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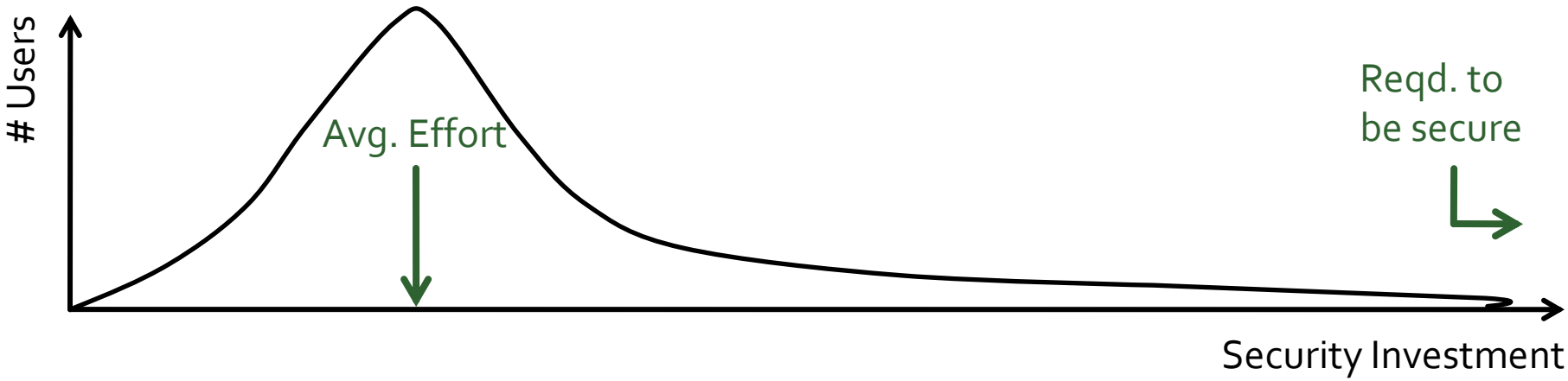
