CS514: Intermediate Course in Operating Systems

Professor Ken Birman
Vivek Vishnumurthy: TA

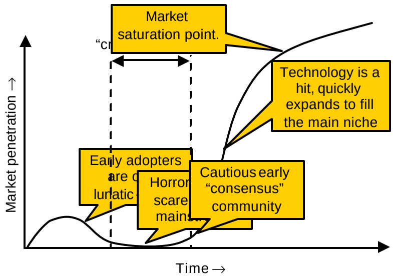
Putting it all together

- Today is our last lecture!
  - Wednesday was originally used as an in-class final by Professor Schneider, but we don't have an exam this year
  - People interested in doing an early demo are encouraged to do so, Wednesday or any time in the next two weeks
  - All group members must be there!

Today's topic: "Synthesis"

- Let's look back over the semester
  - What's the big picture to take away?
  - Where will complex systems of systems go next?
  - What kinds of bets on the future are starting to emerge right now?

Technology adoption curve



The world we live in?

- We're seeing Web 1.0 reaching that saturation situation
  - For desktop uses, the web is probably doing much of what it "will do"
  - For wireless and mobile, of course, the situation is very different
  - And we're using Web to mean "web sites with relatively static content"

The world we live in?

- Meanwhile Web 2.0 is taking off
  - Technologies that leverage and support social networking
  - Google mashups, RSS feeds, search
- Arguably Web 2.0 is already hitting its own saturation point

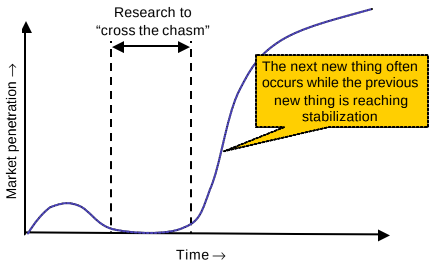
The world we live in?

- Web Services
  - Basically, can recognize these in terms of a set of (simplistic) steps
    - Let's allow programs to do what browsers do
    - Let's use Web Services standards to build systems of systems
    - Let's make it easier to construct these solutions and interconnect them
  - Call this a Web 2.0 technology area

The world we live in?

- Web 3.0
  - Makes for a fun homework topic (someday you'll thank us… ☺)
  - But really just a distant glimmer right now
- The real Second Life system is just your basic datacenter, very much a Web 2.0 construct!
  - Technology to support social networks

Technology adoption curve



The next new thing often occurs while the previous new thing is reaching stabilization

A multi-layered picture

- Over time, a technology "area" such as web services ends up having wave after wave of major technologies
- Each follows a similar curve
- (Assumes that there is a larger and larger aggregate market to pursue)

CS514 emphasis was on reliability, mostly via replication

- We looked, superficially, at the technology backdrop against which all this is happening
- Client-server interaction models
  - CORBA (we skipped this "epoch")
  - Web Services (the current new thing)
  - Systems of systems (SoS of SOAs)

CS514 emphasis was on reliability, mostly via replication

- Gossip technologies
  - Very scalable and robust, at least in some ways. Predictable, low load
  - But sluggish; poor choice if we want snappy response
- Other P2P technologies
  - BitTorrent, RON, DHTs
  - Some combine P2P ideas with gossip

CS514 emphasis was on reliability, mostly via replication

- Group communication
  - Multicast, but normally in support of replication or event notification
  - Many “types”, which leads towards a perspective that multicast “type” is a type much like any other “type”
    - Object-oriented multicast would probably look like “live distributed objects”
    - Multicast type extends the component type

CS514 emphasis was on reliability, mostly via replication

- Against this backdrop we looked at
  - What can and cannot be done (FLP)
  - Scalable best-effort multicast (QSM)
  - Virtual synchrony model
  - Consensus (Paxos model)
  - Quorums and static membership
  - Transactional replication (1SR)
  - Time-critical and real-time multicast
- Can view all of these as “types” of multicast and in fact QS/2 will do just this

