INTERNET TECHNOLOGY, ECONOMICS AND POLICY

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http://www.cs.columbia.edu/~hgs/teaching/itep/

Fall 2017
CLASS OVERVIEW
Big questions

- How does the Internet work, technically?
- How come your Internet bill is so high (or low)?
- What’s hard about extending the Internet to rural areas?
- Is the Internet local, national or international?
- What does it mean for the Internet to be “open” or “neutral”?
- Do Google and Facebook differ from Comcast and AT&T?
  Should any of them be able to ban offensive speech on their platform?
- How can we make the Internet useful for public safety & people with disabilities?
- Why do carriers pay billions of dollars for spectrum?
- What makes “cyber security” hard?
What’s on the syllabus?

• **Technology**
  • Overview of Internet technology (how does the Internet work)
  • Protocol and architecture standardization (IETF, 3GPP, OMA, ...)
  • Wireless communications
    • From AM radio to cellular
    • Spectrum: properties, allocation and co-existence

• **Economics**
  • Review of basic principles of micro-economics
  • The economics of networks
    • building networks, natural monopolies, …

• **Law & policy**
  • How does the law work?
  • A bit of communication history
  • The role of communication policy and regulation
    • Telecom Act, FCC overview
  • Common carriage, public utilities, significant market power and other regulatory frameworks
What’s on the syllabus?

- Network neutrality and the Open Internet
- Peering, transit and traffic exchange
- Names, numbers and addresses
- *Internet security challenges*
  - Basic principles of network security
  - “Cybersecurity”
  - Unwanted communication
  - Privacy and surveillance
- *Communication for all*
  - Enabling technologies for people with disabilities (relay services, accessibility, CVAA, ...)
- Internet governance
  - ICANN, ITU and other actors
What should you be able to do after taking the class?

• Elevator pitch
  • “What is spectrum and why is it hard to find” – in 2 minutes

• In-depth survey
  • “The economics of Internet adoption in rural and urban areas”

• Research
  • Know sources and approaches
    • engineering models vs. economic models vs. legal analysis
  • Appreciate need to consider
    • technical feasibility
    • economic factors
    • policy enablers and constraints
Materials

- No formal text book, but draws from
  - “The Master Switch” (T. Wu).

- Other materials:
  - Technical papers (IEEE, ACM, tech reports, …)
  - Law review articles (*Federal Communications Law Journal*)
  - SSRN
  - White papers
  - Industry analysis reports (analysts, OECD, Census, …)
  - Regulatory filings (FCC, Ofcom, BEREC, …)
  - Laws & regulations (US, mostly)
How to benefit from this class

• Be prepared (e.g., read assigned materials)
• Expand your mental horizon beyond your discipline
• Understand positions you may not “like”
• Participate in class discussion
• Pick an interesting project
  • “big data”
  • apps & software for public-good applications
  • system modeling
How not to benefit

- Catch up on Facebook
- Cat videos!
- Transcribe the class into your notebook
- Flip through the slides
- Voice only popular opinions
  - or opinions you read in the NY Times, WSJ or Breitbart
- Believe that the instructor is always right
  - on facts or interpretation
Mechanics

- Homework assignments
  - may allow options to accommodate different backgrounds
- Semester (group) paper
  - start early – may need to be defined & refined by iteration
  - outcome: research paper
  - may be review, quantitative analysis or experiment (not just software)
- Pop quizzes, occasionally
- Guest (video) lectures
  - colleagues from Washington, DC
- Possibly, field trip
Semester project

• Pick topic and team by 9/15
  • including goals and tools
  • responsibilities (who will do what)
  • observable milestones (every two weeks) create project page
  • submit via CourseWorks

• Bi-weekly progress reports for each team

• End-of-semester presentation

• Report suitable as technical report, i.e.,
  • proper citations (IEEE format, etc.)
  • useful abstract
  • standard paper conventions, including format and style
  • not just a bunch of bullet points or graphs
Semester project

• Student chosen, with guidance
  • encourage cross-disciplinary teams
  • teams of 1-3 students
• Data analysis
  • *Measuring Broadband America*, ATLAS
  • other data sources (FCC, Ofcom, OECD, ITU)
  • own data gathering
• Measurements
  • Open Internet measurements
  • 911 services: (indoor) location accuracy, non-traditional emergency coordination (Harvey)
  • Services for people with disabilities: closed captioning; speech-to-text
  • Spectrum measurements
• Analysis
  • Network economics (e.g., spectrum usage, pricing or universal service)
Field trip?

