



Fred Hutchinson Cancer Research Center
University of Washington
Children's Hospital & Regional Medical Center

Regional Collaborative Cancer Care Using the Next Generation Internet

National Library of Medicine

NGI Phase 2 final briefing

August 27, 2003

Bill Lober, MD

Dave Chou, MD

University of Washington



Outline

- Collaborative Cancer Care
 - Why?
- What we did & what we found
 - Technical
 - Clinical Practice
- What it means



Outline

- ***Collaborative Cancer Care***
 - *Why?*
- What we did & what we found
 - Technical
 - Clinical Practice
- What it means



University of Washington

- IAIMS
- Bench to Bedside: Research and Testing of Internet Resources and Connections in Community Hospital Libraries
- WWAMI - Rural Telemedicine Network
- Advanced Telecommunications Technology Satellite
- Ultrasound Telemedicine Projects
- Bench to Bedside and Beyond
- Digital Anatomist
- Biomedical Applications of the NGI – Phase 1



Broad Objectives

- Facilitate regional collaboration around cancer care of individual patients
- Continue exploring telemedicine
 - new IP capabilities
 - privacy and security



Generalizable Opportunity

- Seattle Cancer Care Alliance (SCCA)
 - University of Washington Medical Center
 - Childrens Hospital and Regional Medical Center
 - Fred Hutchinson Cancer Research Center
 - Southeast Lake Union (SELU) Outpatient Center
- March, 2001: all outpatient adult oncology services move 3 miles away – inpatient and outpatient providers are divided



Oncology Practice

- Tumor conferences important in oncology
 - Requires a gathering of multidisciplinary experts
 - Relative tradeoffs of treatment alternatives
 - Collegial atmosphere – a place for networking and learning
- Hematology-Oncology Tumor Board
 - “Typical” case conference
 - Synchronous communication
 - Local & Regional value



Specific Aims

- Develop infrastructure for collaborative, regional practice of oncology
- Develop specific tools for collaborative diagnosis and treatment
 - Case conferences
 - Physician consultations
- Facilitate
 - Increased participation by experts
 - Remote provider participation
 - Increased resident/mid-level participation



Seattle Cancer Care Alliance Network



**Fred Hutchinson
Cancer Research Center**



**Seattle Cancer Care
Alliance (SCCA/SELU)**



**University of Washington
Medical Center**



**Childrens Hospital and
Regional Medical Center**



Seattle Cancer Care Alliance Network



**Fred Hutchinson
Cancer Research Center**



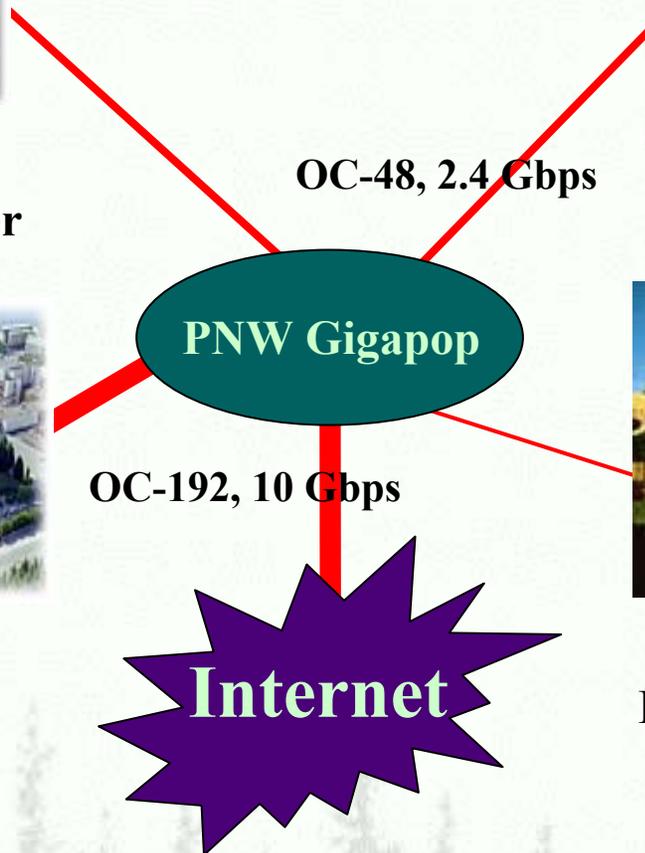
**Seattle Cancer Care
Alliance (SCCA/SELU)**