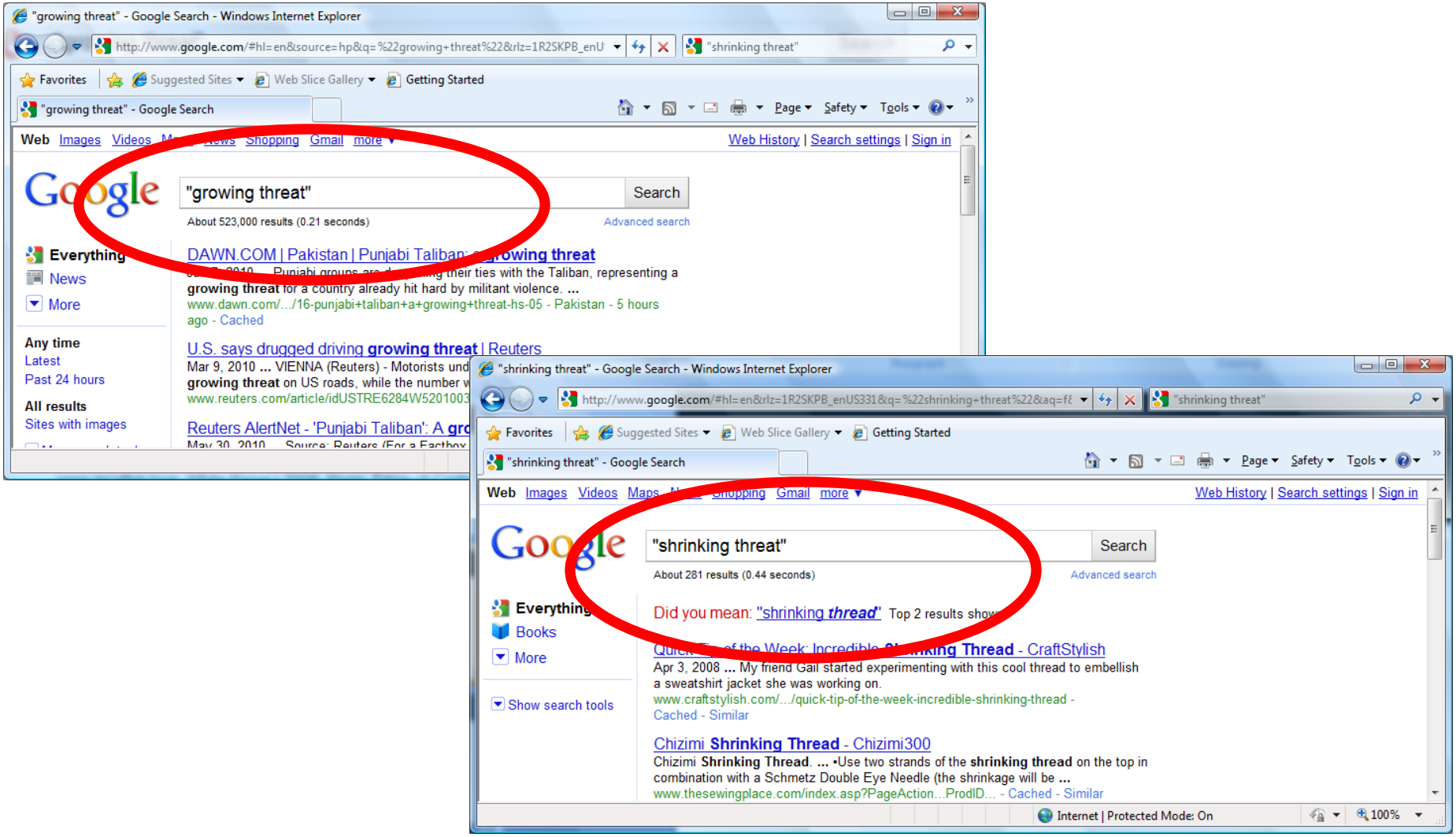
The Plight of the Targeted Attacker in a World of Scale