- Possible field trip to Washington, DC
  - FCC
  - NTIA
- Interest & logistics

Figure 1
Global Internet users and penetration rate (1995-2009)

A quarter of the world’s population is online

Sources: Nielsen, ITU; A.T. Kearney analysis
Internet growth – 2009–2016

Global Internet Users (MM), 2009 – 2016

Source: United Nations / International Telecommunications Union, US Census Bureau. Internet user data is as of mid-year. Internet user data for: USA from Pew Research, China from CNNIC, Iran from Islamic Republic News Agency / InternetWorldStats / KPCB estimates, India from KPCB estimates based on IAMAI data, Indonesia from APJII.
US Internet access

% of adults who have internet access at home

Pew
But not all are happy about this…

Newspaper industry estimated advertising and circulation revenue

Total revenue for U.S. newspapers (in U.S. dollars)
Basic Internet money routing

Internet
$56B fixed
$141B mobile

ISP

content & service aggregators

OTT (over-the-top)

consumer spending ($11.9T)

$285B (NA, 2016)

$191B (2016)

Source: Statista, Revenue of major U.S. wireless telecommunication providers in 2016 (in billion U.S. dollars)

AT&T
Verizon
T-Mobile USA
Sprint Corporation
US Cellular

Additional information: United States, Statista
Internet service providers (by age)

- "phone companies"
  - 1880s
  - (incumbent) Local Exchange Carrier (LEC) & Rural LEC
  - large ILECs: AT&T, Verizon
  - large RLECs ("independents"): CenturyLink, Frontier, Windstream
  - thousands of small RLECs

- "cable companies"
  - 1960s
  - all are MVPDs, but phone companies can also be MVPDs
  - Comcast, Charter, Cox, Altice, Mediacom

- "cellular providers"
  - 1980s
  - AT&T, Verizon, T-Mobile, Sprint

- Internet backbone & "dark fiber"
  - 1990s
  - Level3, Cogent, Zayo
The industry is complicated

- all entities can serve as a *Broadband Internet Access Service* (BIAS), commonly known as *ISP*
- almost all "TV" distributors are MVPDs, but not all MVPDs are ISPs (e.g., satellite)
- AT&T, as an ILEC, owns a satellite MVPD (DirecTV)
- Same company can be ILEC in one state & CLEC in another (rare)
Converging Destinies

AT&T and Time Warner have reached an agreement to merge after decades of consolidation and deals in the telecommunication and media industries.

Other deals and attempts among media and telecom companies:
- Walt Disney Co. buys Capital Cities/ABC Inc.
- News Corp buys 34% stake in DirecTV
- Comcast drops its bid for Walt Disney Co.
- Comcast completes purchase of NBCUniversal
- 21st Century Fox withdraws a bid for Time Warner

Source: staff and news reports
It used to be simple (ca. 1990)
OTT, VOD, SVOD, …

- **OTT** = delivery of services (interactive voice, entertainment video) over the Internet without subscribing to traditional cable or telephone service
  - Video: Netflix, Hulu, HBO Go, YouTube, Vimeo, Go90
  - Voice: Skype, Vonage, FaceTime, …
- **OVD** = online video distribution (linear, scheduled [not VOD])
- **SVOD** = streaming/subscription video on demand
- **AVOD** = ad-supported video-on-demand
- **TVOD** = transactional; “pay TV”
- **MVPD** = multi-channel video programming distributor
  - typically, linear = “live TV” → can be cable (all cable systems are MVPDs), satellite (also) or fiber!
- **TV Everywhere** = cable service over IP (same bundle)
## OTT, SVOD, ...

