

Security & Economics — Part 1: Introduction

Dusko Pavlovic

Spring 2014

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Course on the web

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- ▶ slides and notes: asecolab.org
- ▶ homeworks and solutions: moodle

- ▶ L. A. Gordon and M.P. Loeb, *Managing Cyber-Security Resources*, Mc-Graw Hill 2006
- ▶ L.J. Camp and S. Lewis (eds.), *Economics of Information Security*, Kluwer 2004
- ▶ T. Moore et al (eds.), *Economics of Information Security and Privacy*, Springer 2010
- ▶ D. Easley and J. Kleinberg, *Networks, Crowds and Markets*, Cambridge University Press 2010

What do you expect from the course?

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Why study Security and Economics together?

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Is this a security problem
or an economic problem?

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Whose problem is harder?

The troubles

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- ▶ It is a trouble to not have.

- ▶ It is a trouble to have.

Security is the problem of having

J.K. Gallbraith:

- ▶ The poor man has always a precise view of his problem: he hasn't enough and he needs more.
- ▶ The rich man [has] a much greater variety of ills and he [is] correspondingly less certain of their remedy.

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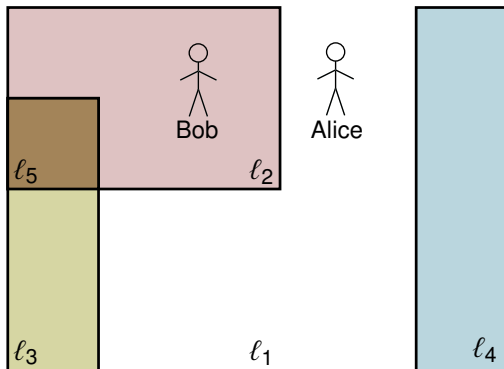
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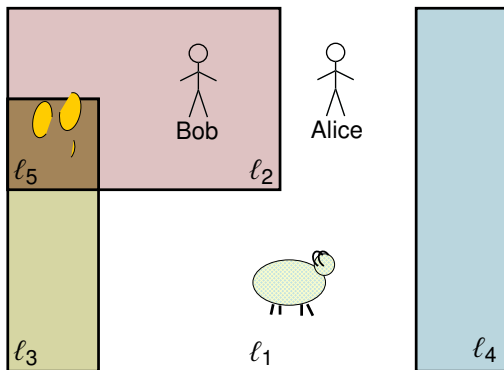
Example 1: Early security protocol

About 6000 years ago, Kain's son Bob built a secure vault



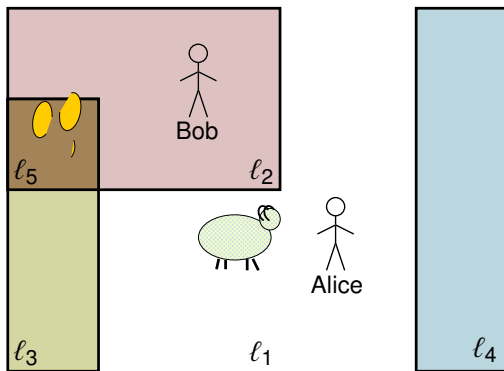
Example 1: Early security protocol

and stored his goods in it.



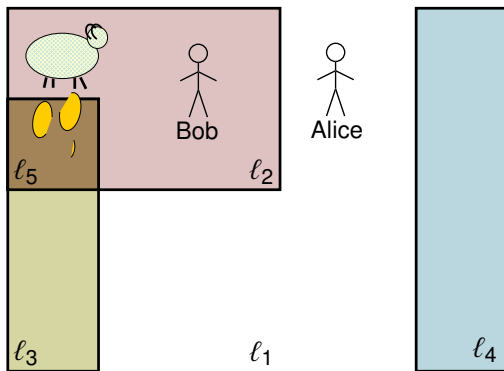
Example 1: Early security protocol

and stored his goods in it. When Alice wanted to go for a vacation



Example 1: Early security protocol

and stored his goods in it. When Alice wanted to go for a vacation, she stored her goods there too.



Example 1: Early security protocol

As a receipt for her deposit in Bob's vault, Alice got a *secure token in a clay envelope*.



Figure : Louvre, Paris

Example 1: Early security protocol

As a receipt for her deposit in Bob's vault, Alice got a *secure token in a clay envelope*.