**University of Washington
Medical Center**



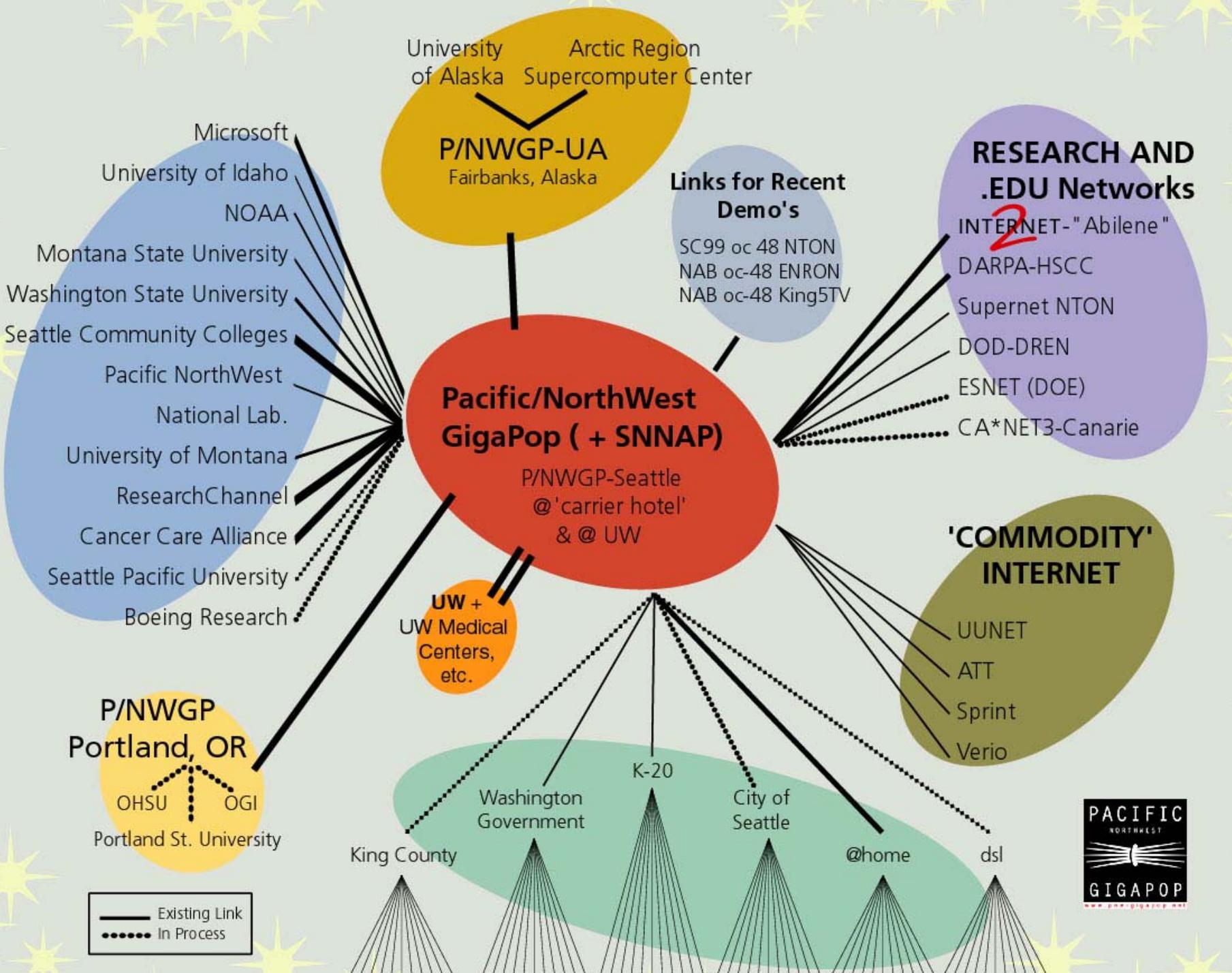
**Childrens Hospital and
Regional Medical Center**