Puzzle: Where Do All the Attacks Go?

- **Observation: ~2 billion Internet users**
- **Most ignore most security investments**
  - Weak passwords, expired AV, password re-use, obvious secret questions,
- **Amazingly sophisticated attacks**
  - LCD screen reflections, hash collisions, realtime MITM
- **Life goes on**. (Obla-di, Obla-da)



New Threats Every Day



Common Threat Model

- Alice is an internet user
- Charles has ever-increasing number of attacks
- If Alice neglects any defense Charles wins

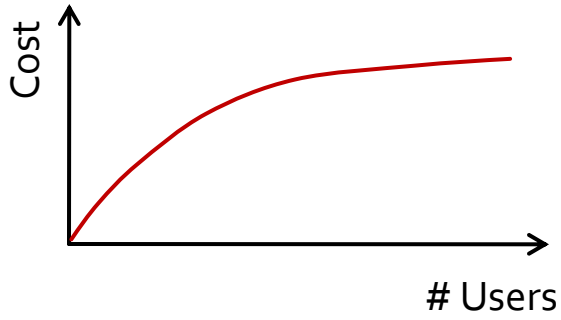
New Threat Model: Scaleable Attacks

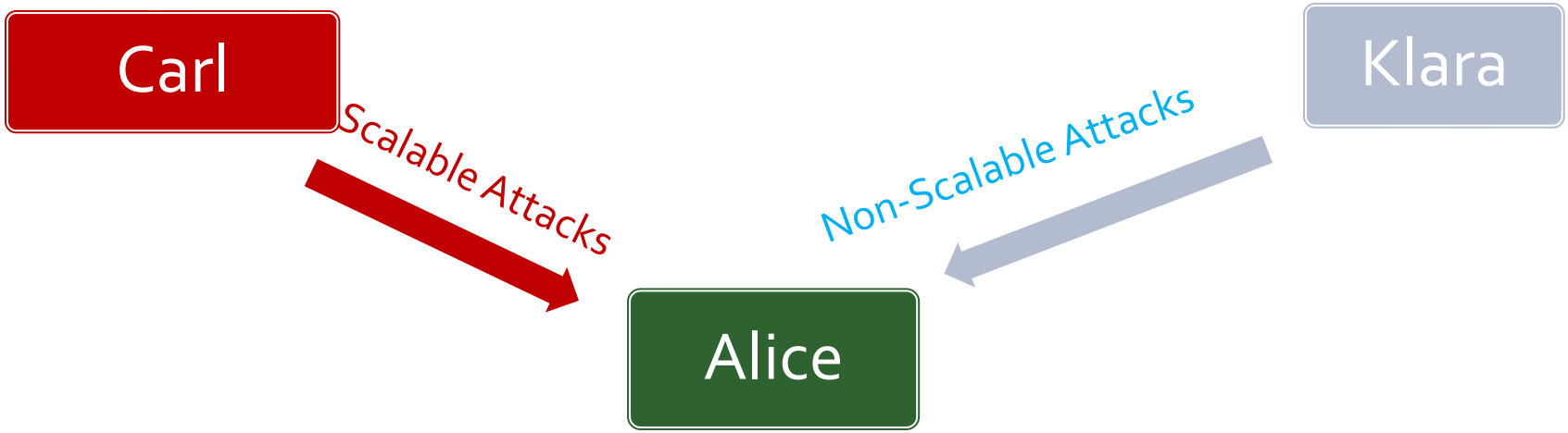
Carl: Scaleable Attacks

- Sub-linear Cost Growth

  $C_s(2N) << 2C_s(N)$

- E.g. spam, phishing, anything automated





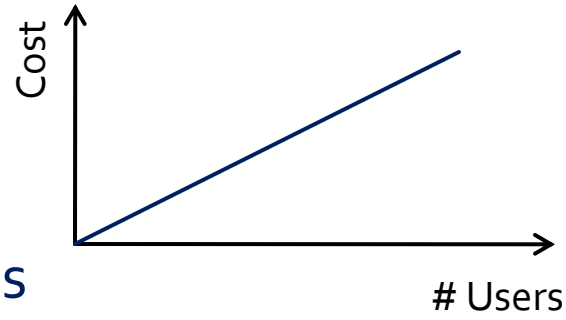
New Threat Model: Non-Scaleable Attacks

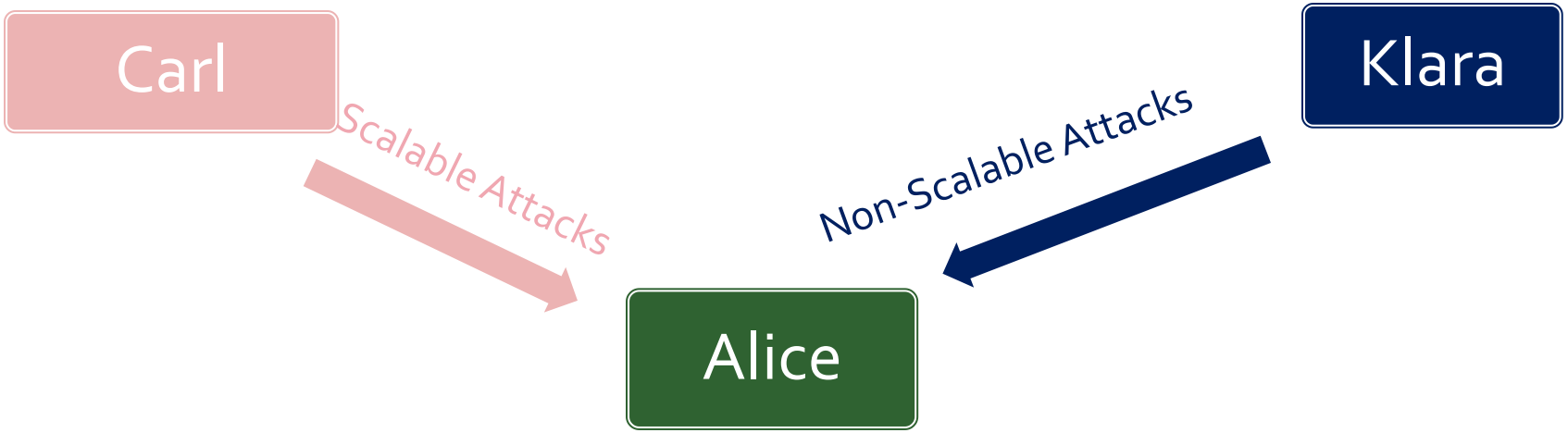
Klara: Non-Scaleable Attacks

- Linear (or worse) cost growth

  $C_n(2N) \approx 2\,C_n(N)$

- E.g. spear phishing, anything that involves per-user effort, knowledge of victim, proximity etc





Threat Model

- Two Attackers, two cost models
  - **Carl achieves economies of scale**
  - **Klara has per-user cost**