<table>
<thead>
<tr>
<th>Service</th>
<th>Linear vs. on-demand</th>
<th>bundle or individual</th>
<th>payment</th>
<th>example</th>
</tr>
</thead>
<tbody>
<tr>
<td>OVD</td>
<td>both</td>
<td>any</td>
<td>any</td>
<td></td>
</tr>
<tr>
<td>MVPD</td>
<td>linear (may offer VOD)</td>
<td>bundles</td>
<td>monthly</td>
<td>cable TV, satellite</td>
</tr>
<tr>
<td>TV Everywhere</td>
<td>linear</td>
<td>subset of TV bundle</td>
<td>monthly</td>
<td>Comcast, TWC</td>
</tr>
<tr>
<td>SVOD</td>
<td>on demand</td>
<td>bundle</td>
<td>monthly</td>
<td>Netflix, HBO Go, Hulu Plus</td>
</tr>
<tr>
<td>TVOD</td>
<td></td>
<td>movie</td>
<td>movie</td>
<td>Amazon Instant Video</td>
</tr>
<tr>
<td>AVOD</td>
<td></td>
<td>short form content, movie</td>
<td>ad-supported</td>
<td>YouTube, Vimeo, Hulu</td>
</tr>
</tbody>
</table>
Basic video money routing

MSO/MVPD

retransmission consent fees
$50B

consumer spending
($11.8T 2Q17)

reverse compensation

CABLEVISION

Cable television

COMCAST

media companies

reverse compensation

Coca-Cola

Scottrade

Ford

Time Warner Cable

Ford

CBS

NBC

Fox
More industry revenues

<table>
<thead>
<tr>
<th>Company or sector</th>
<th>US domestic revenue, 2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Netflix (US)</td>
<td>$5.1B</td>
</tr>
<tr>
<td>Cisco (Americas)</td>
<td>$28.4B</td>
</tr>
<tr>
<td>US subscription TV (cable, SAT)</td>
<td>$101.8B</td>
</tr>
<tr>
<td>US film (box office)</td>
<td>$9.9B</td>
</tr>
<tr>
<td>US music (incl. concerts)</td>
<td>$15.5B</td>
</tr>
<tr>
<td>US games (software &amp; ads)</td>
<td>$17.6B</td>
</tr>
<tr>
<td>US wireless telecom (services)</td>
<td>$188.5B</td>
</tr>
<tr>
<td>Google (worldwide)</td>
<td>$89.5B (56% international)</td>
</tr>
</tbody>
</table>
Cable TV subscriptions

Pay TV Households (MM), USA, 2010-2016

Source: Nielsen Total Audience / Cross Platform Reports, US Census Bureau, St. Louis Federal Reserve FRED Database
Note: Pay TV households represented by Nielsen “Cable Plus” metric, which includes households who receive television via Wired Cable (No Telco), Telco, or Satellite. “Programming Costs” includes total program and production costs for Cable and Other Subscription Programming firms, 2006-2015, as per US Census Services Annual Survey for Employer Firms ($25B in 2015, up from $12B in 2006).
News revenue

- 2016: $29B for 1,331 US dailies
  - 62% ($18B) from advertising
  - ¼ ($11B) digital & print circulation
  - rest: events, commercial printing, e-commerce, …

- 12 cable news channels, 3 broadcast networks news, 800 news-producing local TV stations
  - $16.4B revenue
  - total of about 2,192 TV stations
  - 3 news networks: $691M average

- Non-commercial sector: $1.9B
  - includes 1,000 local public radio stations
  - 393 public TV stations (PBS)
# 2015-2020 U.S. Advertising

## Exhibit 15

### U.S. Advertising Revenue by Media Forecast

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>TV</td>
<td>$70.6</td>
<td>$73.9</td>
<td>$69.9</td>
<td>$70.8</td>
<td>$67.1</td>
<td>$68.6</td>
<td>-1%</td>
<td>-4%</td>
</tr>
<tr>
<td>Internet</td>
<td>$59.6</td>
<td>$71.7</td>
<td>$84.2</td>
<td>$97.0</td>
<td>$110.2</td>
<td>$124.0</td>
<td>16%</td>
<td>130%</td>
</tr>
<tr>
<td>Radio</td>
<td>$16.5</td>
<td>$16.1</td>
<td>$15.7</td>
<td>$15.3</td>
<td>$14.9</td>
<td>$14.5</td>
<td>-3%</td>
<td>-4%</td>
</tr>
<tr>
<td>New spapers</td>
<td>$13.2</td>
<td>$11.7</td>
<td>$10.2</td>
<td>$8.8</td>
<td>$7.4</td>
<td>$6.1</td>
<td>-14%</td>
<td>-14%</td>
</tr>
<tr>
<td>Magazines</td>
<td>$10.1</td>
<td>$9.4</td>
<td>$8.8</td>
<td>$8.1</td>
<td>$7.3</td>
<td>$6.6</td>
<td>-8%</td>
<td>-7%</td>
</tr>
<tr>
<td>Outdoor</td>
<td>$6.3</td>
<td>$6.2</td>
<td>$6.1</td>
<td>$6.0</td>
<td>$5.9</td>
<td>$5.8</td>
<td>-2%</td>
<td>-1%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>$176.3</td>
<td>$189.0</td>
<td>$194.9</td>
<td>$206.0</td>
<td>$212.9</td>
<td>$225.7</td>
<td>5%</td>
<td>100%</td>
</tr>
</tbody>
</table>

