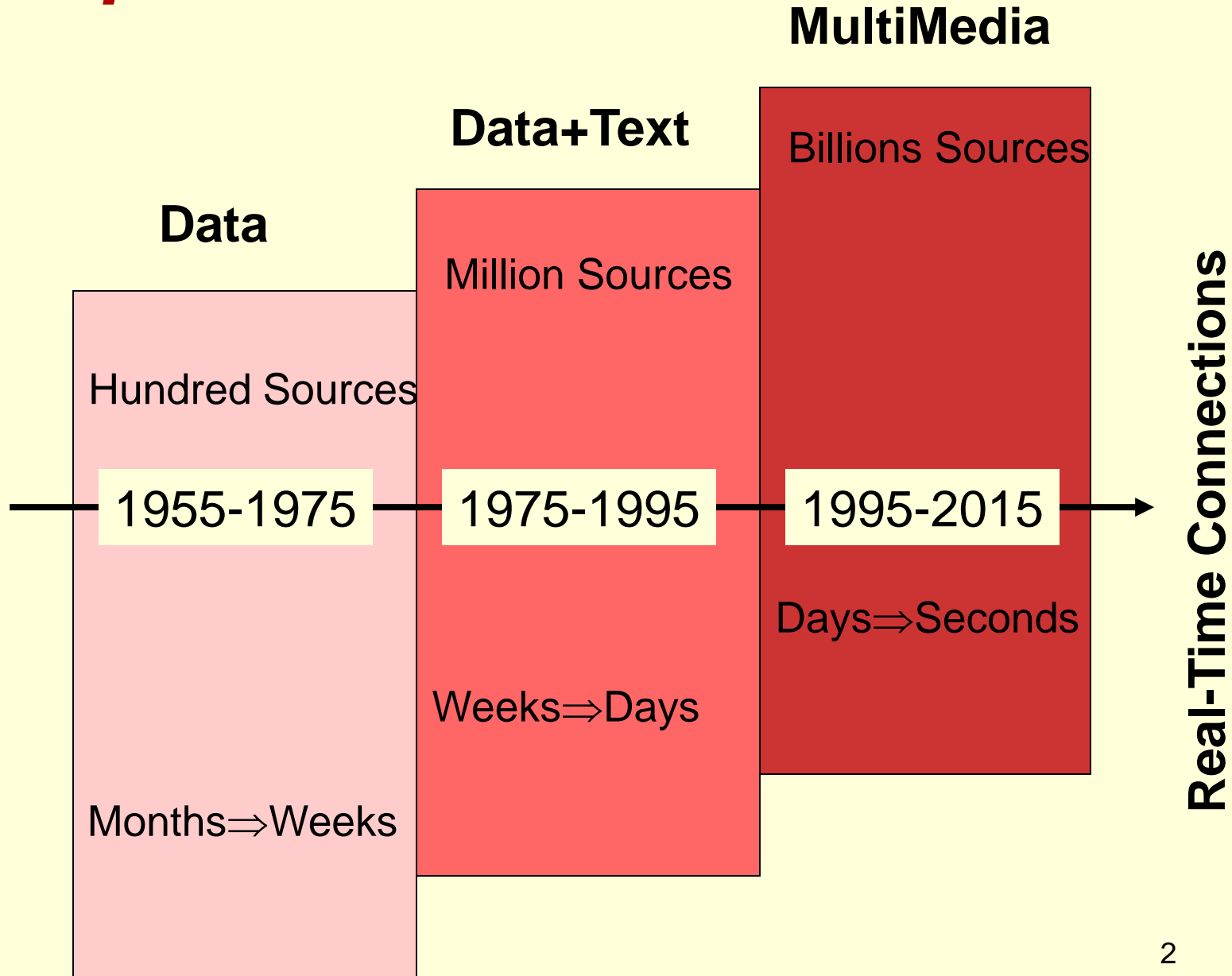


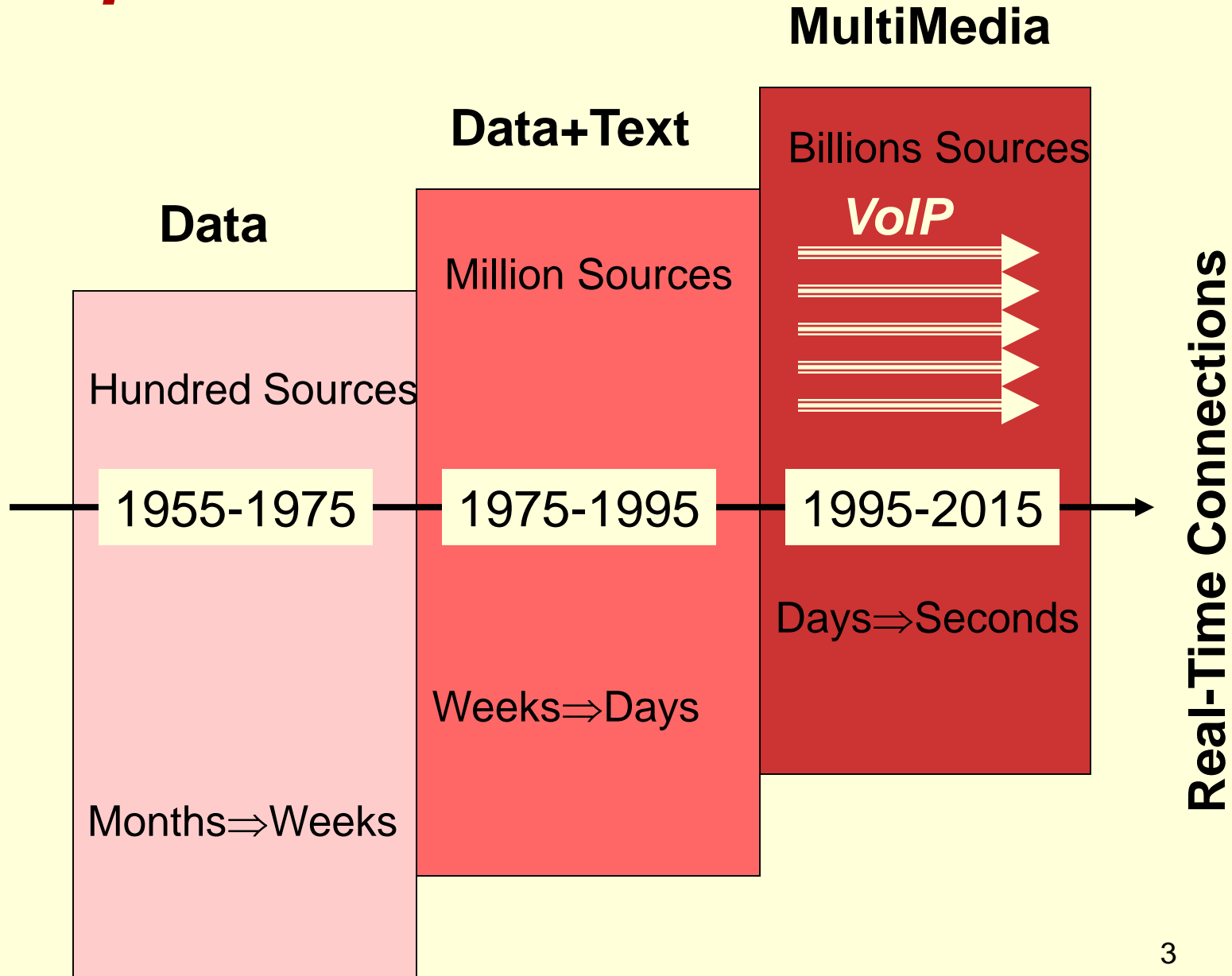
# The Next I.T. Tsunami

Paul A. Strassmann

# Perspective



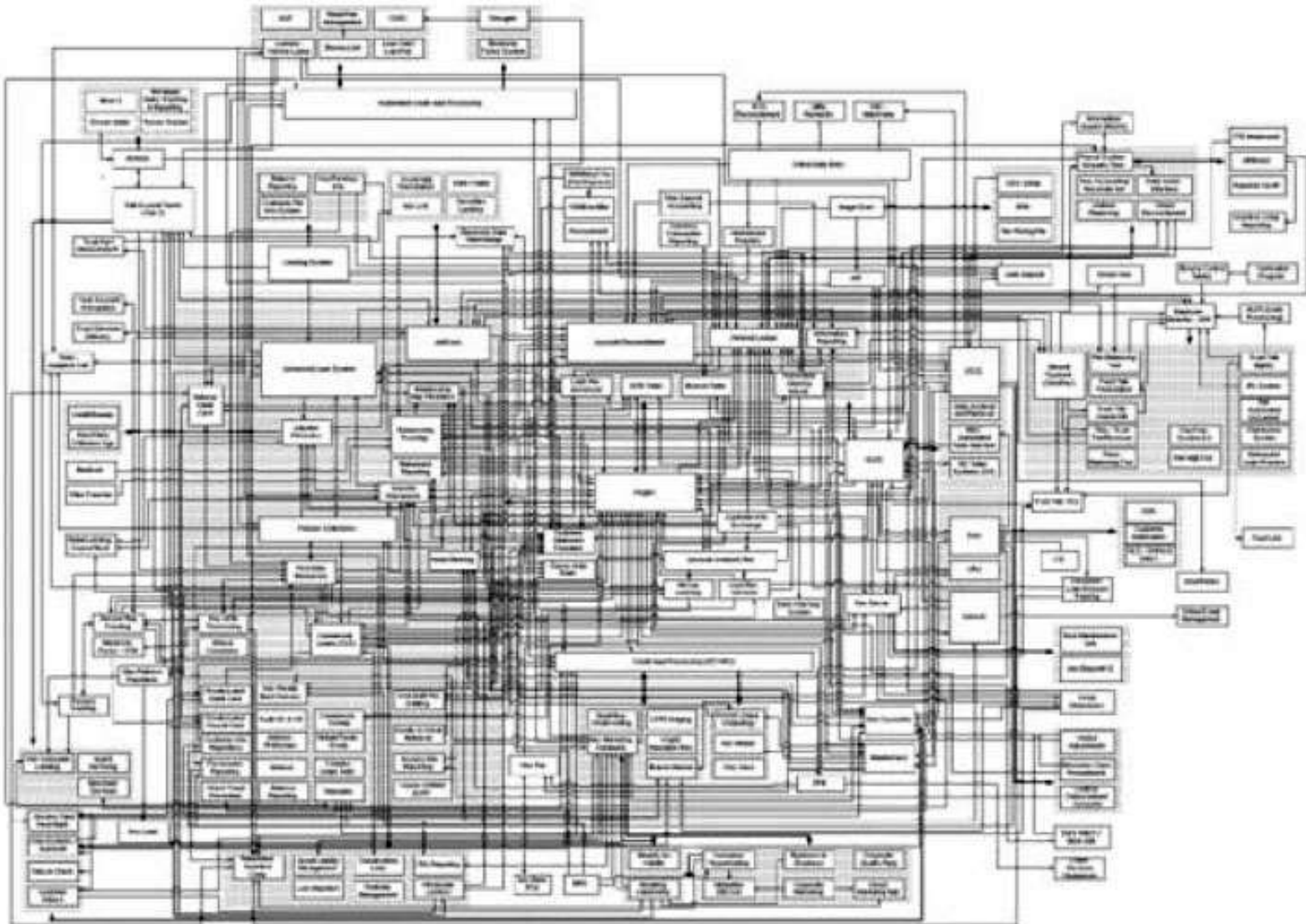
# Perspective



# ***Today's Presentation***

- Organization of multi-media communication.
- Internet services.

# ***A View of Corporate Networks***



# *The Challenge*

- Infrastructure costs = >50% of total spending;
- Networks insecure;
- Integration costs = >50% of application costs;
- Network downtime = >20 hrs/year;
- Desktop costs = Excessive;
- Time to innovation = Excessive.

# ***Metrics for the Future***

- **Integrated data, voice and video services:**
- Six Sigma+ Reliability (<5 min downtime/yr);
- Workstation Speed (200 Billion ops/sec);
- Workstation Connectivity (>1 Gigabyte/sec);
- Systems Reconfiguration (<1 min delay);
- Access to petabytes of data (<0.25 sec);
- Customizing an Application (<1 hr implementation);
- Strong authentication for access.

