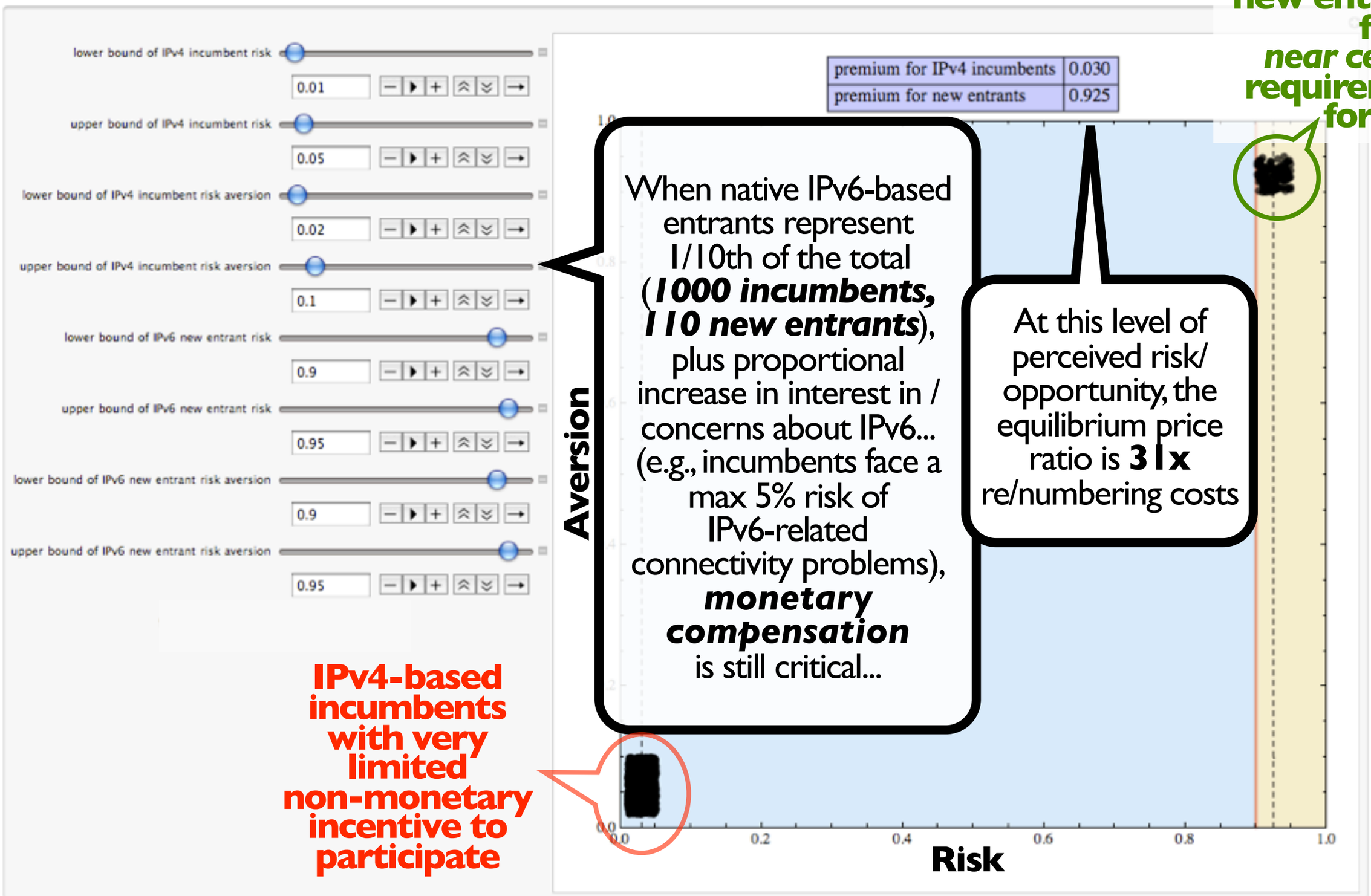
Transition Risk Pool Simulator



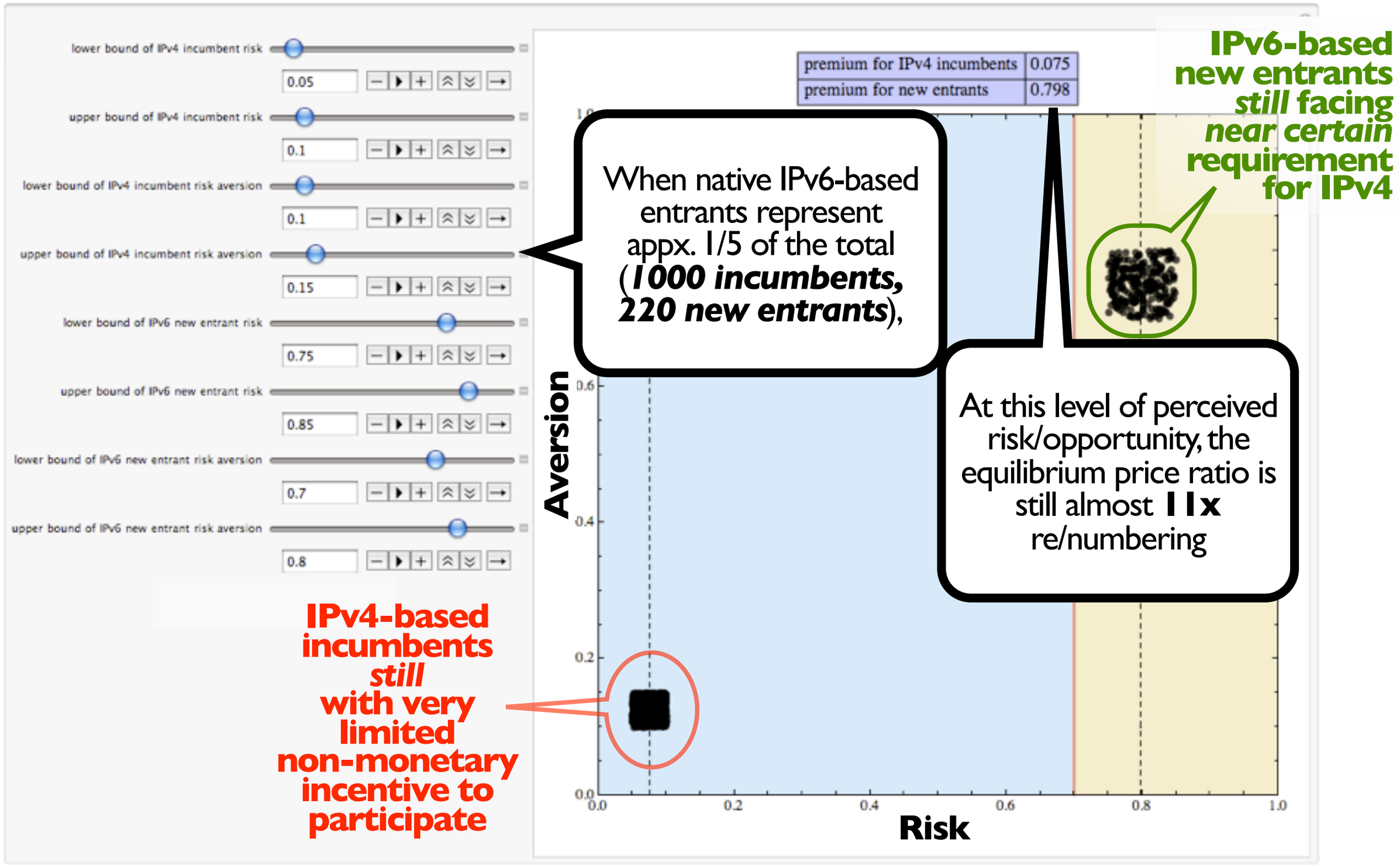
Simulation Examples



Simulation Examples: 10% mark



Simulation Examples: 20% mark



But even getting there.....