### Revenue by Media YoY growth

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>TV</td>
<td>4.6%</td>
<td>-5.3%</td>
<td>1.2%</td>
<td>-5.2%</td>
<td>2.3%</td>
<td></td>
</tr>
<tr>
<td>Internet</td>
<td>20.3%</td>
<td>17.4%</td>
<td>15.2%</td>
<td>13.6%</td>
<td>12.5%</td>
<td></td>
</tr>
<tr>
<td>Radio</td>
<td>-2.4%</td>
<td>-2.5%</td>
<td>-2.6%</td>
<td>-2.7%</td>
<td>-2.8%</td>
<td></td>
</tr>
<tr>
<td>New spapers</td>
<td>-11.4%</td>
<td>-12.5%</td>
<td>-13.9%</td>
<td>-15.6%</td>
<td>-17.8%</td>
<td></td>
</tr>
<tr>
<td>Magazines</td>
<td>-6.6%</td>
<td>-7.2%</td>
<td>-8.0%</td>
<td>-8.9%</td>
<td>-10.0%</td>
<td></td>
</tr>
<tr>
<td>Outdoor</td>
<td>-1.1%</td>
<td>-1.3%</td>
<td>-1.5%</td>
<td>-1.8%</td>
<td>-2.0%</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>7.2%</td>
<td>3.1%</td>
<td>5.7%</td>
<td>3.4%</td>
<td>6.0%</td>
<td></td>
</tr>
</tbody>
</table>

Source: Company reports, MoffettNathanson estimates and analysis

The Digital Duopoly, MoffettNathanson, 2016
Newspaper advertising

Twenty years ago classifieds provided more than a third of the revenue of *The Washington Post*. Craigslist has destroyed that business for the *Post* and every major paper in the country. (Brookings, 2014)
Macy's Kings Plaza opens tomorrow

NY Times,
09/10/1970
Aside: political advertising on TV
Digital advertising revenue

Quarterly revenue growth trends 1996-2016 ($ billions)

Source: IAB/PwC Internet Ad Revenue Report, FY 2016
Who is advertising?

Internet ad revenues by major industry category*, year to date: 2015 vs. 2016

<table>
<thead>
<tr>
<th>Industry Category</th>
<th>FY 2015</th>
<th>FY 2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retail</td>
<td>21%</td>
<td>21%</td>
</tr>
<tr>
<td>Financial Services</td>
<td>13%</td>
<td>13%</td>
</tr>
<tr>
<td>Auto</td>
<td>12%</td>
<td>12%</td>
</tr>
<tr>
<td>Telecom</td>
<td>9%</td>
<td>9%</td>
</tr>
<tr>
<td>Leisure Travel</td>
<td>8%</td>
<td>9%</td>
</tr>
<tr>
<td>Consumer Packaged Goods</td>
<td>6%</td>
<td>6%</td>
</tr>
<tr>
<td>Consumer Electronics &amp; Computers</td>
<td>8%</td>
<td>7%</td>
</tr>
<tr>
<td>Pharma &amp; Healthcare</td>
<td>5%</td>
<td>5%</td>
</tr>
<tr>
<td>Media</td>
<td>5%</td>
<td>5%</td>
</tr>
<tr>
<td>Entertainment</td>
<td>4%</td>
<td>4%</td>
</tr>
</tbody>
</table>

Source: IAB/PwC Internet Ad Revenue Report, FY 2016

* Industry category definitions may have changed over the time period depicted, both within the survey process and as interpreted by survey respondents. Amounts do not total to 100% as minor categories are not displayed.
What kind of advertising?

