Computer Networking

CSE 29: Systems Programming

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Computer Science and Engineering

A “Simple” Task you started to implement in CSE29



User requests a web page over HTTP from a webserver



Host

- Endpoints are called hosts
  - Could be computer, iPhone, laptop, etc.
- The plumbing is called a link
  - We don’t care what the physical technology is: Ethernet, wireless, cellular, etc.



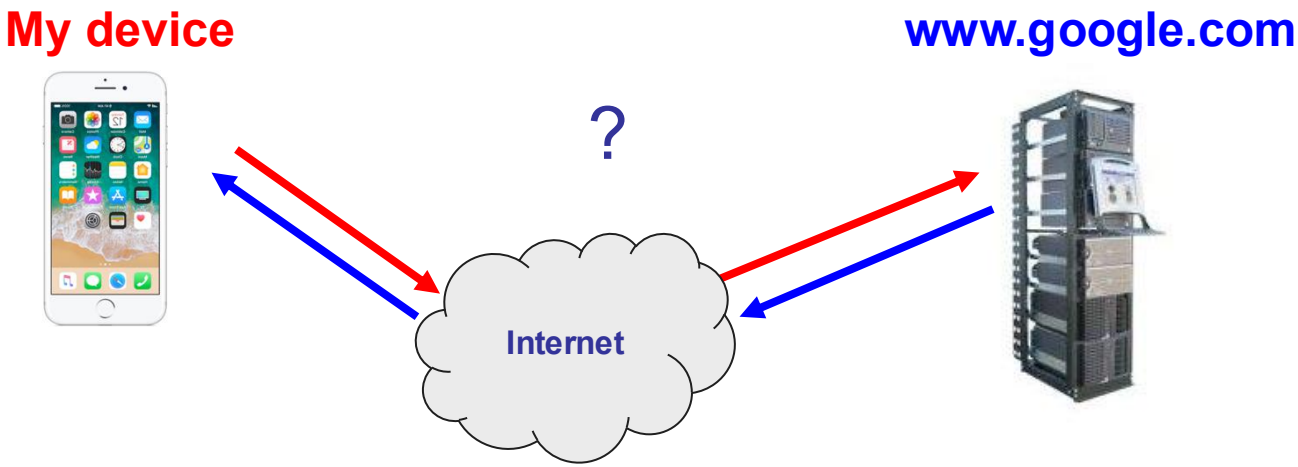




Host

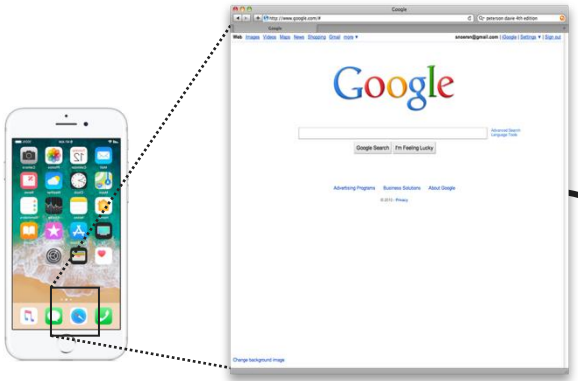
Actually Quite Complicated

- **In CSE123**, we learn about what happens when I click on a Web page from UCSD?



Web request (HTTP)

- Turn click into HTTP request




```
GET http://www.google.com/ HTTP/1.1
Host: www.google.com
…
```

You built a server for HTTP in CSE29
But there is much more…

Name resolution (DNS)

- What is the Internet address (IP Address) for the server www.google.com?

My device (132.239.9.64)



What's the address for www.google.com

Local DNS server (132.239.51.18)



Oh, you can find it at 142.250.189.4

```
dig www.google.com

; <<>> DiG 9.10.6 <<>> www.google.com
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 3386
;; flags: qr rd ra; QUERY: 1, ANSWER: 1, AUTHORITY: 0, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 1232
;; QUESTION SECTION:
;www.google.com.                        IN      A

;; ANSWER SECTION:
www.google.com.         153     IN      A       142.250.189.4
```

What is in a domain name?