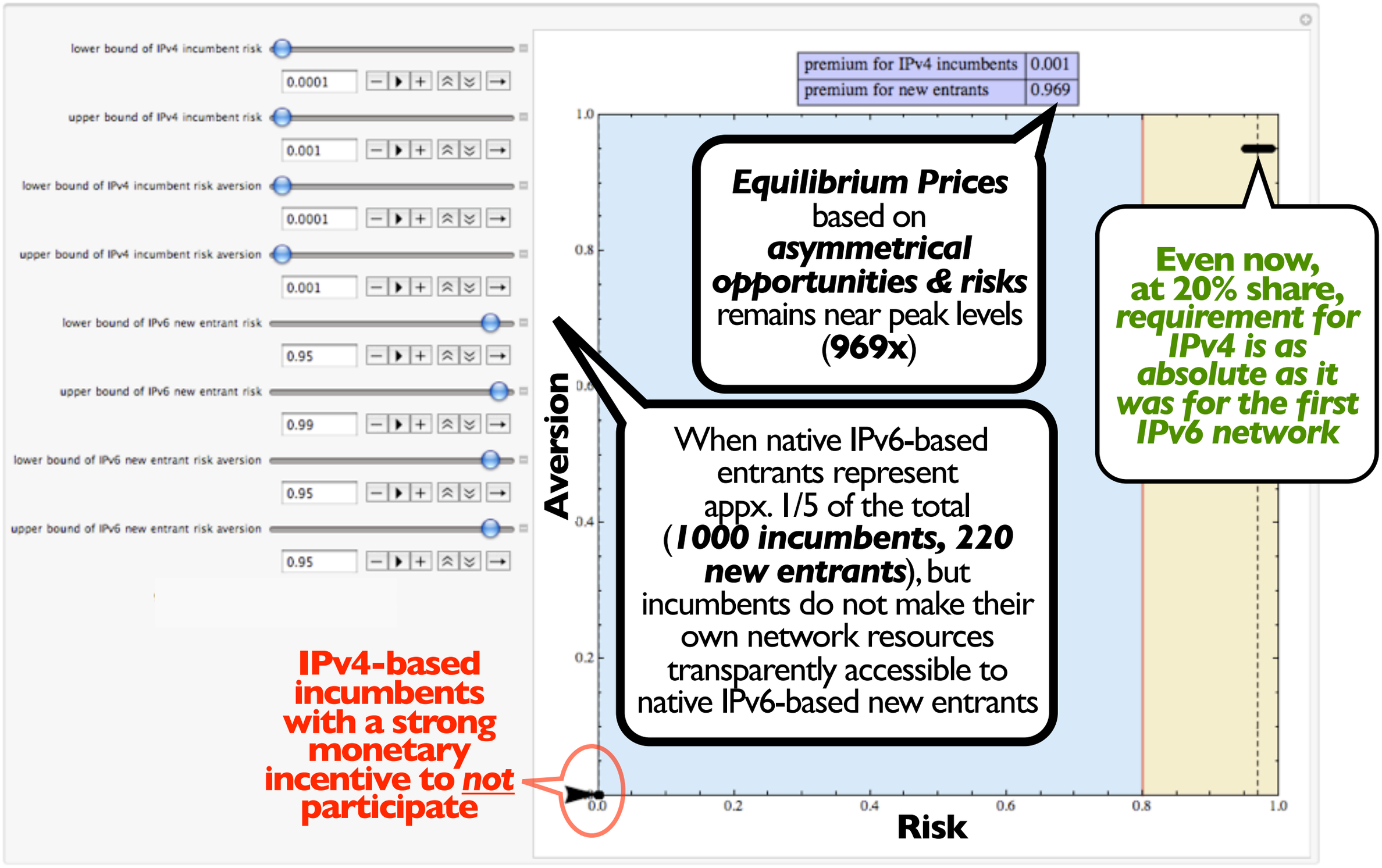
- ***Real risks*** that might promote IPv6 adoption have no real impact until after IPv6 is already widely deployed; ditto ***real opportunities*** that are ***distinctly IPv6 based***...

- IPv4 transfers that are priced based on new entrant connectivity failure risk/demand will likely price new entrants ***out of the market***

- IPv4 transfers between incumbent IPv4-based operators would further reduce the quantity, increase the price of IPv4 for aspiring new entrants, and likely send conflicting signals that would multiply the market contractionary effects

*Simulation Examples: 20% mark**

*What if incumbents choose to participate **only** as insurers?*



"Adverse Selection"

- Term refers to a market process in which "bad" results occur when buyers and sellers have asymmetric information: the "bad" products or customers are more likely to be selected.

- In the insurance industry, term usually refers to the tendency of potential subscribers to purchase insurance in quantities determined by their self-perceived risk levels; lower risk individuals always tend to purchase less insurance, higher risk parties purchase more ***if they can afford it***...