Ad formats – full year 2016

- Total - $72.5 billion****
  - Search: 51%
  - Mobile: 12%
  - Banner: 7%
  - Video: 6%
  - Other: 24%

Mobile Formats
- Search: 47%
- Banner: 38%
- Video: 11%
- Other: 4%

Ad formats – full year 2015

- Total - $59.6 billion****
  - Search: 35%
  - Mobile: 34%
  - Banner: 8%
  - Video: 7%
  - Other: 16%

Mobile Formats
- Search: 44%
- Banner: 45%
- Video: 8%
- Other: 4%

Source: IAB/PwC Internet Ad Revenue Report, FY 2016

Real-time brokered (programmatic): ~80%
What kind of advertising?

- Display (banner) ads
  - brand awareness, mostly
  - fixed cost or bidding for pages
  - pop-ups, inline, interstitial (before & after)
- Search ads
  - bidding for key words
- Location-based (push) advertising
- Email-based
- Sponsored content
- Video ads
  - Pre-roll & insert
- Classifieds (e.g., Craigslist)
Programmatic advertising

Things Happened in This Chart Are Matter of Milliseconds

DSP = demand-side platforms: advertisers offer their ads for placement
SSP = supply-side platform: publishers offer inventory for sale
Buying media programmatically

(source: DNB)
# Types of banner advertising (& video?) inventory

<table>
<thead>
<tr>
<th>Type of Inventory (Reserved(^1), Unreserved)</th>
<th>Pricing (Fixed(^2), Auction)</th>
<th>Participation (One Seller-One Buyer, One Seller-Few Buyers, One Seller-All Buyers)</th>
<th>Other Terms Used in Market</th>
<th>Other Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automated Guaranteed</td>
<td>Reserved</td>
<td>Fixed</td>
<td>One-One</td>
<td>Programmatic guaranteed premium, programmatic direct, programmatic reserved</td>
</tr>
<tr>
<td>Unreserved Fixed Rate</td>
<td>Unreserved</td>
<td>Fixed</td>
<td>One-One</td>
<td>Preferred deals, private access, first right of refusal</td>
</tr>
<tr>
<td>Invitation-Only Auction</td>
<td>Unreserved</td>
<td>Auction</td>
<td>One-Few</td>
<td>Private marketplace, private auction, closed auction, private access</td>
</tr>
<tr>
<td>Open Auction</td>
<td>Unreserved</td>
<td>Auction</td>
<td>One-All</td>
<td>Real-time bidding (RTB), open exchange, open marketplace</td>
</tr>
</tbody>
</table>

*Source: Interactive Advertising Bureau 2013*

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also: sponsored content
Advertising reach

- Classical
  - TV, radio: rating points – 1% of TV households (116.3 M in 2014)
    - particular A18-49 (adults 18 to 49)
    - Live, Live+SD, Live+7
  - Newspaper: circulation

- Digital
  - CPM: thousand impressions
    - $2.80 display ads; $5 email; $3 video
  - CPC: thousand clicks
    - → CTR: click-through rate (relevance for mobile?)
  - Google AdSense: 68% to publisher, 32% to Google

**TV CPM**

In looking at traditional TV video CPMs, Media Dynamics says broadcast network prime time is the highest -- at $19.00. Late-night broadcast programming is at $17.50; syndicated prime-access programming is at $17.00; and cable prime-time programming at $9.85.

Early-fringe syndicated programming averages $9.25; broadcast early evening news is at $9.00; and cable programming early fringe comes in at $7.55. Network daytime is at $6.50; with syndicated daytime programming at $5.50; and cable daytime programming at $3.30.

**Radio CPM: ~$20**

**Radio Advertising Costs by Market**

<table>
<thead>
<tr>
<th>City</th>
<th>M-F Spots</th>
<th>Sa/Su Spots</th>
<th>Weekly Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>New York City</td>
<td>15</td>
<td>4</td>
<td>$4,981.25</td>
</tr>
<tr>
<td>Dallas</td>
<td>15</td>
<td>4</td>
<td>$1,760.00</td>
</tr>
<tr>
<td>Denver</td>
<td>15</td>
<td>4</td>
<td>$1,127.50</td>
</tr>
</tbody>
</table>
# How much can you make on web ads?