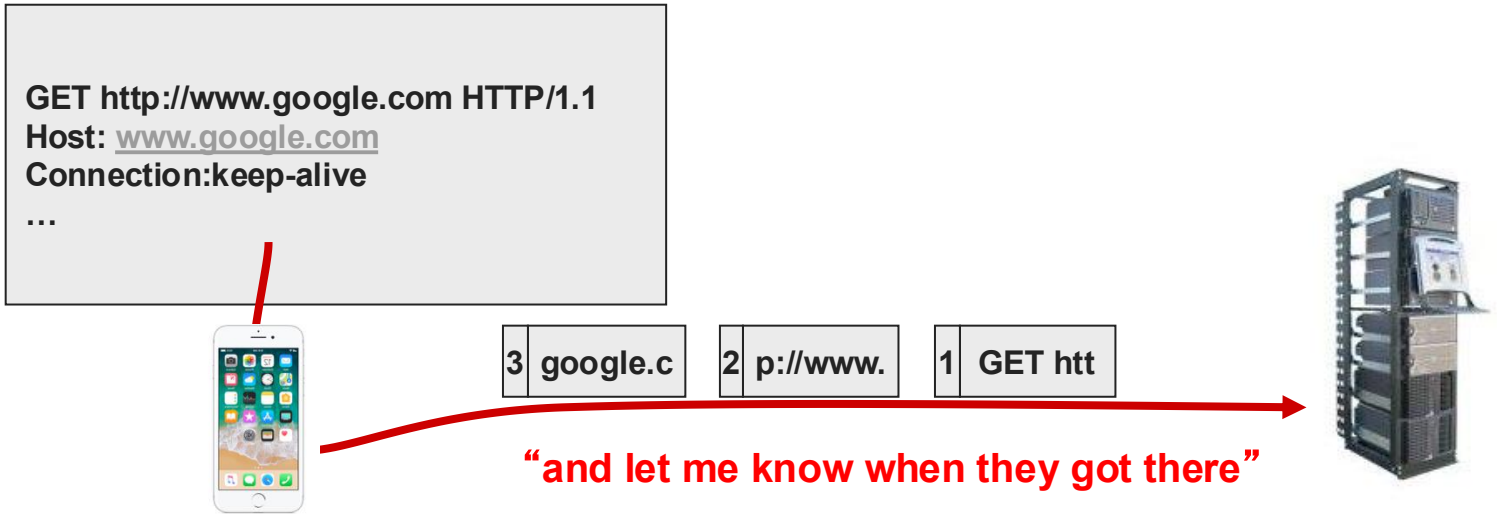


- Domain name: www.ucsd.edu
  - Domain: registrar (company) for each top-level domain (i.e., .edu)
  - Host name: local administrator assigns a name to each host (i.e., ucsd)