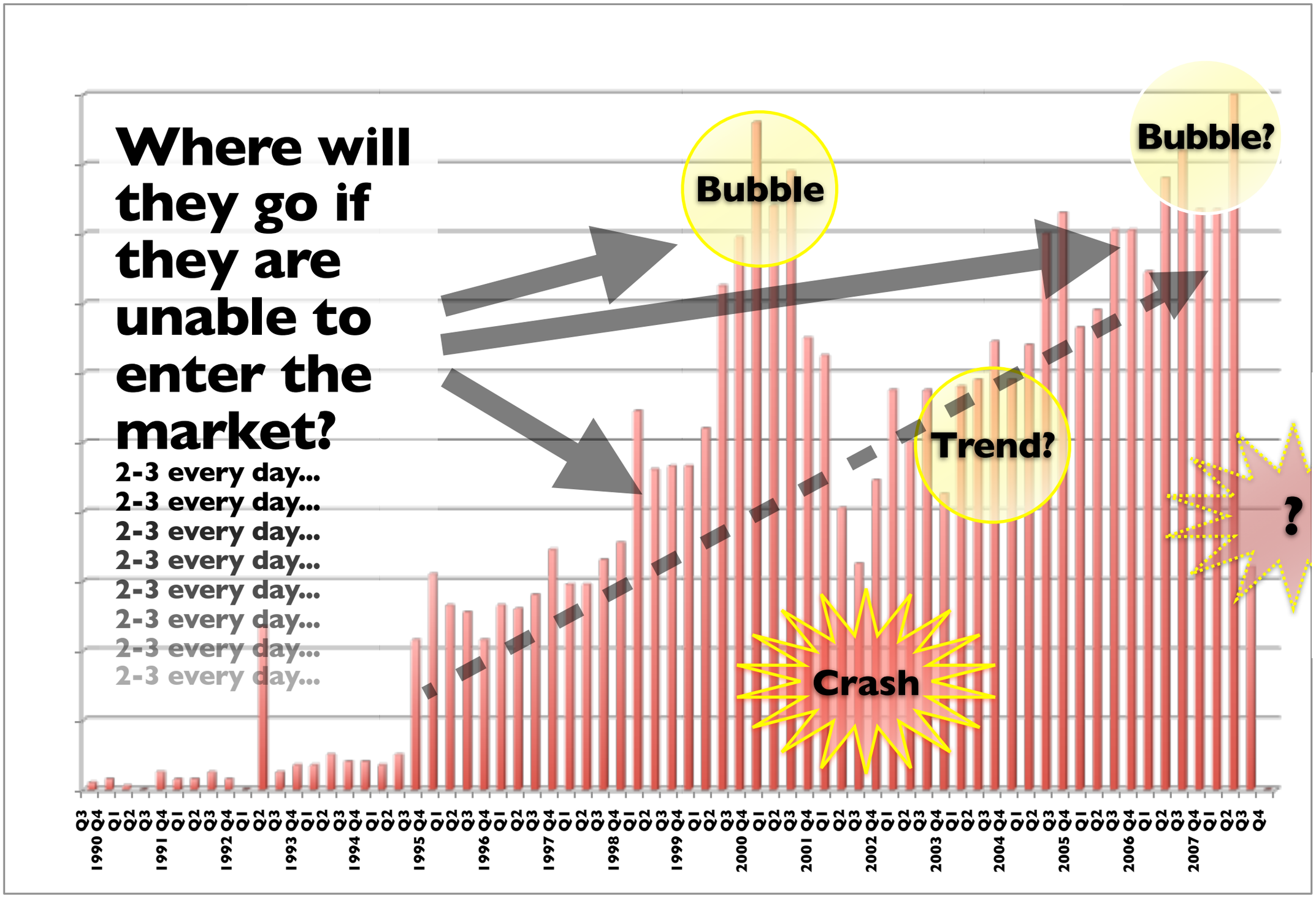
- The larger the gap between perceived and "real" risk, the less insurable the population becomes...

