Managing Risk in Technology Organizations

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Overview

• Why startups matter in UC.
• Cenus… a startup howto (or hownot:)
  – Technology
  – Product development
  – Funding
• Managing risk.
What is Purpose of UC?

• Research
• Teaching
• Public Service.

• Creation
• Dissemination
• Application…
• …of new knowledge.

• *Important goal of applying new knowledge is...*
• …*enhancing competitiveness of California economy.*
• *Technology transfer is important function of UC.*
• *Startups are an important vehicle for tech transfer.*
• *Opinion: students are the best agents of tech transfer!*
UC in World of Higher Ed

• Carnegie Foundation (www.carnegiefoundation.org) classifies degree-granting institutions in the U.S.
  – Tribal
  – Special Focus
  – Associate
  – Baccalaureate
  – Master’s
  – Doctorate
    • Doctoral/Research
    • Research University (high research activity)
    • Research University (very high research activity) - “R1”

• In general, UCs are “R1s”.
• Opinion: R1’s have primary responsibility for tech transfer.
Importance of UC as R1?

- There are 4,388 degree-granting colleges or universities in the U.S.
- How many are R1s?
  - 96 (2.2%) Research Universities (very high research activity).
  - 63 (1.4%) of these are public.
- UCSC’s role
  - 1 of < 2.2% dedicated to expanding human knowledge.
  - 1 of < 1.4% who serve this role solely for the public good.
  - 8 of which are UC’s that are near/at the top of this list.
- **Tech transfer is core to UC, and UC is one of few doing this**
- **Opinion: UC’s tech transfer role is incredibly important!**
Cenus
Summary

- Startup called Cenus Technologies
- Content routing
- Chief Architect from 2000-2002
- Based on research with Prof. JJ Garcia-Luna
- Have not been involved since ~2003
- Cenus is still in business…
Cenus
The Technology
The Internet

• What is a (the?) primary invariant of the Internet?
• It grows.
Client-Server

• Clients communicate directly with server
• All requests traverse the Internet
• Average latency is half the Internet’s diameter
• As the Internet grows this becomes painful
  – High latency → loose customers
  – High jitter → poor streaming performance
  – Single-point of overload and failure
Client Server in the Internet

• What’s the problem?
• Performance always gets worse.
Problem with Client-Server

- Clients communicate directly with server
- All requests traverse the Internet
- Average latency is half the Internet’s diameter
- As the Internet grows this becomes painful
  - High latency $\rightarrow$ loose customers
  - High jitter $\rightarrow$ poor streaming performance
  - Single-point of overload and failure
Solution - Caching

• Store copy of fetched data “locally”
• Satisfy future requests from cache
• Previous uses: memory, disk
• Effectiveness depends on
  – Locality of reference (requested object requested recently?)
  – Differential in access times (how far to the server?)
  – Request rate (how many clients does cache see requests for?)
  – …only control last one
Web Caching

- Clients talk to cache
- Cache fetches content for client
- Subsequent requests satisfied by cached content
- Weak cache coherency (TTL)
- Goals – improve performance, save external bandwidth
- **Effectiveness of cache measured by hit rate**
  - is a function of request rate…
  - … increase chance that content requested recently enough.
Standalone Caches not Effective

- Need very high request rate for effective caching
- Place caches high up network hierarchy
- Expensive
  - Big cache machine
  - High bandwidth cache connectivity
- Same problems - latency, jitter, reliability
- From many loaded web servers…
- …to one loaded cache server
Hierarchical Caching

• Attempts to resolve hit rate/performance trade-off
• Organize caches in hierarchy
• Only root cache fetches content from server
• In effect, aggregates request streams over set of caches
Results

• Performance is worse(!)
• Multiple caching hops exacerbates…
  – Latency
  – Jitter
  – Reliability
Our Original Insight

- Limitations of client-server model
  - On-demand caching attempts to address
- Simple caching depends on very high locality of reference
  - Web access does not have adequate locality of reference
- Hierarchical caching involves too many hops
  - Attempts to address this have not been effective

- Object routing
Internet Routing

• Telephone routing
  – Phone number specifies route
  – Statically configured route to each telephone

• Internet routing
  – IP address says nothing about location
  – On-going computation of route to each host
  – Have developed very efficient solutions
Object Routing

• View object (web page) as destination
• Compute route to each object on on-going basis
  – Closest instance of that object (“anycasting”)
• Organize caches in overlay network
  – Can’t require object routing in all routers (“boil the ocean”)
• Object router
  – Place next to each cache
  – Configured as parent of its cache
Object Routing

• In effect, a hierarchy…
  – With at most 2 hops
  – Where 2nd hop always “has content”

• I.e. hierarchy with bounded overhead(!)