Figure : Louvre, Paris

- ▶ To take the sheep, Alice must give the token.

Example 1: Early security protocol

As a receipt for her deposit in Bob's vault, Alice got a *secure token in a clay envelope*.



Figure : Louvre, Paris

- ▶ To take the sheep, Alice must give the token.
- ▶ To give the sheep, Bob must take the token.

Example 1: Early security protocol

As a receipt for her deposit in Bob's vault, Alice got a *secure token in a clay envelope*.



Figure : Louvre, Paris

- ▶ To take the sheep, Alice must give the token.
- ▶ To give the sheep, Bob must take the token.
- ▶ Anyone who gives the token can take the sheep.

Example 1: Early security protocol

- ▶ This protocol goes back to Uruk (Iraq), 4000 B.C.

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Example 1: Early security protocol

- ▶ This protocol goes back to Uruk (Iraq), 4000 B.C.
- ▶ *Money* developed from *security* tokens.

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Example 1: Early security protocol

- ▶ This protocol goes back to Uruk (Iraq), 4000 B.C.
- ▶ *Money* developed from *security* tokens.
- ▶ Numbers developed from security annotations.
- ▶ Writing developed later.

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Example 2: Security in E-commerce

Security seals convey trust



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Example 2: Security in E-commerce

Adverse selection

	TRUSTE-certified	uncertified
honest	94.6%	97.5%
malicious	5.4%	2.5 %

Table : Trustworthiness of TRUSTE [Edelman 2007]

Example 2: Security in E-commerce

Adverse selection

Google		
	sponsored	organic
top	4.44%	2.73%
top 3	5.33%	2.93 %
top 10	5.89%	2.74 %
top 50	5.93%	3.04 %

Table : Malicious search engine placements [Edelman 2007]

Example 2: Security in E-commerce

Adverse selection

Yahoo!		
	sponsored	organic
top	6.35%	0.00%
top 3	5.72%	0.35 %
top 10	5.14%	1.47 %
top 50	5.40%	1.55 %

Table : Malicious search engine placements [Edelman 2007]

Example 2: Security in E-commerce

Adverse selection

Ask		
	sponsored	organic
top	7.99%	3.23%
top 3	7.99%	3.24 %
top 10	8.31%	2.94 %
top 50	8.20%	3.12 %

Table : Malicious search engine placements [Edelman 2007]

Example 2: Security in E-commerce

Questions

- ▶ Why does adverse selection happen?
- ▶ How can it be avoided?

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Questions

- ▶ Why does adverse selection happen?
- ▶ How can it be avoided?

Answers

- ▶ Reputation
- ▶ Trust

Example 3: Digital rights management (DRM)

Economic art history

- ▶ art used to be bound to the artist
 - ▶ music was available only from a musician
 - ▶ a story from a storyteller
 - ▶ a painting could only be seen in the cave, church. . .

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Example 3: Digital rights management (DRM)

Economic art history

- ▶ mass reproduction bound art to copiable media
 - ▶ copying technologies led to *copyright*-based markets
 - ▶ artists could sell lots of books and records
 - ▶ **Copyright Management**: branding, celebrities

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Example 3: Digital rights management (DRM)

Economic art history

- ▶ digital networks freed art (science, religion. . .) from physical tokens (books, CDs. . .)
 - ▶ copying of digital content is essentially costless
 - ▶ Copyright Management becomes unviable
 - ▶ **Digital Rights Management:** seeks to
 - ▶ prevent (sandboxing. . .)
 - ▶ detect (watermarking . . .)
 - ▶ deter (lawyers . . .)

unauthorized copying of digital content

Example 3: Digital rights management (DRM)

Art economy as a security problem

In DRM, economics and security cannot be separated

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Art economy as a security problem

In DRM, economics and security cannot be separated:

- ▶ unauthorized copying of digital content cannot be prevented

Example 3: Digital rights management (DRM)

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Art economy as a security problem

In DRM, economics and security cannot be separated:

- ▶ unauthorized copying of digital content cannot be prevented
- ▶ the cost and the risk of copying needs to be made greater than the price of the downloads

Example 3: Digital rights management (DRM)

OR should art be a common resource, like air, or the Internet?

