National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

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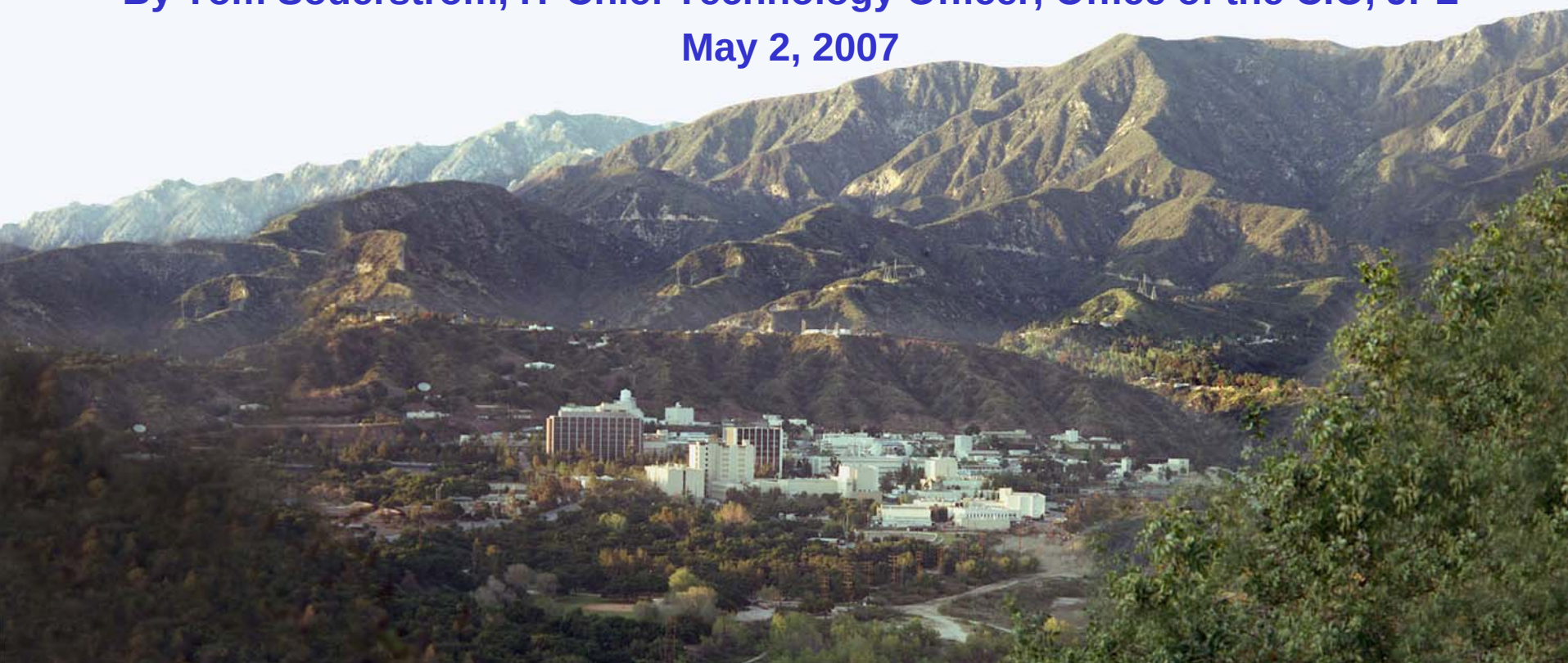
Sustained Collaboration – The Next Generation

Presentation at the
9th NASA-ESA Workshop on Product Data Exchange (PDE)

By Tom Soderstrom, IT Chief Technology Officer, Office of the CIO, JPL

May 2, 2007




Can you hear me now?

Facts About the Jet Propulsion Laboratory

- **Managed by the California Institute of Technology**
- **NASA's lead center for robotic exploration of the solar system**
- **$1.6B contract per year, ~ 5,000 employees; 177 acre facility located in Pasadena, CA**

  - **Manages worldwide Deep Space Network**
    - **3 Locations - Goldstone CA, Madrid Spain, Canberra Australia**
    - **Spacecraft Command & Control - Recording scientific data**
- **50+ years experience in spacecraft design, production and operation JPL spacecraft have visited all planets in our solar system except Pluto!**

Innovation Approach:
The Right IT Technology at the Right Time

- Collaborative approach to priorities and solutions
- Use emerging trends and industry innovations
- Long term view and short term infusion opportunities
- Enable effective innovation
- Unify enterprise IT…

- **In short: "Seek – Find – Chew – Bring"**


Star-Birth Clouds

IT/Web Evolution → Enterprise Computing

Trends
- Accelerating changes
- Perpetual beta
- Faster, cheaper development
- Easier deployment
- Increased standardization
- Wisdom of crowds
- Increased productivity…

Web 4.0 - ?

