Tiretracks nouveau - the network systems slice

David E. Culler
University of California, Berkeley
July 23, 2012
NOW – Scalable Internet Service Cluster Design

NOW Project Timeline

- ATM, fddi
- Start of Funding
- Myrinet
- SCI
- VIA
- G-Ether
- NOW Finale
- Many PhDs

- CS 252
- Case for NOW
- NOW I
- Inktoni
- 1st PhD
- NOW II
- NOW Workshop II
- CS 267
- NOW Sort
- NPACI
- 2nd PhD
- CS 287
- NOW Finale
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TMC CM5
IBM SP1
No nodes
NOW – Scalable High Performance Clusters

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- NOW II
- Asplos Workshop I
- AS 262
- CS 258
- 1st Ph
- NOW Workshop II
- CS 267
- NOW Finale

REJECTION is not fatal.
NOW – Scalable High Performance Clusters
NOW — Scalable High Performance Clusters
Paul Gauthier

CS267, Spring 1995: Final Projects

- Fast Parallel Iterative Matrix Diagonalization
- Ptolemy C Code Generation and Scheduling for the Network of Workstations (NOW)
- Parallel Raytracing using a Network of Workstations for Rendering Spline Surface Animation
- Parallel Monte Carlo Simulation
- Berkeley Search Engine
- Porting and Characterization of GATOR, an Atmospheric Chemical Tracer Model
- A Distributed Memory Concurrent B-tree Implementation
- Design, Implementation, and Performance Evaluation of a Portable Distributed Task Queue
- Porting The BLACS From MPL To GAM On The SP-1
- Implementation of a Parallel Preconditioned Conjugate Gradient (PCG) Solver in Finite Element
- Parallelizing Impulse, a dynamic simulation system
- Model of LPARX multigrid performance on the CM5
NOW – Scalable High Performance Clusters

The Critical Carpool
Large Ultra/Myrinet NOW
Massive Cheap Storage

Serving Fine Art at http://www.thinker.org/imagebase/
NOW performs ‘96
No $’s in Search
Big $’s in caches

Yahoo moves from inktomi to Google
Cluster of SMPs (CLUMPS)
Expeditions to the 21st Century
Service Based Applications

- Application provides services to clients
- Grows/Shrinks according to demand, availability, and faults
Ninja Internet Service Architecture

Opportunity: infrastructure services

- Prehistoric: DNS, IP route tables, ...
- Historic: crawl, index, search,
- Emerging: compose and manipulate data and services

And client diversity has just begun!


Java Grande
Startup of the Week …

Example: Ninja Jukebox 98

- **Collaborative Community:** anyone can add content
  - => mp3.com, real jukebox, napster
- **Authentication and Authorization was built-in**
- **Jukebox 99:** Music similarity query engine
  - => mongomusic.com, ...

- **CD “ripper” service**
- **CDDB service**

1. Ninja iSpace
   - Fetches track/title & artist information from an online DB.
2. iSpace
   - An index of available songs to your directory.
3. WWW Browser
   - Web page with song playlists
4. Music Directory service
5. HTTPd service
6. Music stream (.au or .mp3)
... and ...
Existing Applications

- **Ninja "NOW Jukebox"**
  - Harnesses Berkeley Network of Workstations
  - Plays real-time MPEG-3 audio served from 110+ CD's worth of music
- **Voice-enabled room control**
  - Speech-to-text Operators control room services (camera, lights, microphone)
  - Eventual integration with GSM cell phones and PDA-based UI
- **Stock Trading Service**
  - Accesses real-time stock data from Internet
  - Programmatic interface to buy/sell/trade stocks through online brokerage
- **NinjaFAX**
  - Programmable remotely-accessed FAX machine service
  - Send/receive FAXes; authentication used for access control
- **Keiretsu: The Ninja Pager Service**
  - Provides instant messaging service via Web, 1/2-way pagers, WorkPads, etc.
Composable, Secure Proxy Architecture for Post-PC devices

S. Ross, J. Hill

Diverse Clients

Internet Services

Transient Store

Identity Service

Filter and Control Modifier

Format Transcoders

Security Adapters

https

Java Grande
A ‘Structured Architecture’ Approach

- **Bases (1M’s)**
  - scalable, highly available
  - persistent state
  - databases, agents
  - “home” base per user
  - service programming environment

- **Active Proxies (100M’s)**
  - not packet routers
  - bootstrap thin devices into infrastructure
  - soft-state and well-connected

- **Units (1B’s)**
  - sensors / actuators
  - PDAs / smartphones / PCs
  - heterogeneous
  - Minimal functionality: “Smart Clients”

Java Grande
Delayed Gratification

Webos: Operating System Services For Wide Area Applications, HPDC 98

HPDC Best in 20 years, April 2012
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Timeline Events:
- 1/94: NOW 0
- 6/94: CS 252
- 1/95: Case for NOW
- 6/95: CS 258
- 1/96: NOW I
- 6/96: Inktomi
- 1/97: 1st PhD
- 6/97: NOW Workshop II
- 1/98: CS 267
- 6/98: NOW Sort
- 2nd PhD
- Many PhDs
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- NOW Finale
10th ANNIVERSARY REUNION 2008
Network of Workstations (NOW): 1993-98

NOW Team 2008: L-R, front row: Prof. Tom Anderson†† (Washington), Prof. Rich Martin† (Rutgers), Prof. David Culler*†† (Berkeley), Prof. David Patterson*† (Berkeley). Middle row: Eric Anderson (HP Labs), Prof. Mike Dahlin†† (Texas), Prof. Armando Fox† (Berkeley), Drew Roselli (Microsoft), Prof. Andrea Arpaci-Dusseau† (Wisconsin), Lok Liu, Joe Hsu. Last row: Prof. Matt Welsh† (Harvard/Google), Eric Fraser, Chad Yoshikawa, Prof. Eric Brewer*†† (Berkeley), Prof. Jeanna Neefe Matthews (Clarkson), Prof. Amin Vahdat† (UCSD), Prof. Remzi Arpaci-Dusseau (Wisconsin), Prof. Steve Lumetta (Illinois).

*3 NAE members †4 ACM fellows ‡9 NSF CAREER Awards
Monitizing the internet ...

Costis Daskalakis


**Algorithms, Games, and the Internet**

Christos H. Papadimitriou
University of California, Berkeley
christos@cs.berkeley.edu

**ABSTRACT**

The Internet is the most great subject for Theoretical Computer Science to model and optimize mathematically, yet Game Theory, and Mathematical Economics more generally, are likely to prove useful tools. In this talk I survey some opportunities and challenges in this important frontier.

1. **INTRODUCTION**

   Over the past fifty years, researchers in Theoretical Computer Science have sought and achieved a predictive foundational understanding of the von Neumann computer and its software, employing the mathematical tools of Logic and

   ...

   In this talk I shall review some of the many important points of contact between Game Theory and Economic Theory, Theoretical CS, and the Internet. So doing so I am necessarily (and, to an observer, arbitrarily) selective, leaving out important areas such as computational economics \[8\], and computational learning in games \[9\].
Research as “Time Travel”

- **Imagine** a technologically plausible future
- **Create** an approximation of that vision using technology that exists.
- Discover what is **True** in that world
  - Empirical experience
    - Bashing your head, stubbing your toe, reaching epiphany
  - Quantitative measurement and analysis
  - Analytics and Foundations
- **Courage to ‘break trail’** and discipline to do the hard science