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Example 4: Tragedy of the Commons

Commons: publicly shared resources

For centuries, Alice, Bob and Charlie have been sharing an **open field system**.

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Example 4: Tragedy of the Commons

Commons: publicly shared resources

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Example 4: Tragedy of the Commons

Commons: publicly shared resources

In England, such open fields were called *Commons*.

Alice, Bob and Charlie alternated different crops with grazing, and maintained the land together.

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Example 4: Tragedy of the Commons

Commons: publicly shared resources

In England, such open fields were called *Commons*.

Alice, Bob and Charlie alternated different crops with grazing, and maintained the land together.

Two remarkable social processes ensued:

- ▶ Tragedy of the Commons, and
- ▶ Enclosure Movement

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Example 4: Tragedy of the Commons

- ▶ Charlie realized that it was *rational* for him to invest
 - ▶ all effort into exploiting the public resource, and
 - ▶ no effort into maintaining it.

Charlie became a *free rider*.

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 - ▶ to stop maintaining the resource for Charlie, and
 - ▶ to hurry to exploit the resource too.

Example 4: Tragedy of the Commons

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- ▶ **A race to the bottom** ensued.

Example 4: Tragedy of the Commons

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Charlie became a *free rider*.

- ▶ Alice and Bob realized that it was *rational* for them
 - ▶ to stop maintaining the resource for Charlie, and
 - ▶ to hurry to exploit the resource too.

- ▶ **A race to the bottom** ensued.

- ▶ The resource got depleted.

Example 4: Tragedy of the Commons

Common resources cause the **race to the bottom**.



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Example 4: Tragedy of the Commons

Fair sharing of public resources is a security problem.



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Example 4: Tragedy of the Commons

- ▶ the Internet is a common resource
- ▶ spam is an instance of the Tragedy of the Commons
- ▶ it is an economic & security problem

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Example 4: Tragedy of the Commons

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Solution: The Enclosure Movement

- ▶ Charlie *enclosed* the Commons from Alice and Bob.
- ▶ In England, this happened in XV–XVII centuries.

Example 4: Tragedy of the Commons

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Market economy: private vice → public benefit

"It is not from the benevolence of the butcher, the brewer, or the baker that we expect our dinner, but from their regard to their own self-interest. We address ourselves not to their humanity but to their self-love, and never talk to them of our own necessities, but of their advantages"

Adam Smith

Example 4: Tragedy of the Commons

Second Enclosure

Verizon: net neutrality violates our free speech rights

Company argues FCC regulations run afoul of Fifth Amendment property rights too.

by Timothy B. Lee - July 3 2012, 8:15pm CEST

GOVERNMENT 310



"Can you hear me now?"

 Aurich Lawson

Verizon pressed its argument against the Federal Communications Commission's new network

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Example 5: Free market protocol



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Example 5: Free market protocol



Based on trust

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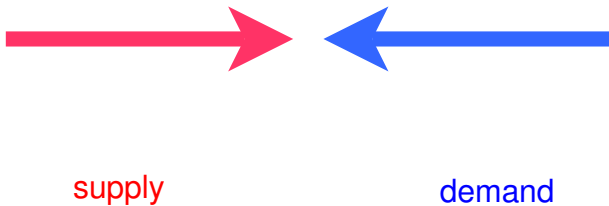
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Example 5: Free market protocol



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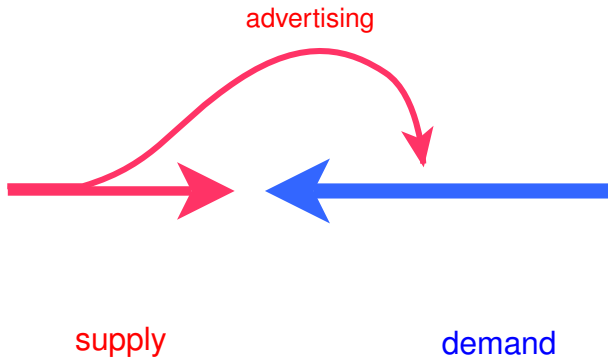
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Example 5: Free market protocol