Web 3.0 - By Enterprise for workers

Web 2.0 - By Consumers for home collaborators

Web 1.0 - By Enterprise for shoppers

Web 0 – By Academia for scientists

Computer-Networks | **E-Commerce** | **Social-Networks** | **Application-Nets** | **PDA-Nets**

1960s/70s
-Packet switching
-ARPANET

1992
-Netscape public
-Smart Developers

~2004
- Google
- "Web 2.0"
- Smart Users

~2008
-Semantic Web
- Smart Data

~2010
- Mobile Web / Always On
- Smart mobile devices

Some Challenges

- Intellectual Capital is retiring without passing on the knowledge
- Future Intellectual Capital has different expectations
- Decreased budget -- as Baby Boomers use up retirement funds; there will be less money for space missions
- Distrust between USA and other countries
- Business Continuity risks (e.g. a pandemic , Asian flu, etc.)
- Dealing with information overload

- So… how do we improve efficiency and effectiveness of group interaction and knowledge sharing

Definition of "Collaboration" Is Becoming Over Complicated

Google search for Collaboration generated 161M hits

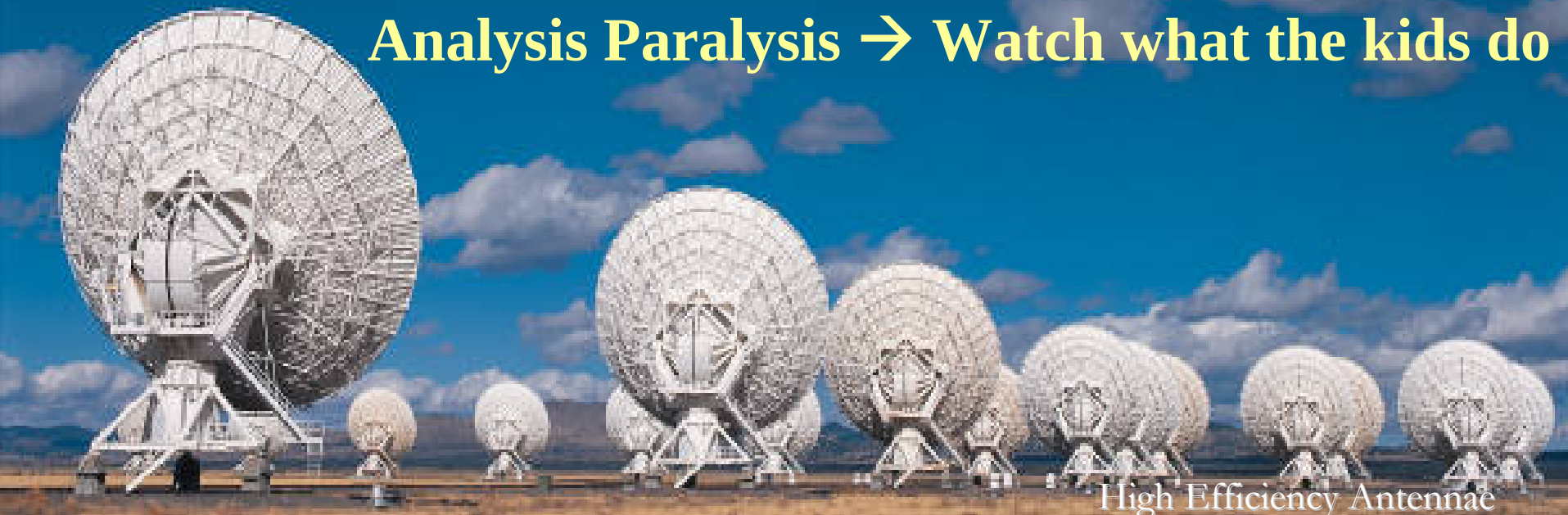
From Wikipedia:

"Collaboration refers abstractly to all processes wherein people work together —applying both to the work of individuals as well as larger collectives and societies.

Blah blah blah

… the nature of collaboration is coming under more intensive study."

Analysis Paralysis → Watch what the kids do



High Efficiency Antennae

Collaboration Drove Last Year's Model… And Will Drive Next Year's Model Even Faster

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- Mars Exploration Rovers success demonstrated collaboration results
- The ante is upped for next year's model (Mars Science Laboratory):
  - Requirement for increased capabilities
  - Much wider international participation
  - Much faster timeframe (everything in 8 hours)
  - Let's take a closer look…

Human Male
1750 mm (5' 9")

Successful Collaboration Incorporates Six Key Characteristics

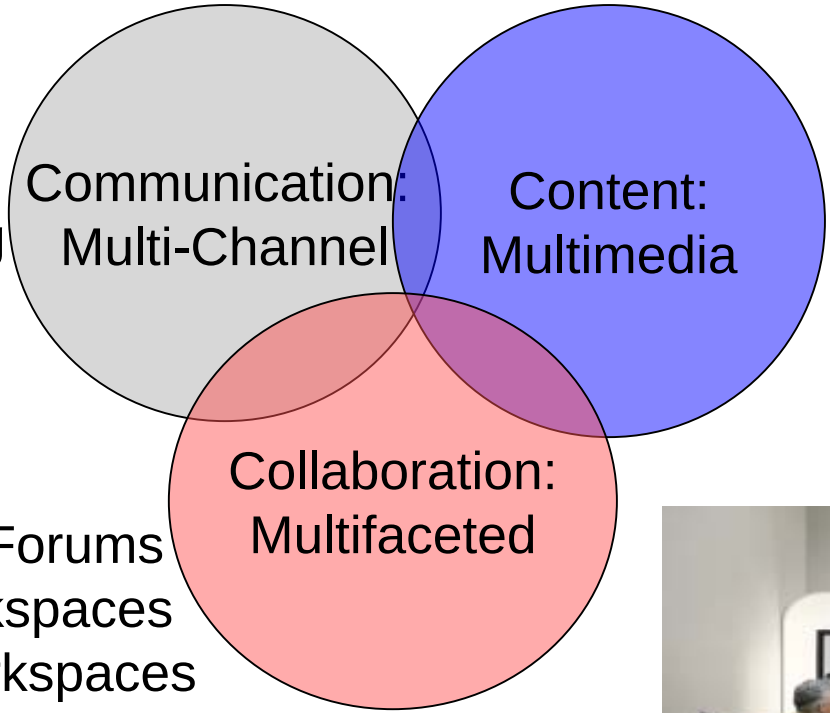
1. **Flexible Time**
   - Synchronous (We're having a conversation) vs.
   - Asynchronous (How do we get out "living in the In-box") vs.
   - Historical (We're reusing the best of breed information)
2. **Any Distance**
   - Collocated →In same company → in same country → on the same planet
3. **Bridges Culture**
   - E.g. Science vs. Engineering; IT vs. Finance; Government vs. Commercial
   - Corporate culture and international differences
4. **Considers Different Ages**
   - Knowledge transfer from retiring Baby Boomers to new generation is hard
   - Rapid changes in collaboration practices creates communication challenges
   - New generation with new work patterns and new tools
5. **Security is Built-in**
   - Reactive → Proactive → Built-in and automatic
6. **Most Effective Mix of Resources**
   - Facilities, standards, network, tools, and people determine specific solution