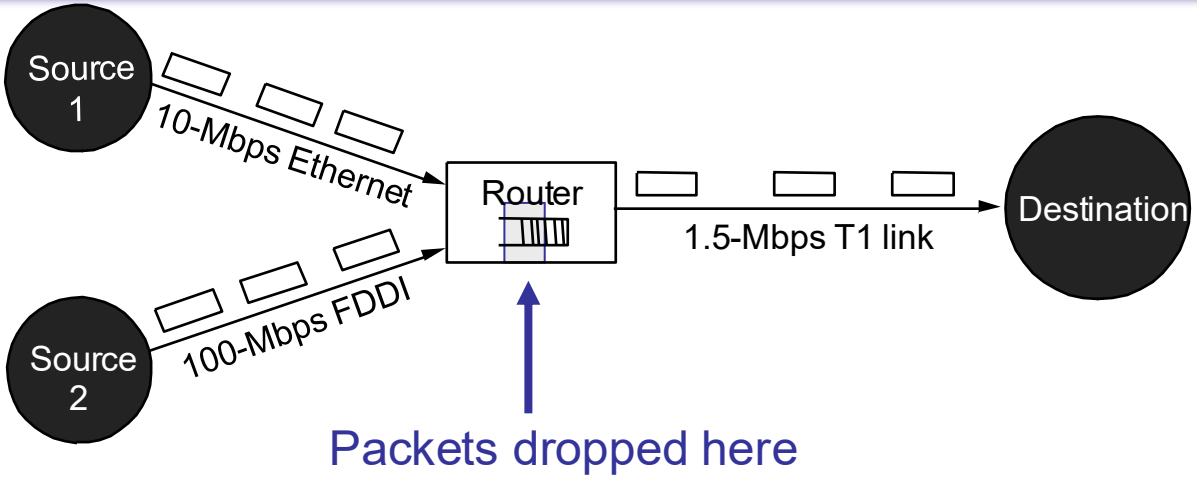
- To look up a domain name, a computer contacts a hierarchy of DNS servers across the Internet.
  - Root servers [13 trusted organizations]
  - Top-level domain (TLD) servers [1,500 TLDs (e.g., .com .org .edu .donught)]
  - Authoritative DNS servers [Thousands of orgs run their own DNS servers for their hosts]

Data transport (TCP)

- Break message into packets (TCP segments)
- TCP is code in OS that ensure they are delivered reliably & in-order
- Also avoids congestion of Internet Links



Network Congestion



- Multiple sending hosts send packets through a link slower than their combined speed
- Leads to packets being dropped (i.e., web page doesn't load)

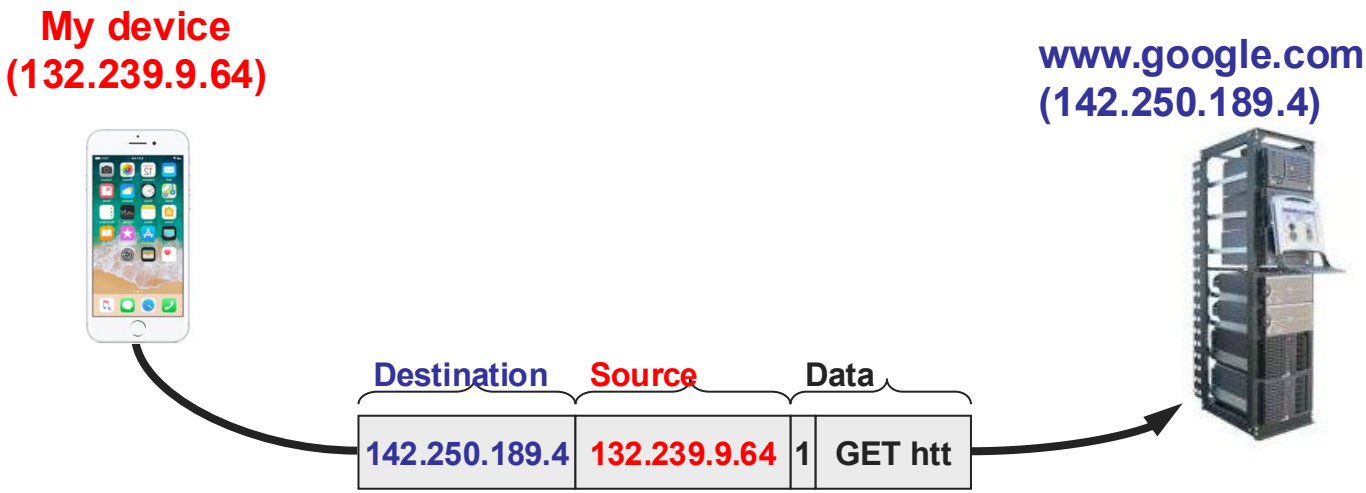
TCP Avoids Network congestion



- All hosts independently probe the network to determine how much bandwidth is available
  - Changes over time, since hosts use the network at different times
- Assume that packet loss implies congestion
  - Since errors are rare; also, requires no support from routers
- Slow down sending packets when congestion is detected
  - And speed up when there is no congestion!