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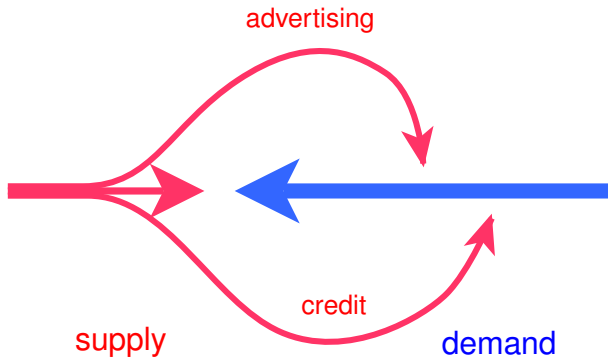
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Example 5: Free market protocol



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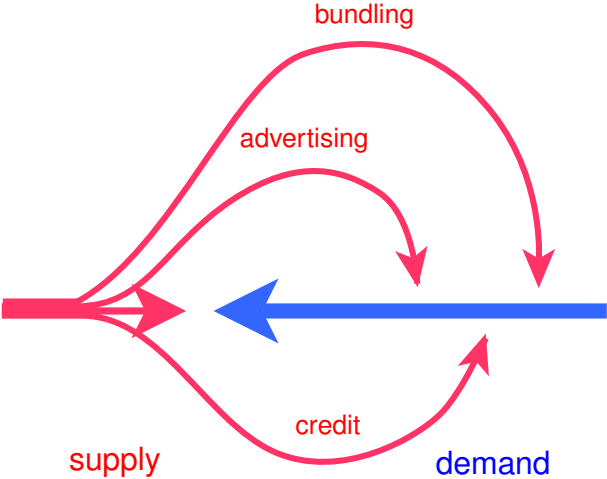
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Example 5: Free market protocol



Example 5: Free market protocol



Based on influence

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Example 5: Free market protocol



Information asymmetry: "Market of lemons"

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Example 5: Free market protocol



Information asymmetry: "Financial derivative"

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Example 5: Free market protocol

Upshot

- ▶ *security goal*: equilibrium of supply and demand
- ▶ *security protocol*: free exchange
- ▶ *"attacks above"*: advertising, information asymmetry
 - ▶ security protocol correctly executed
 - ▶ security goal shifted

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Example 6: Monetizing information

Problem of the Web: Semistructured data

- ▶ no global declarations
- ▶ semantics vary from node to node

Example 6: Monetizing information

Problem of the Web: Semistructured data

- ▶ no global declarations
- ▶ semantics vary from node to node

Proposed solutions

- ▶ *Semantic Web*:
 - ▶ standardize formats for global declarations (ontologies)
- ▶ *search*:
 - ▶ do not standardize
 - ▶ extract the meaning from the documents

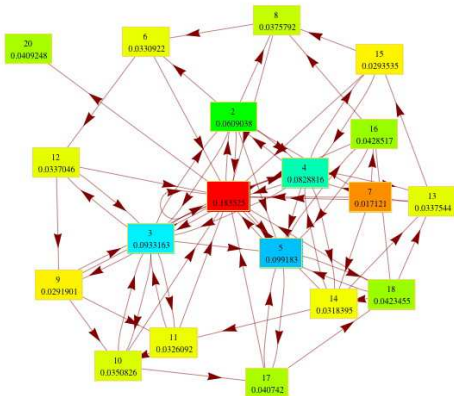
Example 6: Monetizing information

Demise of Web 1.0

- ▶ keyword search
 - ▶ crawling and indexing
- ▶ stealing the meaning is easy and blatant
 - ▶ keyword stuffing, keyword spam, spamdexing
- ▶ race to the bottom
 - ▶ costless advertising overruns all information

Example 6: Monetizing information

Web 2.0 solution: Reputation ranking



Reputation as a fixed point (PageRank, HITS)

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Example 6: Monetizing information

Monetizing search: Ad Words

The screenshot shows a Google search for "flower shops" with results for Australia. The search bar at the top includes "Web", "Images", "Groups", "News", "Scholar", and "more...". The search results are categorized into "Organic Listings" and "Paid Listings".