UW and Internet2

- '96 founding member Internet2
- Computing & Communications
- PNW Gigapop
- Pacific LightRail
- Several Internet2 Firsts
 - First live HDTV over Internet Newscast
 - Previous Internet Speed Record Set (2.4 Gbps – UW/Microsoft)

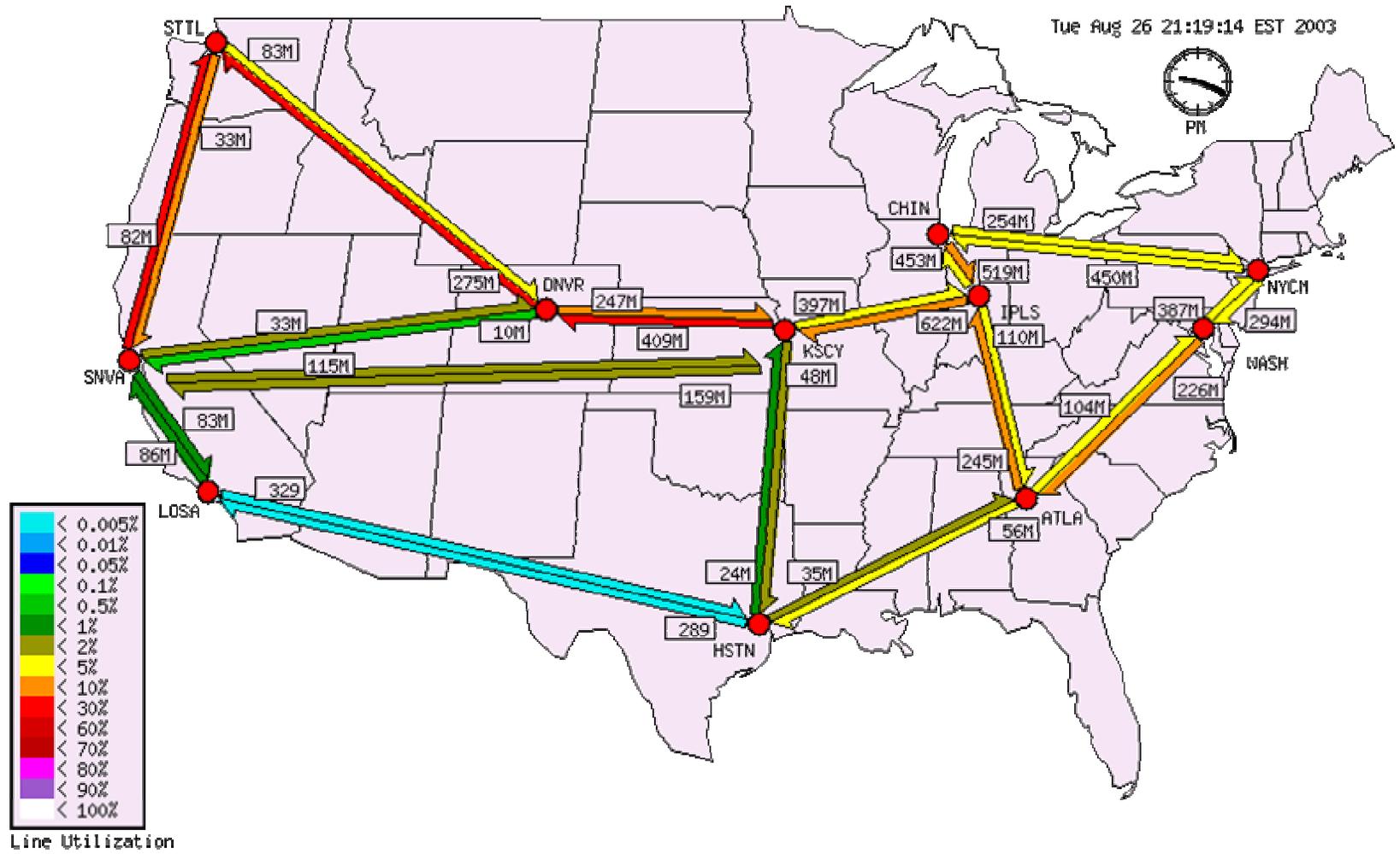




— Existing Link
..... In Process



Abilene Network



Technical Environment

- Equipment mimics Internet
 - Heterogeneous
 - Includes: Cisco, Foundry, Juniper, HP
- Fiber everywhere, (last 30 feet)
- “Local control” to and of Gigapop
- Testbed emulates/is the real world



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- Collaborative Cancer Care
- ***What we did & what we found***
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Methods

- Basic Principle: Participants, Information Artifacts, and Pathways (contextual inquiry)
- Applied to professional practice, video conferencing, and information systems design
- Three Teams
 - Contextual Inquiry
 - Tumor Board Information System
 - Folie á Deux/Telepresence



What Did We Do?

- Studied clinical/professional practice of Heme-Onc and other tumor boards
- Group to group video conferencing over IP using H.323
- Web based information system to support preparation for and discussion during clinical case conferences
- Explored augmented reality and other telepresence visualizations



Heme Onc Tumor Board Intervention

- Pre

- Bi-monthly
- 4-8 patients
- Analog artifacts
- One site
- 30+ people
- Hemepath, Oncology experts, students all together
- Lunch provided

- Post

- Bi-monthly
- 4-8 patients
- Digital artifacts
- Two sites, symmetric
- 60+ people
- Hemepath at UW site
- Experts, students at either site
- Lunch at both sites!



Heme-Onc Information Artifacts

Sue Smith

- 34 year old female