http://en.wikipedia.org/wiki/Adverse_selection

Inference & Implications

- **The IP address transition imposes classic *adverse selection* problems**
- ***Previous studies didn't get this:***
  - Edelman (2007~) does not consider information asymmetries, instead presents a model that builds on on conventional neoclassical assumptions (e.g., market transparency, information symmetry)
  - Elmore, Camp, & Stevens (2008) mention "lemons market" issues, but instead focuses on an ***S-curve adoption model*** that is incompatible with information asymmetries & *intentional* adoption path-altering strategies
  - Mueller (2008, et al.) operates from a "subjective value" theoretical perspective, which defines all transactions that are not *purely* market price-based as equally illegitimate

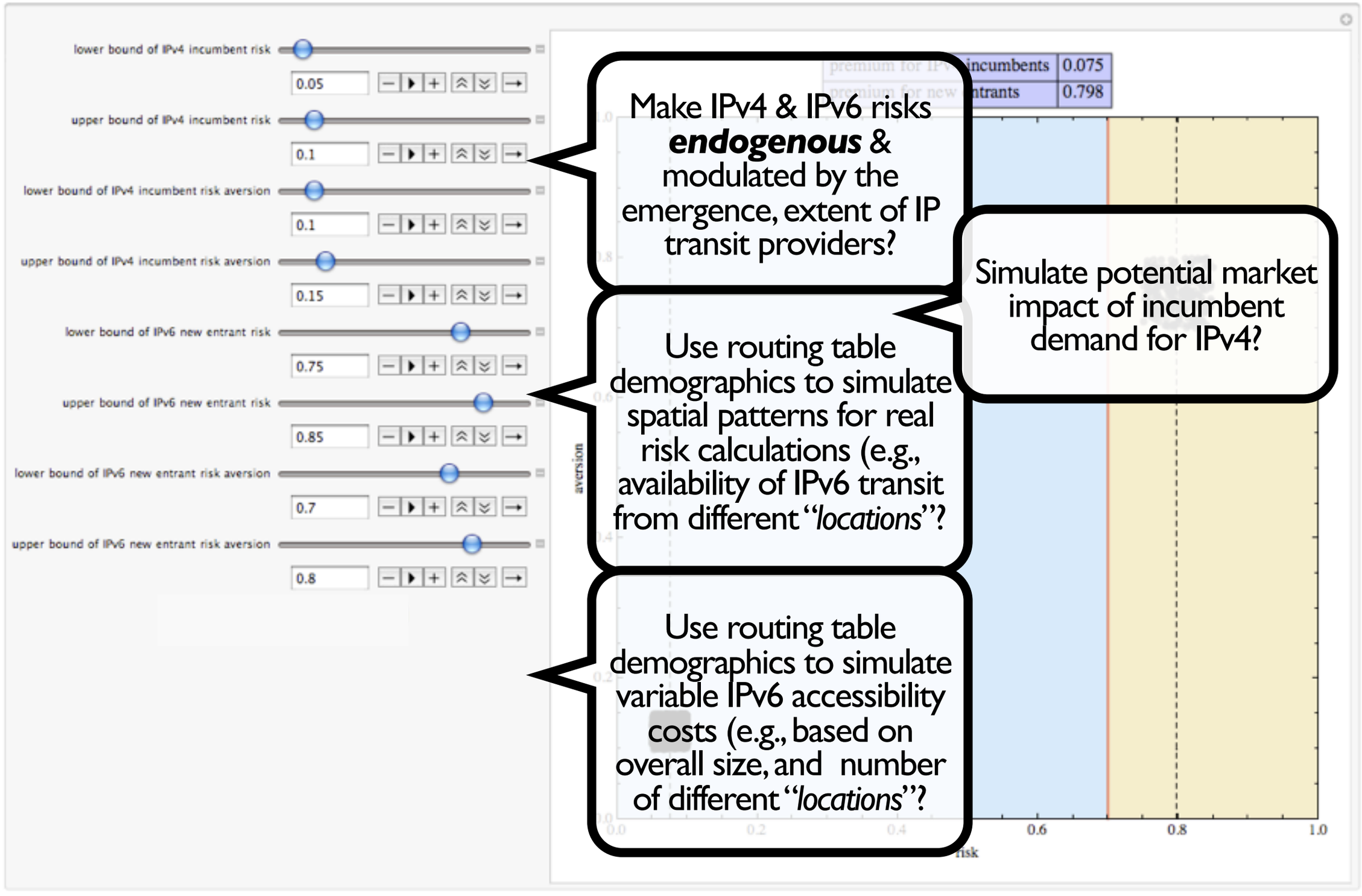
Demand is not going to disappear...