Organic Listings:

- Flower Delivery Australia:** Australia's favourite online florist - same day flower delivery. easyflowers.com.au
- interflora Australia:** Flowers & gifts for all occasions. Delivery Australia & World Wide. www.interflora.com.au
- Flower Shops - Want to Buy Flowers from Flower Shops Online in ...**
Want to shop? Sale Online Shopping Starts at ShopGate - Flower Shops listings include , Flowers For Everyone, The Flower Factory - Flowers Made Easy, ... www.shopgate.com.au/pageinfo/flowershops.htm - 59b - 7 Jul 2007 - [Cached](#) - [Similar pages](#) - [Note this](#)
- Florist Brisbane, Sydney, Melbourne, Perth, Canberra, Adelaide ...**
Florist Brisbane, Sydney, Melbourne, Perth, Canberra, Adelaide send flowers from Flowers Basket Australian flower orders for flowers, roses, arrangements, ... www.flowersbasket.com.au/ - 39a - [Cached](#) - [Similar pages](#) - [Note this](#)
- Melbourne florist - Melbourne flowers, gifts buy online from a ...**
Find a local Melbourne Florist who takes online orders, or use our rating system to leave your opinion about other Melbourne florists. www.e-cbd.com/101360.php - 12a - [Cached](#) - [Similar pages](#) - [Note this](#)
- San Francisco florist - San Francisco flowers, gifts buy online ...**
San Francisco Florist listing in the e-CBD Flower Store www.e-cbd.com/103189.php - 10a - [Cached](#) - [Similar pages](#) - [Note this](#)
[[More results from www.e-cbd.com](#)]
- Florist Perth Florist Flower The Online Grower free flower delivery**
Florist Perth Florist Perth Flowers at OnlineGrower.com.au for just AU\$55 we can deliver fresh flowers to loved ones anywhere in Western Australia WA, plus ... www.onlingrower.com.au/ - 39a - [Cached](#) - [Similar pages](#) - [Note this](#)
- Flowers For Everyone Australia - Flower Delivery Australia wide ...**
Every flower arrangement is made to order, fresh & beautiful ... Flowers delivered sydney by our sydney florist shops located in Sydney City, Brookvale ... www.flowersforeveryone.com.au/ - 39a - [Cached](#) - [Similar pages](#) - [Note this](#)

Paid Listings:

- Ready Flowers Australia:** Fantastic flowers, from under \$50 Same day delivery Australia-wide www.readyflowers.com.au
- Send Flowers - Same Day:** Send a Fresh, Innovative Floral Gift Today. Same-Day Delivery! www.SendAFlower.com
- Online Flower Shops:** Quality Service. Free Shipping! Order Now For Fresh Flowers Today! www.FlowerQueen.com
- Flower Shops:** Order your Mother's Day bouquet now Australia's leading online florist www.Sewees.com.au
- Flower Shops:** Free delivery to all suburbs today Australia wide - Same day delivery www.recessonly.com.au
- Flower Shop Online:** Gorgeous Flowers. Send Your Thanks, Love, Sympathy Or Congratulations. www.flowersforEveryone.com.au
- Flowers & Gift Baskets:** Flowers for all occasions 35 years of Experience www.taff.florist.com

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Monetizing semantics: Ad Sense

The screenshot shows the homepage of nameadog.com. At the top, there's a navigation bar with links like Home, Training, Social, Photos, and a 'Dog & Cat' dropdown menu. Below the navigation is a large banner for 'Jenny's DOG-NAMING SERVICE'. The main content area features an article titled 'The Top 10 Most Popular Dog Names in America' with a sub-headline 'Keep Your Dog's Name Trendy!'. The article includes a list of names and a small image of a dog. Below the article is a 'Name a Dog' form with a heading 'Do You Hope People Won't Hear You When You Call Your Dog?'. The form contains several bullet points and a 'Submit' button. To the right of the form are two small advertisements: one for 'Dog Training' and another for 'Puppy Housebreaking'.

The screenshot shows two AdSense ads. The top ad is titled 'Dog Training' and is for PetSmart. The text of the ad reads: 'Dog Training PetSmart Dog Training is Fun, Safe & Convenient. Find Classes Near You'. Below the text is the URL 'www.PetSmart.com'. The bottom ad is titled 'Puppy Housebreaking' and is for IAMS. The text of the ad reads: 'Puppy Housebreaking Discover IAMS Smart Puppy Formula. Register for Advice, Offers & More!'. Below the text is the URL 'www.iams.com/marpu'.

You get relevant text and image ads that are precisely targeted to your site and your site content.