# ***Example of Next Generation Design***





# *The Google Infrastructure*

- >200,000 commodity Linux servers;
- Storage capacity >5 petabytes;
- Indexed >8 billion web pages;
- Capital and operating costs at fraction of large scale commercial servers;
- Traffic growth 20-30%/month.

# *Dimensions of a Google Cluster*

- 359 racks
  - 31,654 machines
  - 63,184 CPUs
  - 126,368 Ghz of processing power
  - 63,184 Gb of RAM
  - 2,527 Tb of Hard Drive space
- 
- Appx. 40 million searches/day

# *Architecture for Reliability*

- Replication (3x +) for redundancy;
- Replication for proximity and response;
- Fault tolerant software for cheap hardware.
- Policy: Reliability through software architecture, not hardware.

# *Query Serving Infrastructure*

- Processing a query may engage 1000+ servers;
- Index Servers manage distributed files;
- Document Servers access distributed data;
- Response time = <0.25 seconds anywhere.

# ***Systems Engineering Principles***

- Overwhelm problems with computational power;
- Impose standard file management;
- Manage through standard job scheduling;
- Apply simplified data processing discipline.

# ***Google: The Network is the System***

- Coordinates servers in real-time;
- Automates distribution of workload;
- Assures fault tolerance;
- Performs systems-wide cluster scheduling;
- Delivers status and performance monitoring.

# *Intelligence Built into Services*

- Tools examine millions of documents in real time;
- Automated learning for logical processing
  - Query: “Bay Area Cooking Classes”
  - Matches: “San Francisco College Classes”;  
“The Magic of Thai Cuisine”

# ***Rapid Additions to Robust Infrastructure***

**Google Services:** Use one of our many services to find what you're looking for.



[Answers](#)



[Catalogs](#)



[Directory](#)



[Froogle](#)



[Groups](#)



[Images](#)



[Google Labs](#)



[Google Local](#)



[News Search](#)



[Special Searches](#)



[University Search](#)



[Web Search](#)



[Wireless](#)

**Google Tools:** We offer various tools to help you get more done.



[Blogger](#)



[Browser Buttons](#)



[Picasa Photo Organizer](#)



[Google in your Language](#)



[Google Toolbar](#)



[Translate Tool](#)



[Web APIs](#)





[Web](#) [Images](#) [Groups](#) [News](#) [Froogle](#) [Local](#)<sup>New!</sup> [more »](#)

restaurants

Pleasantville NY

Search

[Search the map](#)  
[Find businesses](#)  
[Get directions](#)