It's the easiest of times, it's the hardest of times…

Thirty-one Employees of the JPL All-female Computing Section, 1953

Collaboration Trends: Emerging Communication, Collaboration, and Content Product Categories *

- E-mail
- Telephony
- Mobility
- Instant Msg
- RSS
- …



- Documents, xCAD
- Databases
- Directories
- Audio/video content
- Recorded events
- …

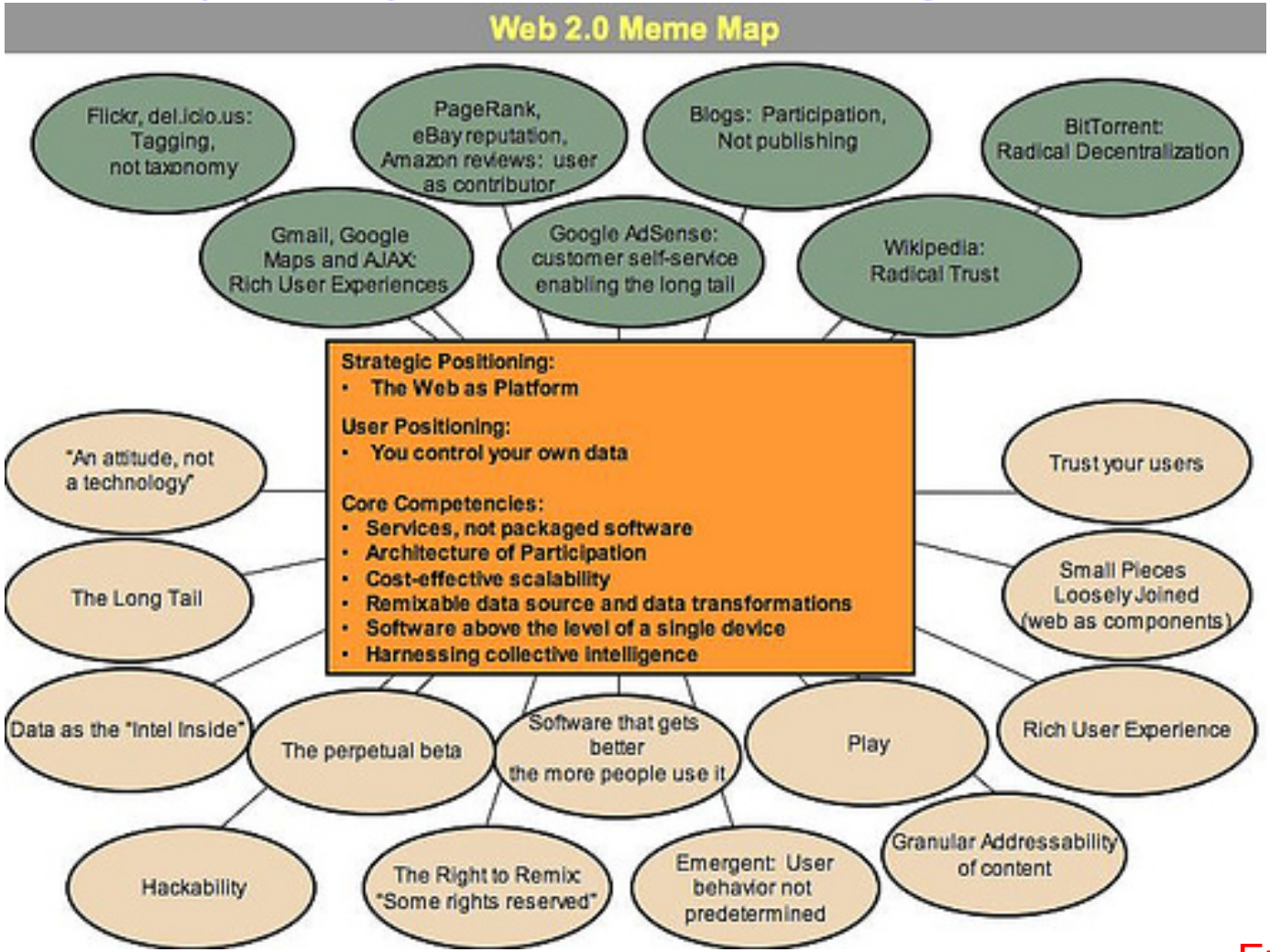
- Discussion Forums
- Project workspaces
- Meeting workspaces
- Conferencing
- Shared tools
- Wisdom of Crowds
- Virtual Worlds
- …

Like Being There
(Cisco TelePresence Mtg)