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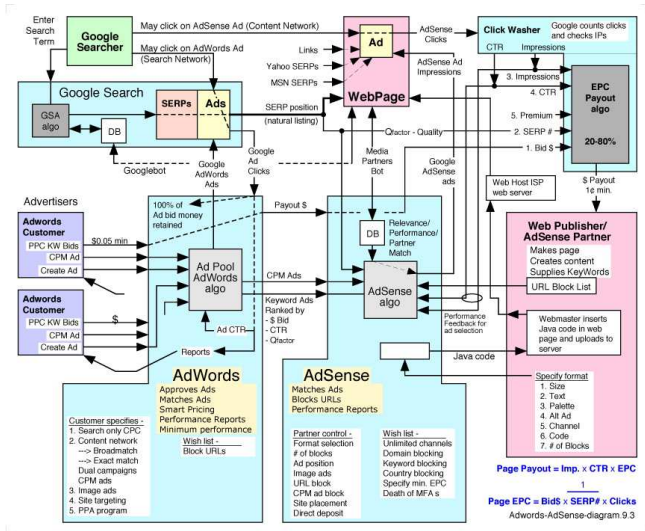
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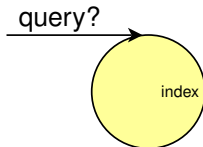
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Example 6: Monetizing information

Search engine protocol

User

SE



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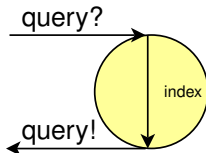
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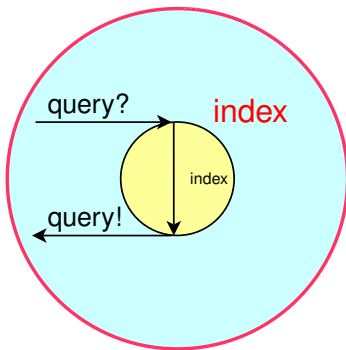
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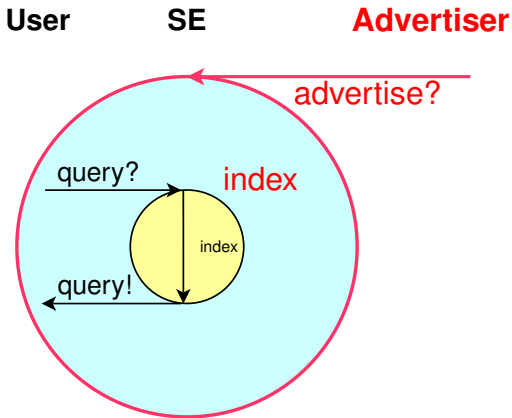
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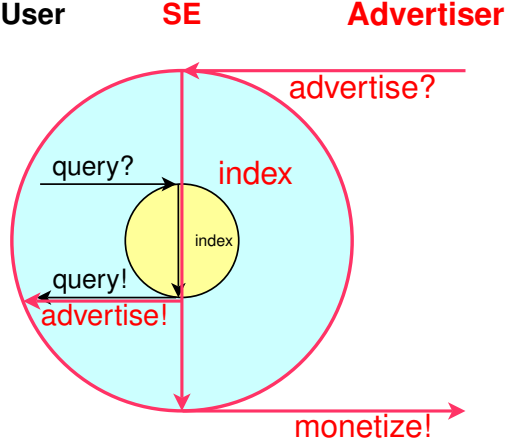
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Example 6: Monetizing information

Search engine protocol



- Early security protocol
- Security in E-commerce
- DRM
- Tragedy of the Commons
- Securing free market

Example 6: Monetizing information

Upshot

Search protocol participants have **different security goals**:

- ▶ *surfer*: acquire information
- ▶ *search engine*: monetize information
- ▶ *sponsors*: influence information

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Upshot

Search protocol has **different executions**:

- ▶ *surfer*: information retrieval
- ▶ *search engine*: man-in-the-middle
- ▶ *sponsors*: user tracking and profiling

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Upshot

... And these security problems arise before fraud...

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Claim 1

Networks open up **social problems** like

1. trust and reputation
2. digital property rights
3. commons and the environment
4. free market
5. information economy

...

Claim 2

Such social problems open up to **technical solutions** that combine

- ▶ security methodologies and
- ▶ economic modeling

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Why Economics & Security?

Conceptual roots of network economy

Structure of the course

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What are Economics & Security?