  - No loss of generality
- Rewards:
  - Reward(N) = N Y V
    - N = # attacked users
    - Y = Yield
    - V = Average ***Extracted*** value

1. Scaleable Attacks Reach Many More Users (for same cost)

- **Scalable Attacks :** Profit improves with scale
  - $\text{Profit}_s(2N_s) = \text{Reward}_s(2N_s) - C_s(2N_s)$
    $> 2\,\text{Reward}_s(N_s) - 2\,C_s(N_s)$
    $> 2\,\text{Profit}_s(N_s)$
  - Attack everyone, as often as possible
- **Non-scalable attacks:** profit constant w/ scale
  - $\text{Profit}_n(2N_n) \approx 2\,\text{Profit}_n(2N_n)$
  - Be selective

2. Scaleable Attacks Produce Commodity Goods

- **Scripted => Anyone can do**
  - Commoditization
  - Tragedy of the Commons
- Competition drives $V_s \rightarrow 0$

- **Data:**
  - Spam: $2800 for 350e6 emails [Kanich etal 2009]
  - Price of CCNs, creds falling [Symantec 2009]
  - Captcha Solving: [Motoyama etal 2010]

	Captcha/ 1000
2007	$10.00
2008	$1.50
2009	$1.00
2010	$0.75

How do Carl/Klara compete?

- Carl reaches many more users ($N_s >> N_n$)
- Economies-of-scale businesses are tough on non-scaleable actors
- Klara should switch to scaleable strategy if she can't match Carl's return