* Ideas from Burton Group

Web 2.0 – A Collaboration Step Ladder

http://www.youtube.com/watch?v=6gmP4nk0EOE&eurl



…
Blogs,
Social networking,
Folksonomies,
Wikis,
Podcasts,
RSS feeds,
AJAX,
SOAP,
REST,
Mashups,
Web Svcs,
Flickr,
Del.ici.ous,
YouTube,
Google
…

- From O'Reilley

Year 2010 Model: The Virtual Is The Mainstream

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Available Today:

- **HBR: marketing to Avatars**
- **Wharton: Second Life as platform for training / exercises**
- **Masie: Extreme learning (Wikis, gaming, pod casts, …)**
- **Duke University: classroom**
- **IBM: Virtual town halls, CEO has an avatar**
- **NASA, NOAA, …**
- **Teaches measured risk taking, multi-tasking, leadership, strategy**

- Meeting in Second Life

The Next Generation Workforce Is Training…
What can we learn from Cheeky Monkey and Love Puppy?

There are 29M US kids 8-14 years old with annual purchasing power of $40B. 90% are online.

Webkinz®

www.clubpenguin.com/

1.6M unique visitors/month (2.9M in Jan.)
Free access to virtual penguins; pay to decorate
Worldwide, simultaneous parties. "Snow Days"
2 years to reach 1M users (SL took 3).
4x stickier than YouTube.

www.webkinz.com

900K unique visitors/month (1.6M in Dec)
Access to purchased virtual pets.
Hold virtual jobs to upgrade lifestyle.
2 years to reach 1M users
4x stickier than YouTube.

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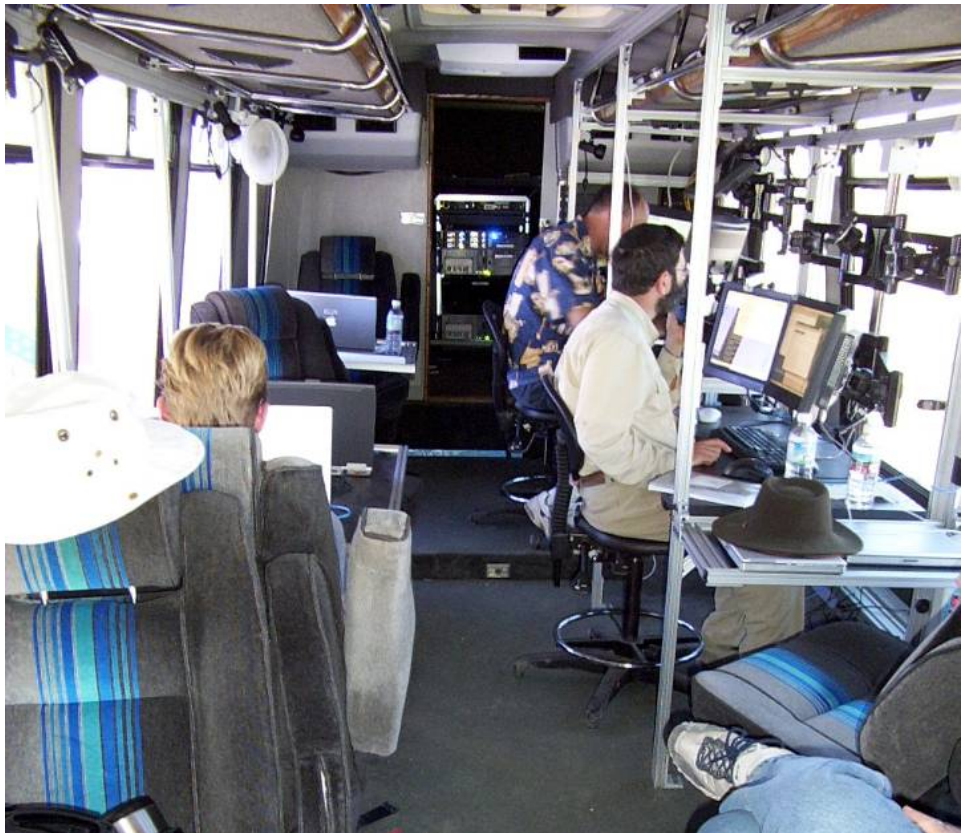
Expanded Definition of Collaboration: So, How Do You Motivate A Robot?

ATHLETE Robots

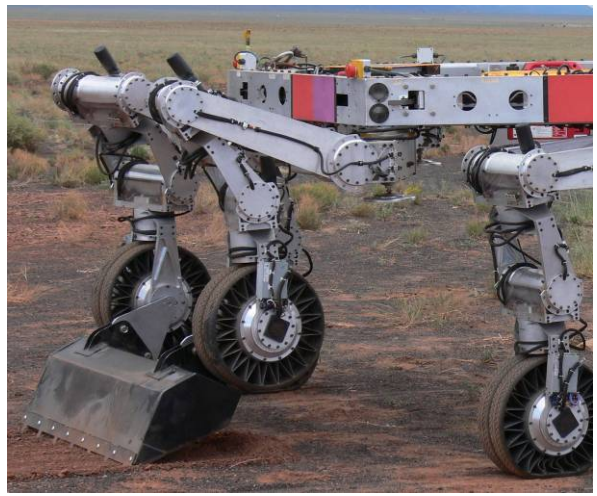


COACH configured for dual-robot operations

- **Sustained simultaneous operations of two robots for multiple days**
- **Drove vehicles on flat terrain and on sand dunes**
- **Performed basic walking**