• Request streams aggregated over all cache sites…

• …high “cache cloud” hit rate(!!).

• Effectiveness depends on performance differential…
Object Routing Protocol

• Very efficient
  – Unpopular objects, low update rates, wide distribution
  – Popular objects, high update rates, limited distribution
  – Supports request rate to pull all Internet content into caching system!

• Very robust
  – Benefits depend on local cache.

• Requires huge (billions) routing tables
  – Map object to destination
  – Developed proprietary solution
  – ~10-20bytes per entry
  – Constant access time (10’s of instructions)
Technology Summary

- Hugely scalable, weak coherency, on-demand caching

- Applications
  - Peer-to-peer
  - Web caching
  - Domain Name Service (DNS)

- Futures
  - Strong cache coherency (e.g. distributed filesystems)
What were the Risks?

- How will object routing perform?
  - Analysis
  - Simulation
  - Prototype
- How handle huge routing tables?
Cenus
Product Development
Cenus History

• Late 1999 - Developed object routing ideas
• 1/2000 - Cenus Technology calls
  – Existing company from Florida in on-line video distribution
  – Existing investors all private, “angel” investors
  – Looking for technology
• 2000 - Worked with Cenus to get further investment
  – No luck with VCs
  – Expanded group of angels
Census History (cont.)

• 2001 - Development in Utah
• 2002 - Development in Scotts Valley
• 2003 on
  – Basic technology developed
  – Attempt to find market
Cenus Product Development

- During .com boom needed very little… today need prototype
- Concept
  - “Mock-up”
  - Illustrate concept with scripted demo
- Prototype
  - Open source tools and FreeBSD
  - Ex-Novell engineers
  - Primitive build technology
  - Performance problems
**Cenus Product Development**

- **Production**
  - Ported to Solaris
  - Replaced Novell engineers with Silicon Valley engineers
  - Resolved performance problems

- **Challenges**
  - Routing algorithms are *very* subtle
  - Routing is tough to debug
  - Routing is not sexy to demo
  - Object routing table design is very abstract…
What were the Risks?

- 2000 was boom time in Silicon Valley
  - Engineers were expensive.
  - Space was expensive.
  - *Located in Scotts Valley and used Novell engineers*
- Novell engineers were not Valley engineers
  - DOS/Windows perspective
  - Primitive software engineering technologies
  - Robust product development models
  - *Didn’t know how to work on Valley time.*
- Marketing...
  - Spent our time looking for investors
  - No time identifying customers
Census Funding
Sources of Funding

• Venture Capitalists
• Angel Investors
• Grant funded research
Venture Capitalists

• Professional investors
• Invest other people’s money
• Provide
  – Connections (talent, partners, services)
  – Discipline
• Require
  – A (large) share of the company
  – Control of the company
How VCs Work

• They aren’t technical
• Herd mentality
• Funding process
  – Rounds
  – Lead and secondary investors
• They prefer large investments
• They don’t say “no”
• They don’t sign NDAs
• They will use what you teach them
What Gets VC Attention

• An unfair advantage
  – A good idea
  – A good team
    • Reputation
    • Skills

• “Buzz”
  – Something that gets investors attention
  – Well known team members
  – In a currently hot field
How to Work With VCs

• You need an introduction
• You need something they can’t buy elsewhere cheaper
  – Management team
  – Critical technical talent
• In the end you’ll be depending on their integrity!
  – Reputation
  – Gut sense of trust
• Remember - they’re accountable to their investors
Angel Funding

- Wealthy individuals
- Not professional investors
  - Less involvement in business
  - Less help with connections
  - Don’t do discipline
- Don’t require as large a share of company
- Don’t get as involved in company
- Can be impediment to VCs
Academic Research

• Grant funded research

• Technology ownership
  – Funding agency may claim some ownership
  – University claims ownership
  – Typically inventor is given share (UC > 30%)
  – In the end, not a big issue
    • First to market is the big issue

• Great for developing a prototype
What are the Risks?

• VCs
  – Will give to little…
  – …and take too much

• Angels
  – Will scare away VCs

• Academic research
  – Getting funding for the research you want…
Cenus
Lessons
Risk at Cenus

- What were the risks and how did we deal with them?
  - Technology… did a reasonably good job.
  - Marketing… barely thought about it.
  - Development costs… attempts to mitigate were not effective.
  - Environment… .com crash.
  - Funding… we depended on Angels (exacerbated last three risks)

- We gambled...

- *You don’t succeed in risky environments by gambling!*
Risk in General

• To succeed in a world of risk…
  —…you don’t live with it,
  —…you eliminate it.
Cisco Network Management and Operations Lab
Thank you!

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