Non-scalable vs Scalable

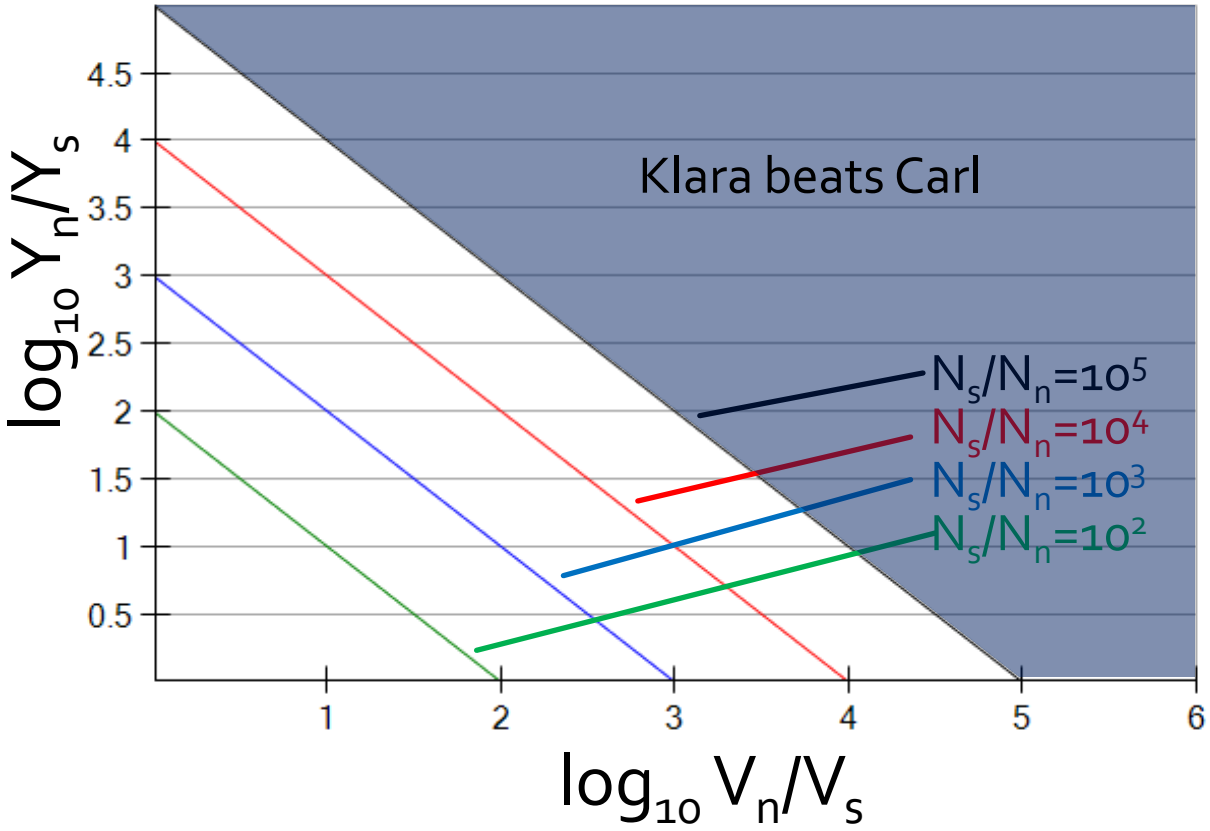
- **Reward(N) = N Y V**
  - N = Users Attacked
  - Y = Yield
  - V = Extracted Value/Successfully attacked user
- **At Equal cost to beat Scalable Return:**

$$N_n Y_n V_n \geq N_s Y_s V_s$$

$$\Rightarrow \quad \log (Y_n/Y_s) \geq \log (N_s/N_n) - \log (V_n/V_s)$$

Profit Frontier:
$\log Y_n/Y_s \geq \log N_s/N_n - \log V_n/V_s$

Non-Scalable needs: beat scaleable Yield-Value by as much as beaten on reach.



Competing on Yield Alone makes no sense

- **$V_n = V_s$ then Klara competes on cost**
- Klara now needs:

$$N_n Y_n \geq N_s Y_s$$

- Since $N_n << N_s$ this is hard:
  - $Y_n \approx 4.5\, Y_s$ [Jagatic et al Spear Phishing '06]
- Also, recall $V_s \rightarrow 0$ due to commoditization
  - Reward decreases, but costs do not

- **$V_n = V_s$ gives Klara difficult task**

Seeking Higher-Value Targets

- Klara needs: $N_n Y_n V_n \geq N_s Y_s V_s$
- Since $N_n << N_s$ must have:

$$\mathbf{Y_n V_n \geq Y_s V_s}$$

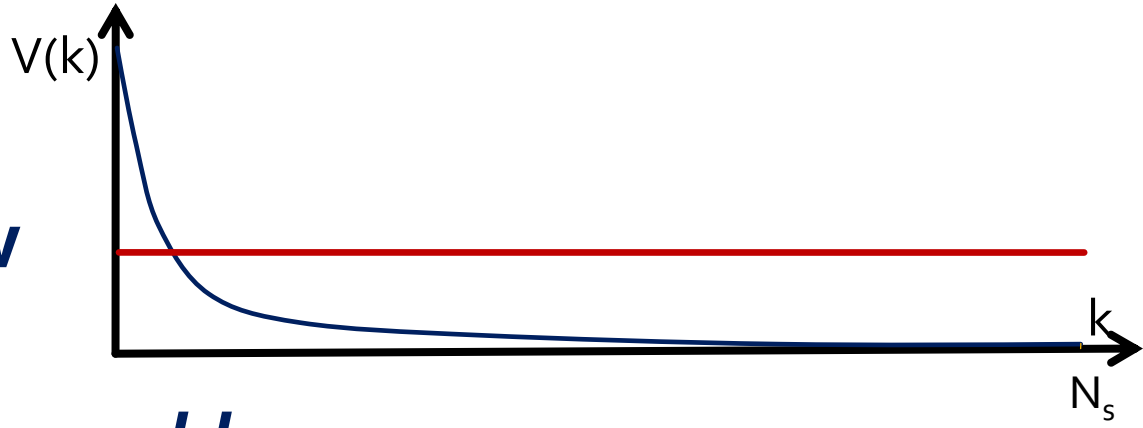
- So, higher yield, or higher value, or both
- Competing on Yield Alone Makes no sense

$$\Rightarrow \quad \mathbf{V_n \geq V_s}$$

- **Needs at least higher-than-average Value**

Klara needs longtail distribution of value

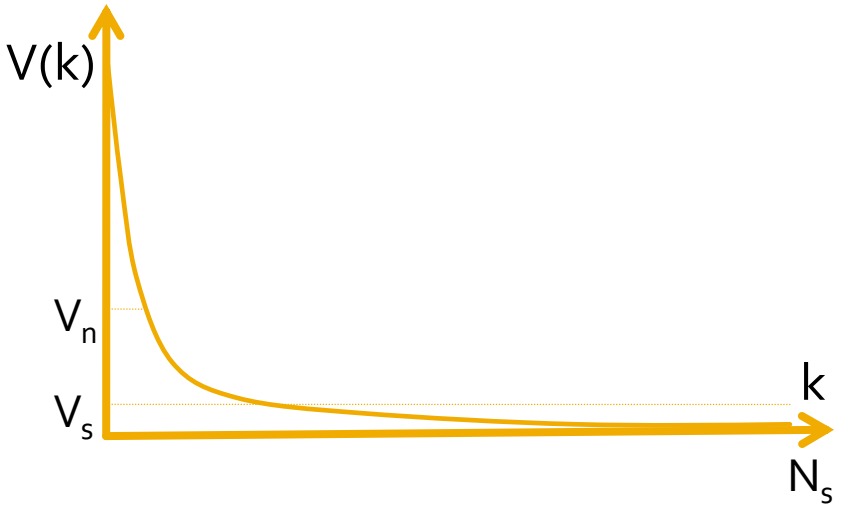
- At very least need $V(k) > V_s$
- Easiest when few users have high value, and most have low value



- **Worst: uniform**
- **Best: power-law**
- Must also be ***observable***
  - Klara must be able to see who has high V(k)

In longtail distributions most Users have below average value

- Power-laws are everywhere
  - Wealth, fame, webite popularity
- Mean >> Median
  - Most users have V(k) < V_s
- Example concentrations:
  - US Wealth: 1.8% above avg.
  - Fame: 2% above avg.
- **98% of users worthless to Klara**
- **Attacking them hurts rather than helps**.
- True no matter how many Klara's there are



The Plight of the Targeted Attacker

- To equal Carl: $N_n Y_n V_n \geq N_s Y_s V_s$
- Competing with $V_n = V_s$ makes no sense

=> Klara seeks high-value targets

=> Klara needs longtail, observable distribution

=> In longtails most users have $V(k) < V_s$

=> Most users not attacked by Klara

On the Internet Nobody Knows You're Not a Dog

- Alice's Bank Backup auth questions can be determined with 1hr effort from facebook
- Acct yields $200.
- Is this $200/hr for Klara?