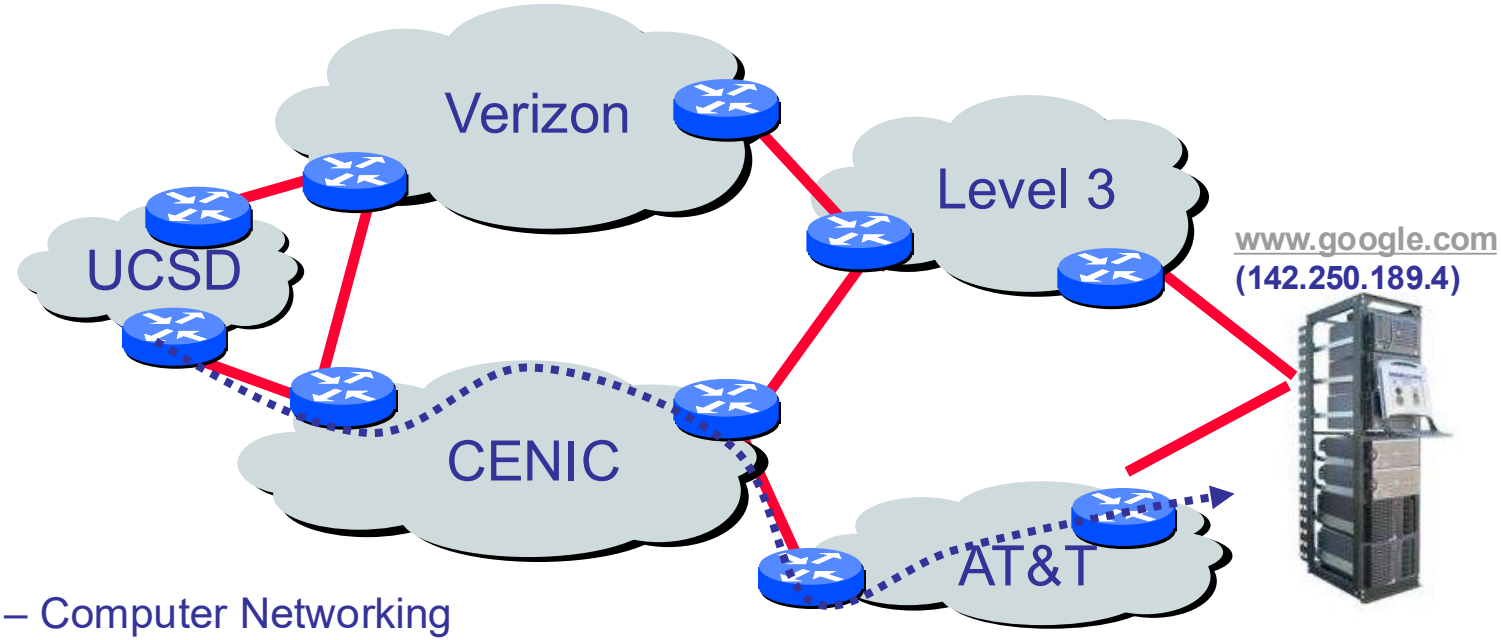
Global Network Addressing

- Address each packet so it can traverse the global Internet and arrive at a host