<table>
<thead>
<tr>
<th>Rank</th>
<th>Website</th>
<th>Ad Type</th>
<th>Impressions</th>
<th>CPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>WebAppers <a href="http://www.webappers.com">www.webappers.com</a></td>
<td>Skyscraper Banner</td>
<td>27k</td>
<td>$2.00</td>
</tr>
<tr>
<td>2</td>
<td>OnextraPixel <a href="http://www.onextrapixel.com">www.onextrapixel.com</a></td>
<td>BSA Premium Ad Zone</td>
<td>129k</td>
<td>$2.00</td>
</tr>
<tr>
<td>3</td>
<td>InstantShift <a href="http://www.instantshift.com">www.instantshift.com</a></td>
<td>Sidebar Top</td>
<td>184k</td>
<td>$1.80</td>
</tr>
<tr>
<td>4</td>
<td>Tuts+ Code code.tutsplus.com</td>
<td>Leaderboard</td>
<td>1.38M</td>
<td>$8.00</td>
</tr>
<tr>
<td>5</td>
<td>Photoshop Star <a href="http://www.photoshopstar.com">www.photoshopstar.com</a></td>
<td>Header</td>
<td>62k</td>
<td>$1.80</td>
</tr>
<tr>
<td>6</td>
<td>Logopond logopond.com</td>
<td>Above Comments (CPM)</td>
<td>212k</td>
<td>$2.25</td>
</tr>
<tr>
<td>7</td>
<td>dafont.com <a href="http://www.dafont.com">www.dafont.com</a></td>
<td>Leaderboard CPM</td>
<td>4.38M</td>
<td>$0.50</td>
</tr>
<tr>
<td>8</td>
<td>dafont.com <a href="http://www.dafont.com">www.dafont.com</a></td>
<td>Skyscraper CPM</td>
<td>2.20M</td>
<td>$0.50</td>
</tr>
<tr>
<td>9</td>
<td>Webdesigner Depot <a href="http://www.webdesignerd%D0%B5%D0%BF%D0%BE%D1%82.com">www.webdesignerdепот.com</a></td>
<td>In article pages</td>
<td>431k</td>
<td>$4.00</td>
</tr>
<tr>
<td>10</td>
<td>Photoshop Tutorial photoshoptutorials.ws</td>
<td>Header Leaderboard</td>
<td>177k</td>
<td>$2.00</td>
</tr>
</tbody>
</table>

https://www.buysellads.com/buy/leaderboard/id/17/soldout/1/ch/-1
Fake news (mostly)

| 1 | chinaSMACK | 300x250 Sidebar A | 124k Est. Impressions | $1.00 CPM | Buy Now |
| 2 | chinaSMACK | 728x90 Header | 129k Est. Impressions | $1.00 CPM | Buy Now |
| 3 | Lunaticoutpost.com | Ad in first post. (Every Pa | 450k Est. Impressions | $0.27 CPM | Waiting List |
| 4 | Dickmorris.com | Rectangle below the fold | 135k Est. Impressions | $1.00 CPM | Buy Now |
| 5 | Dickmorris.com | Home Page Below Fold 1 | 136k Est. Impressions | $1.00 CPM | Buy Now |
| 6 | Dickmorris.com | Single Post Below Post Left | 440k Est. Impressions | $1.00 CPM | Buy Now |
| 7 | Dickmorris.com | Single Post Below Right | 457k Est. Impressions | $1.00 CPM | Buy Now |
| 8 | Reason.com | Premium Rectangle | 1.63M Est. Impressions | $4.00 CPM | Buy Now |
| 9 | The Daily Wire | Medium Rectangle | 22.59M Est. Impressions | $5.00 CPM | Buy Now |
| 10 | Conservative Tribu | In-Content 1 | 21.35M Est. Impressions | $6.00 CPM | Buy Now |
| 11 | Western Journalism | In-Content 1 | 11.34M Est. Impressions | $6.00 CPM | Buy Now |
| 12 | Conservative Tribu | In-Content 3 | 13.39M Est. Impressions | $5.00 CPM | Buy Now |
Web and mobile advertising

• Not just CPM – multiple ads per page
  • “$48/1000 visits”
  • $0.25-$3 for generic sites
  • $1-$10 for content rich sites
  • $10 for product-related sites

• Ad tracking
  • cross-site cookies – embedded frames or images
    • or track by IP address, browser characteristics, etc.
  • effectiveness?