- No. Unless this always succeeds
- Klara's reward depends on:
  - Y = fraction of bank accts hackable from facebook
  - V = Average extracted value
- Alice's ~~security~~ avoidance of harm depends on
  - Worthlessness of average facebook account

What does Klara Attack?

- PC's for Zombie use?
  - Value as Zombie is close to uniform
  - Value of creds on box unobservable
- Email, social networking?
  - Sarah Palin's email, U East Anglia climate researchers
- Bank Creds?
  - Carl bulk-produces consumer creds
  - Small biz creds

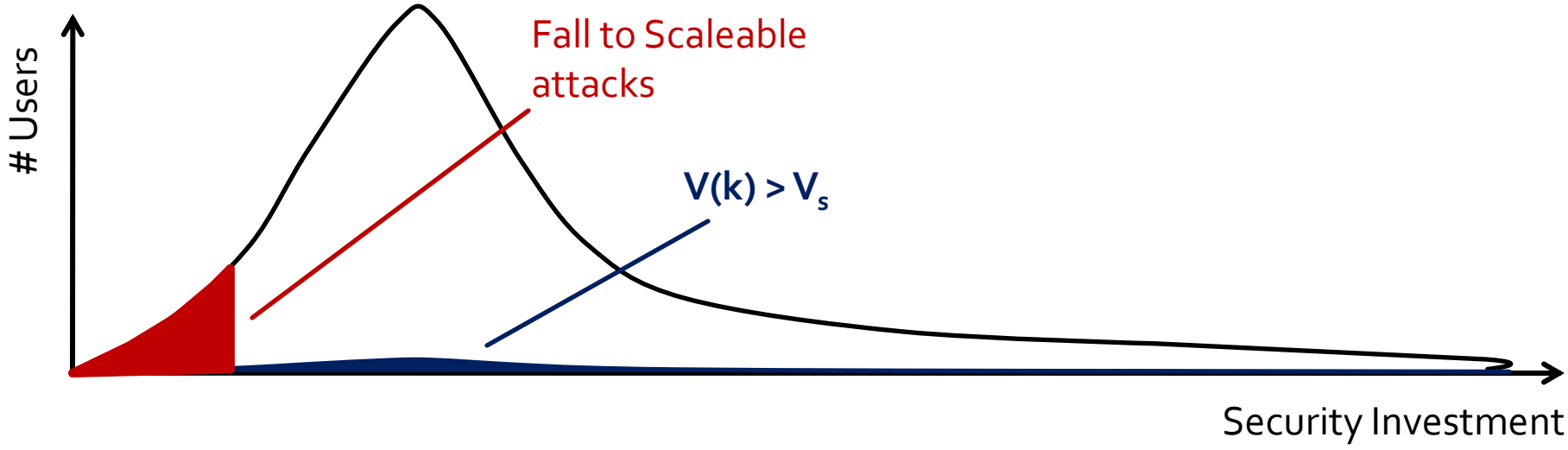
Concentrated/Observable

	Not Observable	Observable
Not Concentrated		**Value Generic** (PC for zombie, email for spam)
Concentrated	**PC for credentials** **Sloppiness** (Hi/Lo value acct. password sharing) **Gullability*** (responds to 419 scam)	**Fame**: (Sarah Palin's email) **Closeness** (jealous ex-SO)

*Gullability not observable. Nigerian 419 email is a scaleable attack which renders gullability observable. Carl/Klara cooperation

Security Investments

- Non-scaleable attacks are common, scaleable rare
- How much you must invest depends on whether anyone is targeting you



Conclusions

- How much should invest depends on targeting
  - Visibly in most valuable few percent for some asset?
- Elaborate non-scaleable attacks fail to happen
  - Benefit (to attacker) < Cost (to attacker)
- Most users never see most attacks