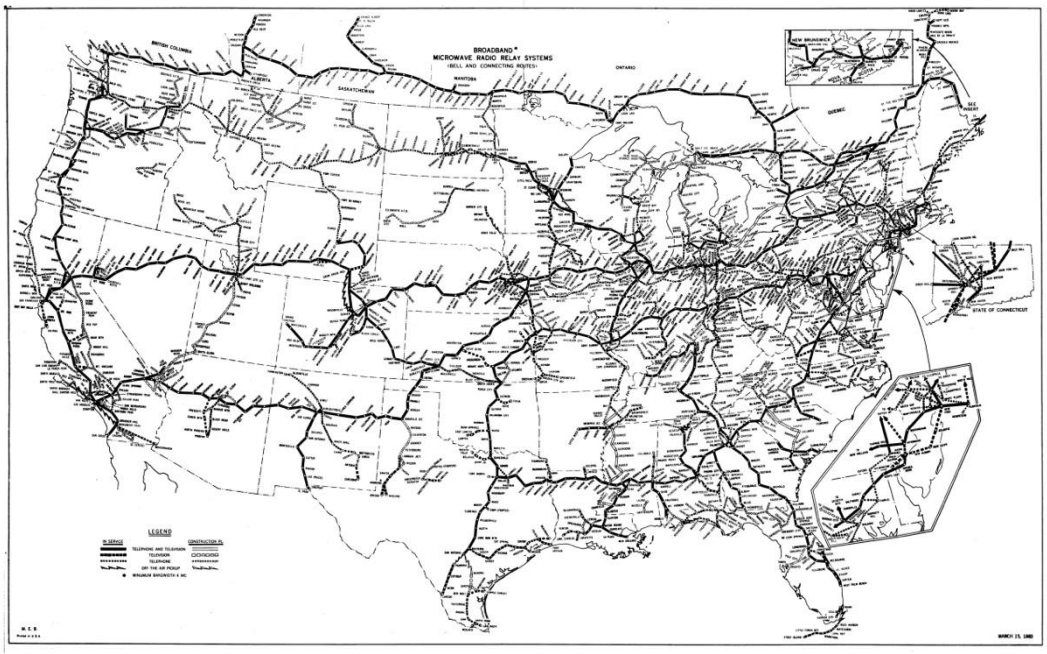


Network Routing

- Each router forwards packet towards destination
- Routers are just computers running C code that forward packets down the “best” path



How do packets travel across the country?



It started as microwave links between towers

Hillcrest, San Diego Site

Directional microwave antennas pointing northeast

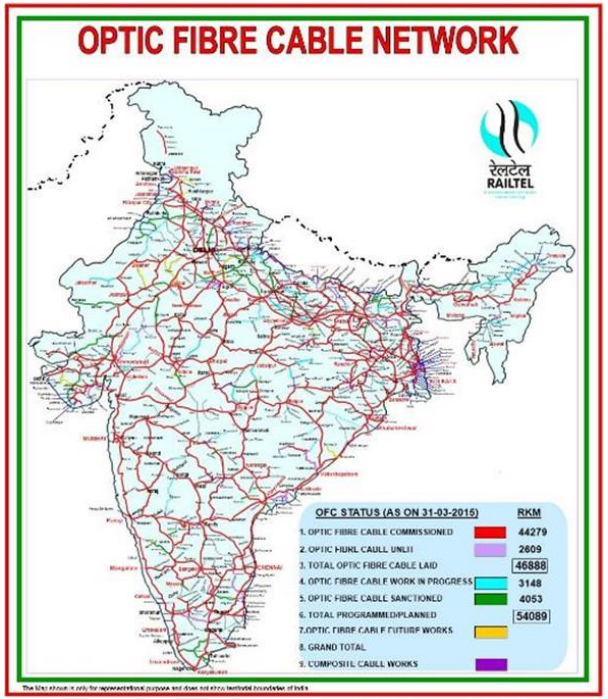


This building holds the core routers for all of AT&T San Diego



Then, the railroads brought nation-wide fiber links for high-speed Internet today