COACH in field camp

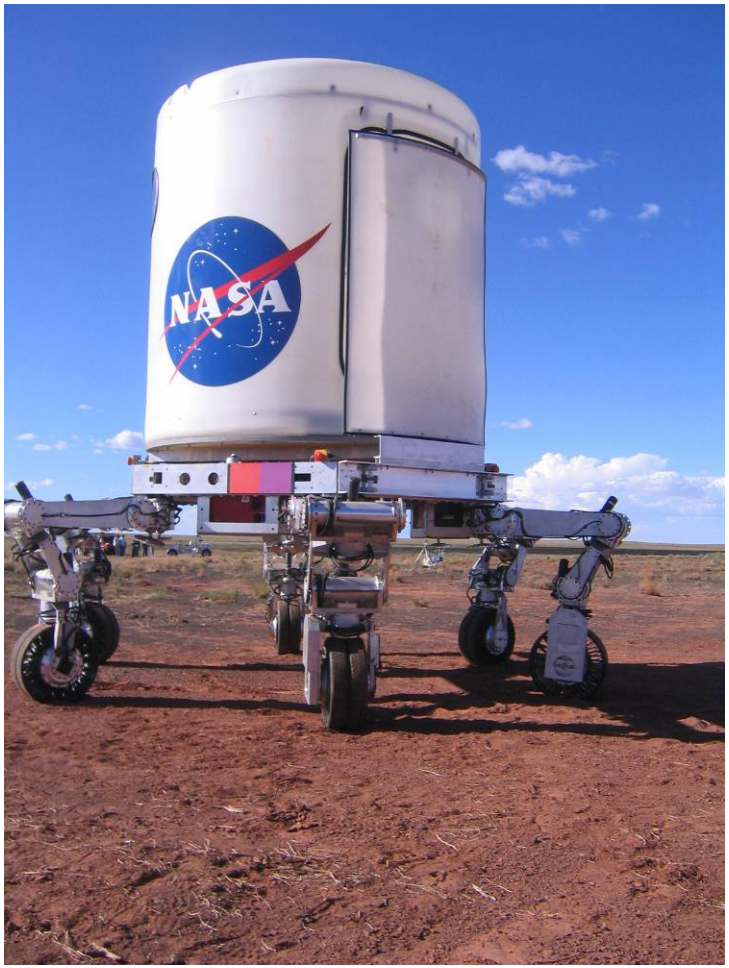
Well, You Let it Play With Teleoperated Tools…



Give it Exercise…

Give It A Purpose …



… And Let it Play With Other Robots

Like… On The Way To Mars…
Important Technical Problems To Be Solved

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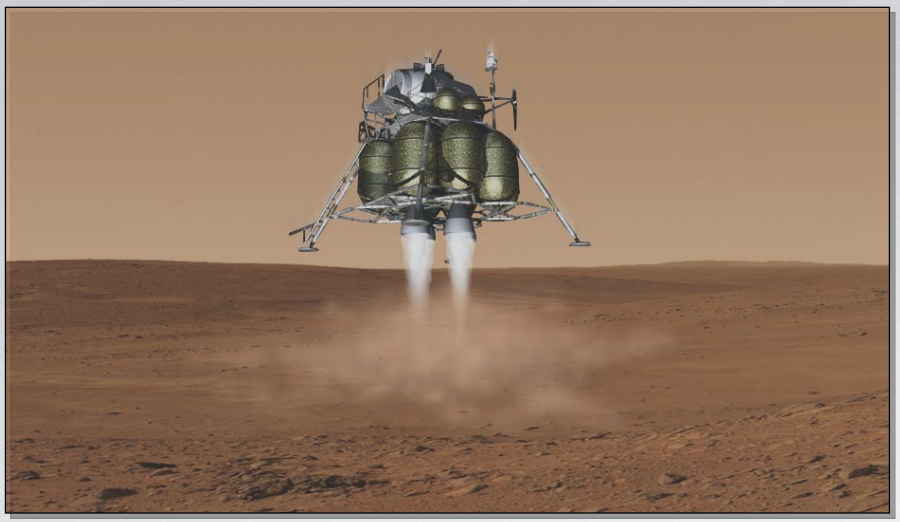
- **Counter measures for human physiological changes**
  - Calcium loss from bones
  - Atrophy in muscles
  - Immune system changes
  - Radiation damage