What e.g., pizza

Where e.g., Poughkeepsie, NY

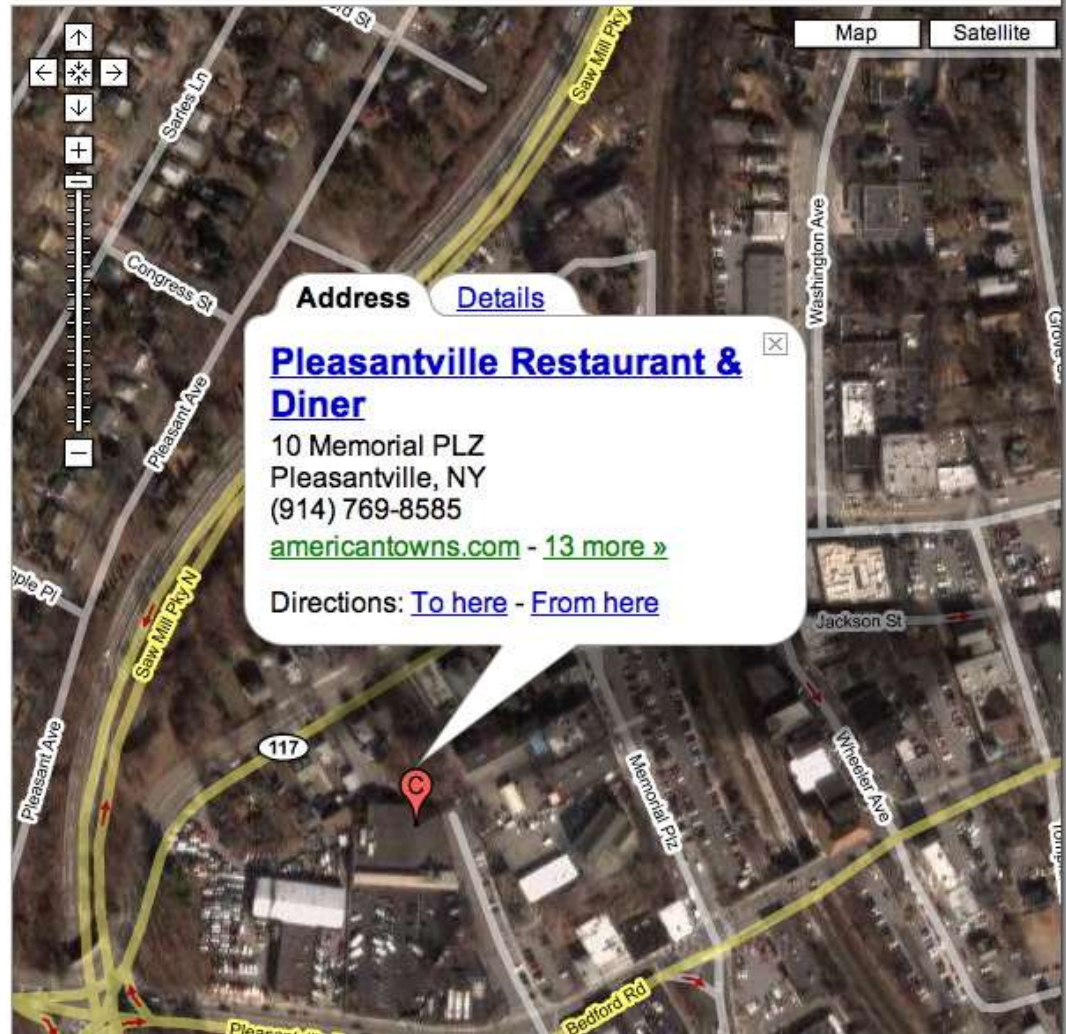
## Local

[Print](#) [Email](#) [Link](#)

### Search results for **restaurants** near **Pleasantville, NY**

Categories: [Restaurants](#), [Restaurant Pizza](#)

- A** [MC Donald's Hamburger Restmnt](#)  
600 Marble Ave,Thornwood, NY  
(914) 769-9687
- B** [Hanada Japanese Restaurant](#)  
8 Pleasantville Rd,Pleasantville, NY  
(914) 769-0638
- C** [Pleasantville Restaurant & Diner](#)  
10 Memorial PLZ,Pleasantville, NY  
(914) 769-8585
- D** [A Unique Affair Caterers](#)  
110 Nannahagan Rd,Pleasantville, NY  
(914) 769-5010
- E** [Garfield's](#)  
859 Franklin Ave,Thornwood, NY  
(914) 769-9837
- F** [Swaddee](#)  
886 Franklin Ave,Thornwood, NY  
(914) 769-8007
- G** [Thornwood Pizza & Pasta Inc](#)  
808 Commerce St,Thornwood, NY  
(914) 741-0707
- H** [Chappaqua Restaurant & Cafe](#)  
10 S Greeley Ave,Chappaqua, NY  
(914) 238-3869
- I** [Lickety Split](#)  
31 S Greeley Ave,Chappaqua, NY  
(914) 238-0690



## ***Future: Rich Internet Applications***

- “Thin-clients” deliver Internet services.
- Browsers display graphic interfaces.
- Standard browsers, not plug-ins.
- Packaged applications available on Internet.
- Delivery of data, voice and video.
- Replaces phones, TV and print media.

# *Summary*

- Computer-centric solutions will be replaced by network-centric services.
- A Google-like architectures open a way for significant reductions in the costs of Internet services.
- We know what will happen, just do not know how to get there.