Give it a try!

- **Download Wolfram Mathematica Player:**
  - *http://www.wolfram.com/products/player/*
- **Download Simulator File:**
  - *http://www.ripe.net/....*

Worth improving? Feedback please!



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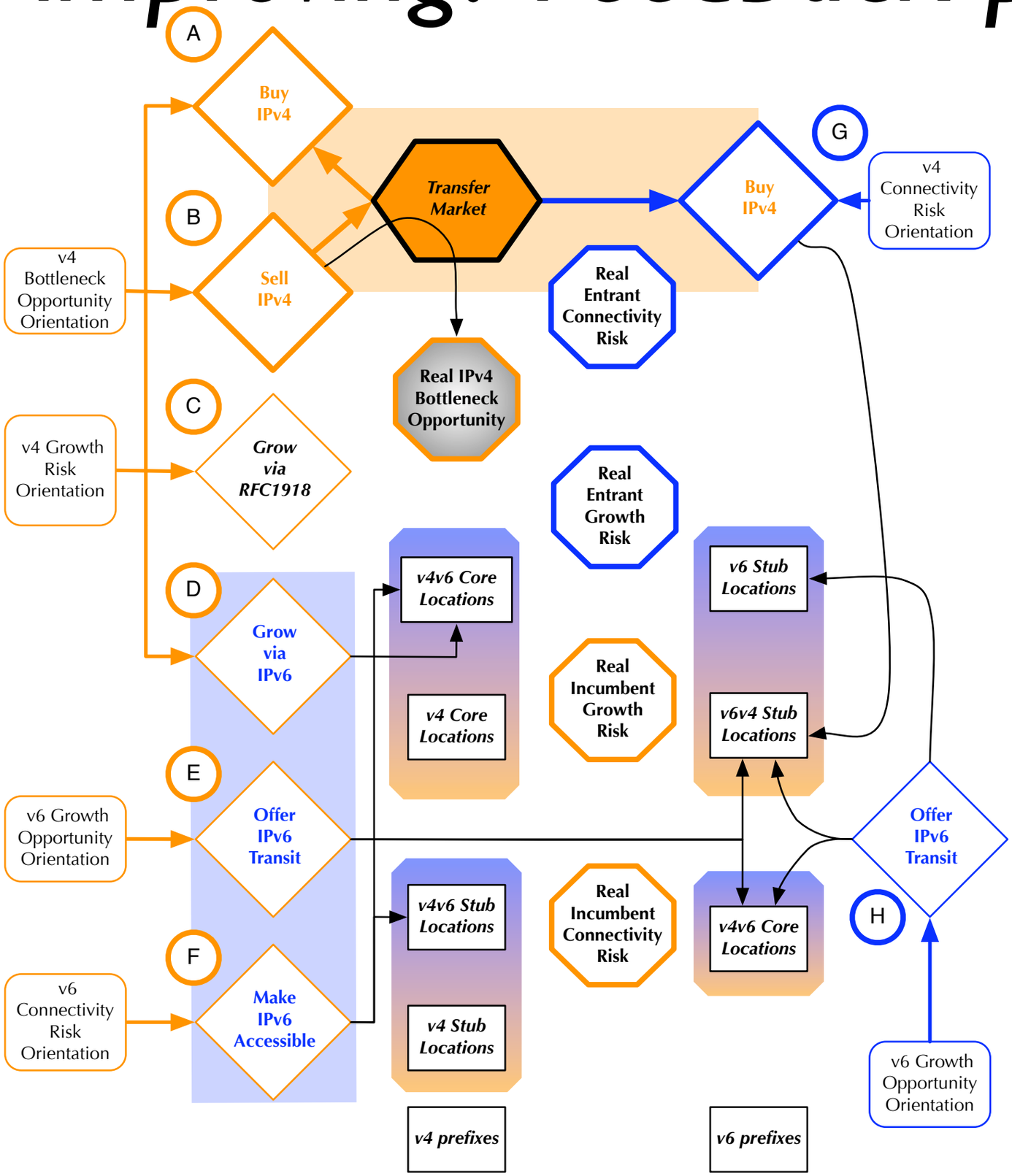


Everyone always wants a pony I guess...

Questions? Thanks!

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***Don't forget the disclaimer**