To mention a few



- **Landing 25 metric tons safely**

… And When We Arrive On Mars
Important Technical Problems To Be Solved

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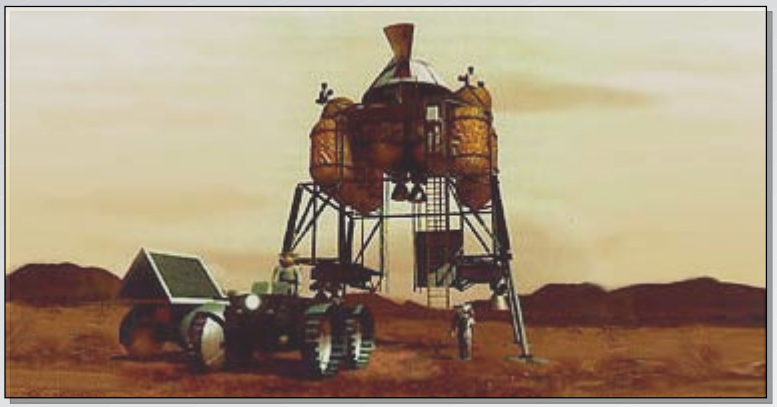
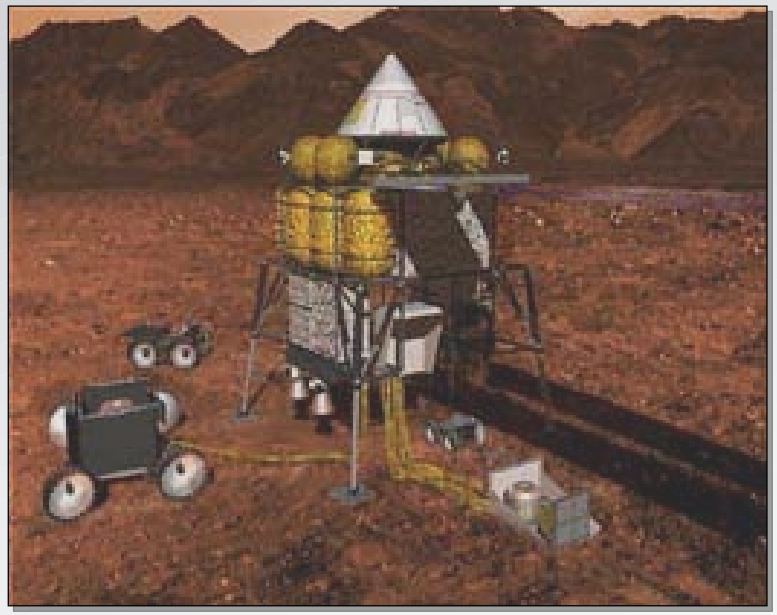
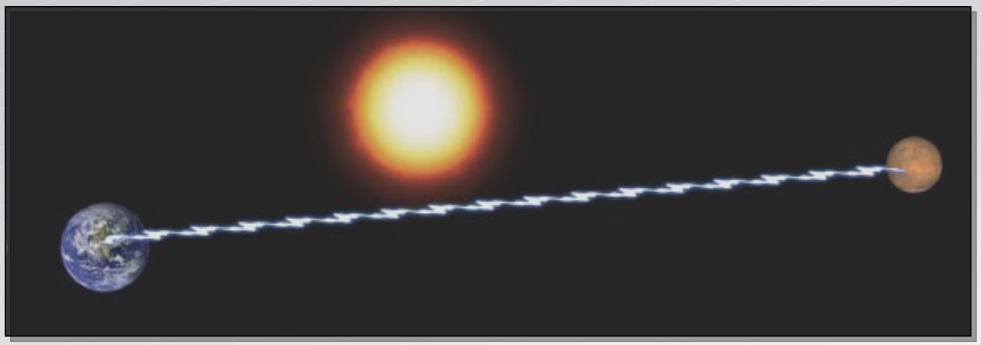
- **Living off the land – using resources from Mars, don't ship from Earth**

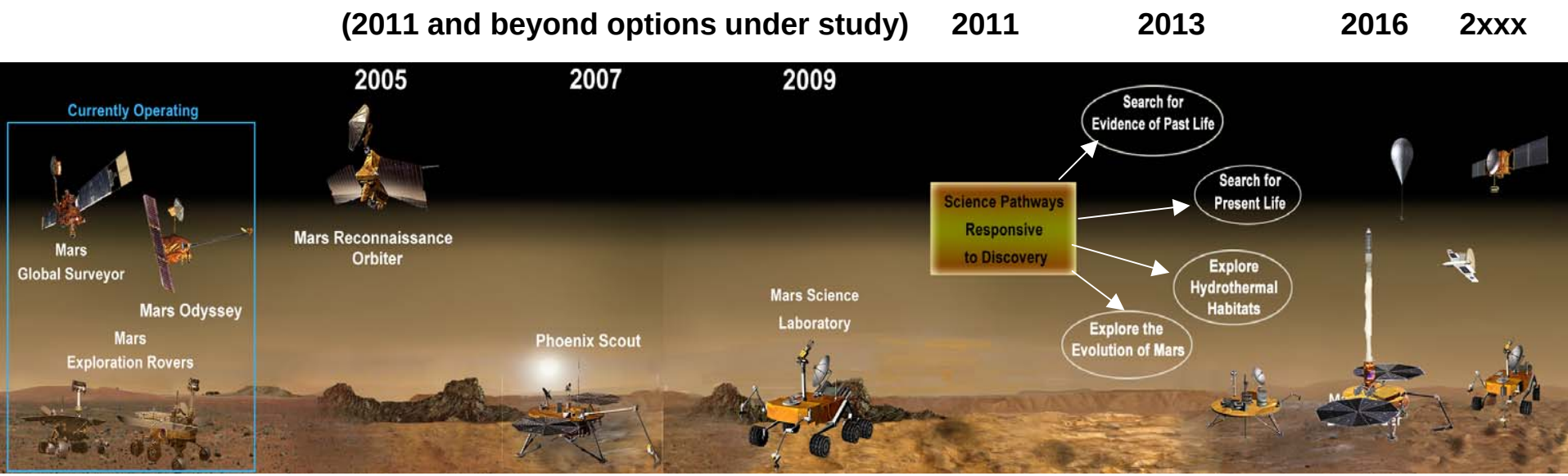






- **Operating 20 minutes (to 30 days) from contact with Earth**

To Reach This Goal…



… We have to overcome

- Time, cultural, and geographical barriers
- Generational gaps
- International disputes
- Budgetary and political challenges

➔ **The only solution is consistently evolving collaboration**

Our Collaboration Needs to Keep Pace With Our Needs

1990s 2000s 2010's 2020's 2030's 2100

Send an avatar, then a robot, then humans

Anticipated JPL Needs in 2010/2015 Model:
Completely working model before any fabrication