- ▶ What is economics?
- ▶ What is security?

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What are Economics & Security?

- ▶ Economics is concerned with production of wealth.
- ▶ Security is concerned with protection of assets.

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What links Economics & Security?

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- ▶ Economics \subseteq Security
 - ▶ economics studies the market
 - ▶ the market is a security protocol
 - ▶ market economy is a security process

What links Economics & Security?

- ▶ Security \subseteq Economics
 - ▶ security protects assets
 - ▶ security costs \leq asset value
 - ▶ security is an economic process

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Dark side of the economic force

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"The efforts of men are utilized in two different ways:

- ▶ they are directed to the production or transformation of economic goods,
- ▶ or else to the appropriation of goods produced by others.

Vilfredo Pareto

A race is won by moving fast

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... or by tripping up the opponent

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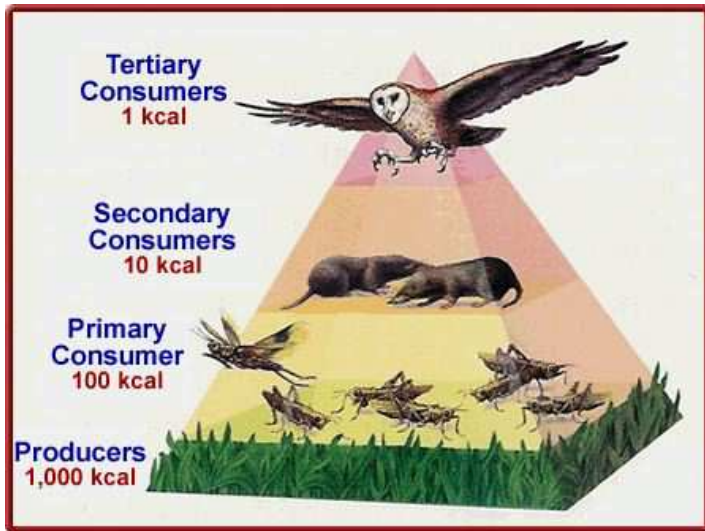
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Economy of production and predation



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Economy of production and predation

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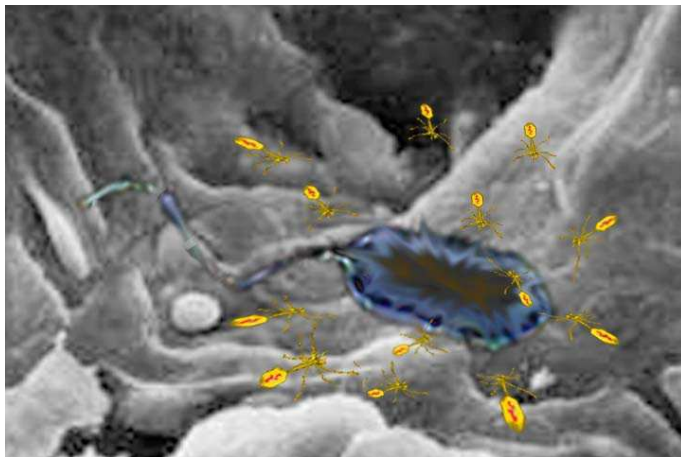
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Bacteria have a security problem to protect their assets.

Economy of production and predation

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- ▶ Production increases wealth.
- ▶ Predation redistributes it.
- ▶ Redistribution leads to new forms of production.
 - ▶ network servers: banks, real estate agents. . .

Dynamics of production and predation

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The rich get richer.

Vilfredo Pareto

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Part I: Methods of economics in security

Lecture 2: Security Investment Analysis

Lecture 3: Interdependency and Gaming

Part II: Methods of security in economics

Lecture 4: Information economy

Lecture 5: Trust and reputation

Teaching outcomes of the course

Part I: Market aspects of security

Lecture 2: Tools for CIO

Lecture 3: Security and competition

Part II: Security aspects of market

Lecture 4: Pricing and market mechanisms

Lecture 5: Monetizing information

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Employment outcomes the course

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Part I: Chief Information Officer

Lecture 2: "How much is this firewall worth to me?"

Lecture 3: "Can I secure this transaction?"

Part II: Monetizing guru

Lecture 4: "Where is the revenue on this network?"

Lecture 5: "How can I monetize this free transaction?"