CS514 emphasis was on reliability, mostly via replication

- Byzantine Agreement
  - Strongest property of all
  - Basically subsumes all the others!
- Not impossibly slow anymore (PRACTI, BASE, other BFT schemes)
- But use only for “sensitive” purposes

Giving rise to a “vision”

- Today, Web Services focuses on how to connect clients to datacenters
  - … and more and more, how to create complex SoS structures with datacenters that talk to one-another
  - But existing platforms offer relatively little autonomic support and forces us to build datacenters more or less entirely by hand

The vision?

- Systems that are
  - Easy to build: Better tools
  - Autonomic by construction: The tools lead us to robust solutions that can manage themselves in large, complex deployments
  - The tools themselves are better integrated into environments like .NET
- Unlike cs513 we didn’t look at security… but even so, add “secure” to this list

Approaching that vision

- Cornell approach:
  - We need better technology
  - Then show how it can integrate seamlessly into major platforms
  - Then hope the world will imitate us
- The problem?
  - The world is drowning in a sea of noise, technologies, buzz…

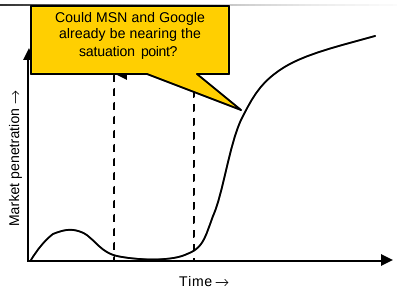
Approaching that vision

- Corporate players?
  - Google is driven mostly by search and social networking opportunities
    - Which for them, are opportunities to leverage their role by helping you find their partner's sales sites, or posting just the right ad at the right moment
    - Many betting that Google is dead on.

Approaching that vision

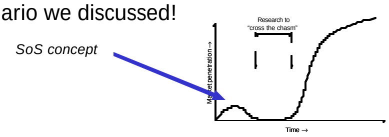
- What about Microsoft?
  - "MSN Live" intended to enter same space
  - But unclear, so far, just what the Live concept will really do
- Could "Live" be "Live distributed objects"? Cornell thinks so, but MS hasn't shown much sign of believing this
- Yet big success of .NET is its clean integration of components, clean use of type system

So... where are we?


Could MSN and Google already be nearing the satuation point?

Betting that "our time is up"

- If we bet that the datacenter/search paradigm is already close to its peak...
  - Microsoft's next bet is on systems of systems, but the technology is full of holes
  - Looks much like that "early adopter" scenario we discussed!


SoS concept

Betting that "our time is up"

- Google is aimed at cell phones
  - Building a national "free" network (lure in the marks with a loss-leader)
  - Faustian bargain: Just agree to run Google on your cell phone
- Then they use GPS, voice recognition, etc. to somehow get you into "their" hotels, restaurants, nightclubs, stores...

Google's problem?

- Cell phone screens are just too small
  - Already need to squint to see anything on them
  - And voice recognition doesn't work very well yet – an A/I challenge for decades with progress, but rather slowly
- Will Google pull it off?

What about us?

- We’re the crowd that ends up dealing with today’s challenges
- These are basically
  - Building datacenters with inadequate tools
  - Making systems self-managed even though Web Services is constantly “in our face” making the job harder than it should be
  - Creating SoS without proper standards

This is a good and a bad thing

- The good news:
  - In fact we do have technologies that can help
- The bad news:
  - Never underestimate how hard it can be to deploy them into your app!
  - They aren’t going to look very “standard” to your boss…

Good luck!

EVERYTHING YOU DO IS DIFFERENT FROM THE WAY I WOULD DO IT.
THAT'S HOW I KNOW YOU'RE DOING EVERYTHING WRONG.
I WOULDN'T BE MAKING THAT FACE.
www.dilbert.com scottadams@aol.com
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