1. Advancement and implementation of Model Based Engineering
2. Establishment and embodiment of Re-use culture within IT and Engineering discipline to be used by all projects and domains
3. Better and scalable cross-discipline/function Product Data Exchange, e.g. Electro-Mechanical also known as Mechatronics
4. “Anywhere” Engineering, Business, and IT processes (e.g. for Design, Build, Sell)
5. Long time and reliable archival and retrieval of data
6. PLM standards enabling multi-disciplinary product integration
7. Aerospace Ontology and Taxonomy
8. Managing Change to Speed User Adoption of Technology
9. Designing Enterprise Architecture to Meet Evolving Business Needs

→ Create and run the entire spacecraft virtually before building anything (including partner models)

The Solution is Sustained Interoperable Collaboration

1. **The vision and needs are astronomical and long term**
   → **We need an ongoing and long term strategy with sustained buy-in**
2. **No company or organization can implement the entire solution**
   → **We must have open, interoperable standards**
3. **No single country can afford the long term budgetary challenge**
   → **We need international cooperation and collaboration**
4. **We will not always know what we need to collaborate on**
   → **We need to scale in realtime to the needs and available resources**
5. **There will be political and cost pressure to give up in all countries**
   → **We need to visibly celebrate successes along the way**

Q&A

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Backup Slides

Get Ready for Year 2010 Model

- Web 2.0 → 3.0 → 4.0 → Be prepared
- Changes will be adopted more easily if they are not seen as counter culture
- Look at the habits of the coming generation to predict the future (mobile computing, “always on”, SecondLife, Webkinz, …)
- Allow Social Software to drive innovation but adopt it in an organized manner (XML, blogs, wikis, folksonomies, podcasts, social-network analysis, tag clouds, …)
- Collaborate actively during entire life cycle of a Space Project: Virtual brainstorming sessions, virtual design/coding/testing sessions, agility and speed, “Wisdom of several”

Jupiter Eye to Io

Recommendations

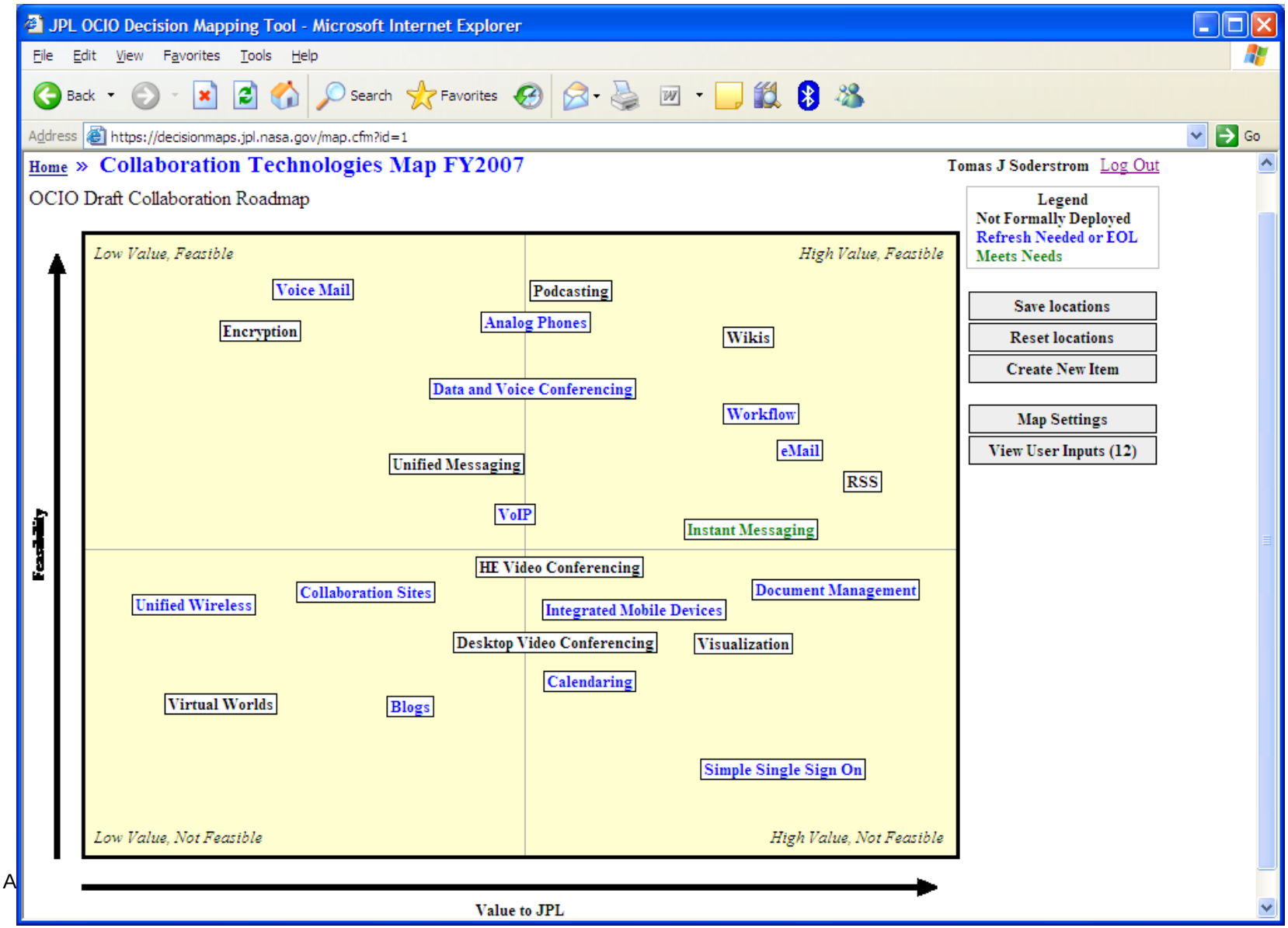
1. Tidy Up the (Enterprise) House – Determine and document
2. Watch the major vendors
3. Experiment with / use innovative tools and ideas
4. Adopt experimental successes into the Enterprise Architecture and work processes
5. Get an Avatar… it'll really impress your kids
6. Get small successes, then publicize