• Impact of ad blocking?
  • IOS9
  • Europe: 20-30%
Example trackers (New York Times)
Tracking users and households

- Cookies ("same origin policy")
- IP address
- Browser characteristics
  - e.g., user agent, links visited
- "Super cookies"
- ISP-based tracking
Browser strings

What's My User Agent?

Your User Agent is:

Mozilla/5.0 (Macintosh; Intel Mac OS X 10_12_6) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/60.0.3112.113 Safari/537.36

Your IP Address is:

2001:18d8:ffff:16:1ca7:2212:ae8:3975

Browser Information:

<table>
<thead>
<tr>
<th>JavaScript Enabled:</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cookies Enabled:</td>
<td>Yes</td>
</tr>
<tr>
<td>Device Pixel Ratio:</td>
<td>1</td>
</tr>
<tr>
<td>Screen Resolution:</td>
<td>1920px x 1200px</td>
</tr>
<tr>
<td>Browser Window Size:</td>
<td>1410px x 931px</td>
</tr>
</tbody>
</table>

http://www.whoishostingthis.com/tools/user-agent/
US dominates marketing

**Top ten ad markets**

*US$m, current prices. Currency conversion at 2016 average rates.*

<table>
<thead>
<tr>
<th>Country</th>
<th>Adspend 2016</th>
<th>Country</th>
<th>Adspend 2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. United States</td>
<td>190,778</td>
<td>1. United States</td>
<td>210,544</td>
</tr>
<tr>
<td>2. China</td>
<td>74,961</td>
<td>2. China</td>
<td>89,936</td>
</tr>
<tr>
<td>4. United Kingdom</td>
<td>24,160</td>
<td>4. United Kingdom</td>
<td>25,812</td>
</tr>
<tr>
<td>5. Germany</td>
<td>21,951</td>
<td>5. Germany</td>
<td>23,715</td>
</tr>
<tr>
<td>7. France</td>
<td>11,381</td>
<td>7. South Korea</td>
<td>12,113</td>
</tr>
<tr>
<td>8. South Korea</td>
<td>11,271</td>
<td>8. Australia</td>
<td>11,973</td>
</tr>
<tr>
<td>10. Canada</td>
<td>8,739</td>
<td>10. Indonesia</td>
<td>10,795</td>
</tr>
</tbody>
</table>

Source: Zenith
<table>
<thead>
<tr>
<th>Country</th>
<th>adspend($M)</th>
<th>pop. (M)</th>
<th>ad$/capita ($)</th>
<th>gdp/capita ($)</th>
<th>ad$/gdp (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>US</td>
<td>190778</td>
<td>323.1</td>
<td>$590.46</td>
<td>$57,466.79</td>
<td>1.027</td>
</tr>
<tr>
<td>Aus</td>
<td>10930</td>
<td>24.13</td>
<td>$452.96</td>
<td>$49,927.82</td>
<td>0.907</td>
</tr>
<tr>
<td>UK</td>
<td>24160</td>
<td>65.64</td>
<td>$368.07</td>
<td>$39,899.39</td>
<td>0.922</td>
</tr>
<tr>
<td>Japan</td>
<td>41924</td>
<td>127</td>
<td>$330.11</td>
<td>$38,894.47</td>
<td>0.849</td>
</tr>
<tr>
<td>Germany</td>
<td>21951</td>
<td>82.67</td>
<td>$265.53</td>
<td>$41,936.06</td>
<td>0.633</td>
</tr>
<tr>
<td>Canada</td>
<td>8739</td>
<td>36.29</td>
<td>$240.81</td>
<td>$42,157.93</td>
<td>0.571</td>
</tr>
<tr>
<td>SK</td>
<td>11271</td>
<td>51.25</td>
<td>$219.92</td>
<td>$27,538.81</td>
<td>0.799</td>
</tr>
<tr>
<td>France</td>
<td>11381</td>
<td>66.9</td>
<td>$170.12</td>
<td>$36,854.97</td>
<td>0.462</td>
</tr>
<tr>
<td>Brazil</td>
<td>13047</td>
<td>207.7</td>
<td>$62.82</td>
<td>$8,649.95</td>
<td>0.726</td>
</tr>
<tr>
<td>China</td>
<td>74961</td>
<td>1379</td>
<td>$54.36</td>
<td>$8,123.18</td>
<td>0.669</td>
</tr>
</tbody>
</table>
Global ad spending by medium