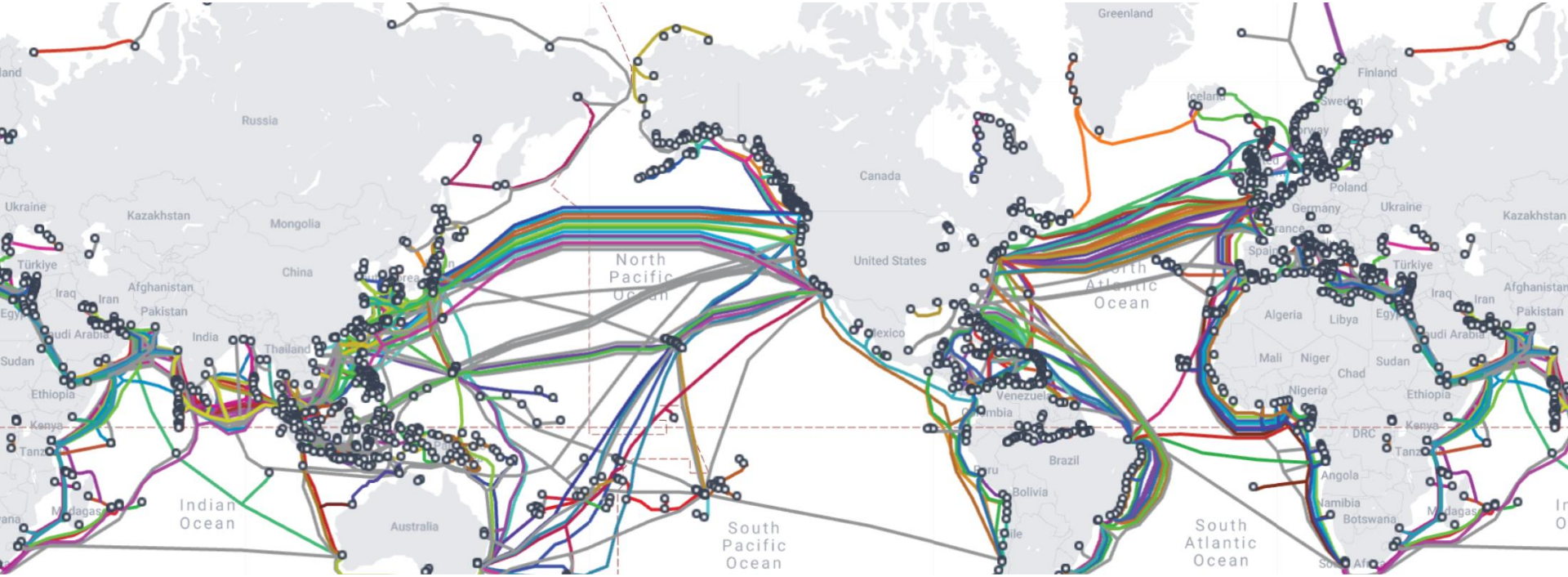




Southern Pacific Rail Internal Networking (SPRINT)

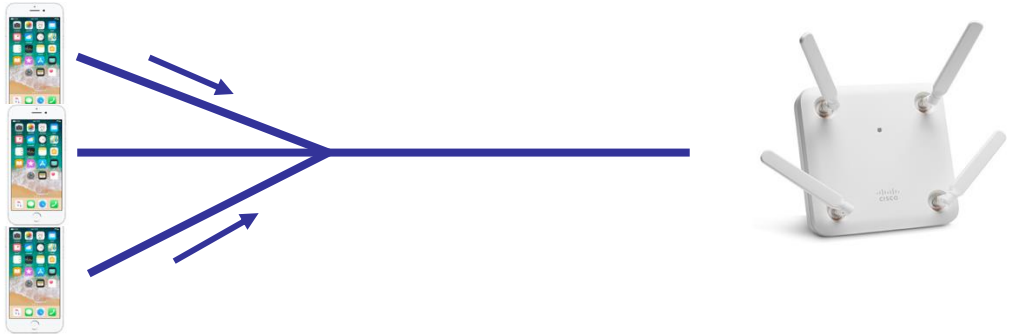
India's RAILTEL

Undersea fiber cables interconnect continents



Link management (WiFi)

- Break message into frames so we all can share links
- Media Access Control (MAC)
  - Can I send now? Can I send now?



- Send frame

Review Questions



1. What is the main resource that drives the operation of the Internet?
2. How does a computer map the name of a networked resource to the computer that has that resource?
3. What is one of the main failure modes of computer networks?
    1. SEE FAA ATC OUTAGE LAST WEEK

Physical layer