7. Don't panic… there is still time, but act now

DAWN Planned Launch: Summer 2007

Sample: Collaboration Roadmap and Technologies

Infuse More Effective Methods (e.g. "Wisdom of Several Experts")



Web 2.0 Patterns *

Harnessing Collective Intelligence

www.mashable.com, www.readwriteweb.com

Data is the Next "Intel Inside"

http://microformats.org

Innovation in Assembly

www.programmableweb.com, http://blogs.zdnet.com/SAAS

Rich User Experiences

http://ajaxpatterns.org; www.ajaxworldsexpo.com

Perpetual Beta

Software Above the Level of Single Device

www.gigaom.com; http://opengardensblog.futuretext.com

Leveraging the Long Tail

www.longtail.com

Lightweight Business and Cost-Effective Scalability

http://gettingreal.37signals.com; www.37signals.com/svn

Enterprise 2.0

http://blog.hbs.edu/faculty/amcafee

* From O'Reilly Radar

Web 2.0 -- How should we use it?

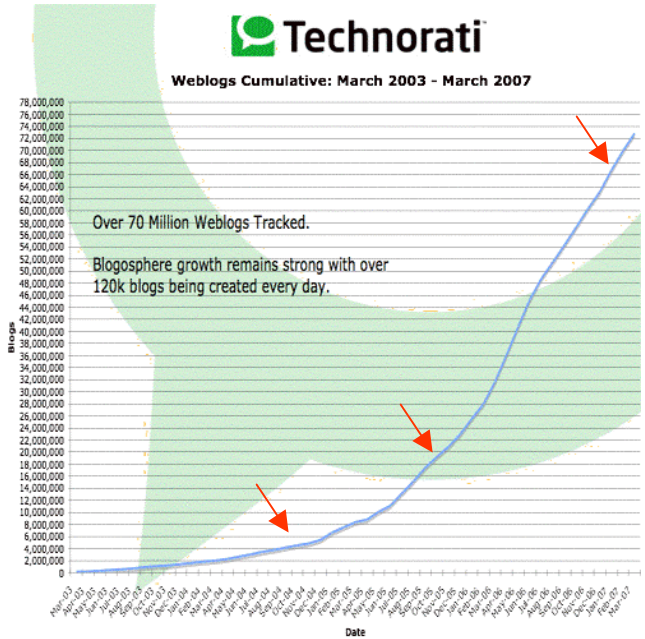
- **Purpose:** Adopt innovative and widely used technologies/methods
- **Benefits:** Allows individual contributors to make a visible difference and participate directly in the organization's mission. Technologies are proven, massively scaleable, inexpensive, and comfortable to users. Adoption allows standardization, improves productivity, and provides a competitive advantage
- **Challenges:** (1) They are seen by many as "toys that will never work in a serious IT environment" and (2) they were invented by consumers, not corporate IT
- **Roadmap:** (1) Canvas our environments for current users; (2) Identify new uses and use cases; (3) Discuss them in an open forum; (4) Form Positions and collaboratively prioritize them into a roadmap; (5) Encourage and sponsor experimentation; (6) Adopt them via standard Governance Process; (7) Continuously communicate the Position on these technologies

Peers' Web 2.0 Plans

- Dip a foot in the river
- Fit it into the culture – create a participatory Web
- Fully implement Wikis, Instant Messaging
- Implement SharePoint 2007 collaborative work spaces, Blogs
- Explore and implement Mashups, AJAX, Folksonomies, Service Oriented Architecture
- Collaborate and learn via Web conferencing and RSS
- Measure and move forward

Numbers in the Web 2.0 Landscape

- 1 new blog per second (1.5M posts/day)
- 21% of blogs are active (15M in March'07)
- 3,200 hits on Wikipedia to 1 on Encarta
- Growing Photobucket.com, Kodakgallery, Flickr
- 4% of visits edit Wikipedia (the older generation)
- 75% of visitors to Wikipedia and YouTube are male
- YouTube passes Yahoo and Google in video searches



- **JPL provides system management for a team of:**
  - **Project Scientists from around the world**
  - **Multiple JPL design teams with some in-house production**
  - **One or more NASA centers doing trade studies and perhaps developing instruments**
  - **One or more space agencies from outside the US also developing instruments**
  - **Industry Partners and vendors assisting with design and production of spacecraft, large assemblies, or components**

Flying Prototypes

- **JPL Projects are all (well, almost all) One-of-a-Kind endeavors**
- **No Mass Production**
- **No Significant Heritage from previous missions**
- **Fresh teams**
- **Very Rapid development cycles**
- **Finding relevant Lessons Learned, Design Information, or other previous knowledge is a challenge**
- **Releasing Designs must be a Rapid – but Controlled affair**

- **Mechatronics**
  - **Support for mechanical and electrical systems**
  - **Full life cycle support for engineering, fabrication, and operations**
  - **“Drive” the models through a simulated environment**
  - **Collaborate on the master model with partners over Internet**