Share of global adspend by medium 2016

Source: Zenith
A BIT OF TECHNOLOGY
Converging communities

since 1900: separate networks, companies, professions

- 1960s: machine \(\rightarrow\) machine
- 1896, 1915: machine \(\rightarrow\) human
- 1876: human \(\rightarrow\) human

Data
- Generality
- Data integrity
- Access control

Broadcast (radio, TV)
- Low cost
- Scalability
- Copyright protection (DRM)

Voice (telephone)
- Ease of use
- Universality
- Reliability
- Privacy

Internet
Lifecycle of technologies

traditional technology propagation:

- **military**: opex/capex doesn’t matter; expert support
- **corporate**: capex/opex sensitive, but amortized; expert support
- **consumer**: capex sensitive; amateur

Can it be done?  Can I afford it?  Can my mother use it?
Internet and networks timeline

- **1960**
  - theory
- **1970**
  - university prototypes
- **1980**
  - production use in research
- **1990**
  - commercial early residential
- **2000**
  - broadband home
- **2010**
  - Internet everywhere
- **2020**
  - Internet everywhere everywhere

### Port speeds
- 100 kb/s
- 1 Mb/s
- 10 Mb/s
- 100 Mb/s
- 1 Gb/s
- 10 Gb/s

### Internet protocols
- email
- ftp
- DNS
- RIP
- UDP
- TCP
- SMTP
- SNMP
- finger
- ATM
- BGP, OSPF
- Mbone
- IPsec
- VoD
- XML
- OWL
- SIP
- Jabber
- SDN
- JSON
- blockchain

### Technical issues
- queuing architecture
- routing
- cong. control
- DQDB, ATM
- QoS
- VoD
- p2p
- ad-hoc
- sensor
- cybersecurity
- data centers
What has changed?

<table>
<thead>
<tr>
<th>1980s/1990s</th>
<th>2000s+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rapid technology evolution in network core</td>
<td>Relatively stable core technology</td>
</tr>
<tr>
<td>Internet exceptionalism (no distance! no borders!)</td>
<td>National laws &amp; customs</td>
</tr>
<tr>
<td>Internet utopianism</td>
<td>“Big Switch”, harms &amp; limitations</td>
</tr>
<tr>
<td>Performance!</td>
<td>Reliability? Usability!</td>
</tr>
<tr>
<td>Cost-insensitive (and “free” phone access)</td>
<td>Deployment cost barriers</td>
</tr>
<tr>
<td>Separated from commercial media (newspapers, magazines, radio, TV)</td>
<td>Affects all media</td>
</tr>
<tr>
<td>Self-revealed data (email, BBS)</td>
<td>Intimate data (information access, behavioral, sensors)</td>
</tr>
<tr>
<td>Little economic impact</td>
<td>One of the largest US exports</td>
</tr>
</tbody>
</table>
What’s different?

<table>
<thead>
<tr>
<th>What</th>
<th>Utilities (gas, water, electricity)</th>
<th>Internet</th>
<th>Consumer electronics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geographic scope</td>
<td>regional</td>
<td>local, national, international</td>
<td>mostly international</td>
</tr>
<tr>
<td>Economics</td>
<td>enabler</td>
<td>entry, competition, enabler</td>
<td>Trade, patents</td>
</tr>
<tr>
<td>Impact on culture</td>
<td>minimal</td>
<td>foundational</td>
<td>rarely (Walkman, iPhone)</td>
</tr>
<tr>
<td>Impact on domestic politics</td>
<td>in LDCs</td>
<td>jobs, education, health, transportation, copyright, income inequality</td>
<td>health &amp; education (smartphones)</td>
</tr>
<tr>
<td>Impact on international politics</td>
<td>water rights?</td>
<td>trade, espionage, propaganda, cyberattacks, copyright, …</td>
<td>trade</td>
</tr>
</tbody>
</table>

10/2/17