- Cervical node noted by chiropractor
- 7/99 - Hodgkin
- 7/99 - s
- (5cm m
- axillary,

MR: 9999991 <<< Study 18 of 20: 3) NCI report - Hodgkin's & pregnancy >>> Close

CancerNet
A service of the National Cancer Institute
Credible. Current. Comprehensive.

Hodgkin's Disease During Pregnancy (PDQ®)
Treatment - Health Professionals
[View Patient Version](#)

Table of Contents

Description

Note: A separate PDQ summary on Adult...
Since Hodgkin's disease affects primarily...
...and the length of the remaining pregnancy...
when necessary.

Chirologists usually counsel therapeutic ab...
the diaphragm and appears to be growing...
Alternatively, these patients can receive r...
delivered after the mothers had received a...
first trimester is associated with congenital...
who received MOPP or ABVD during preg...
and agree to radiation therapy or chemoth...

In the second half of pregnancy, most pat...
mandatory prior to delivery, such as for p...
two weeks until induction of delivery may

MR: 6999999 <<< Study 7 of 7: JBC reference on mechanism of action >>> Close

NCBI PubMed National Library of Medicine NLM

Search PubMed for [] Go Clear

Limits: Previews/links History Clipboard Details

Display Abstract Sort Save Text Add to Clipboard Order

1: J Biol Chem 2001 Aug 6 [pub ahead of print] Related Articles, Books, Links Out

Gleevec (STI571) influences metabolic enzyme activities and glucose carbon flow towards nucleic acid and fatty acid synthesis in myeloid tumor cells.

Boren J, Cacace M, Marin S, Conn-Aubert B, Costelles JJ, Lim S, Bassilhan S, Ahmed S, Lee WN, Boros LG.
Pediatric Endocrinology, UCLA School of Medicine, Torrance, CA 90502.

Chronic myeloid leukemia cells contain a constitutively active Bcr-Abl tyrosine kinase, the target protein of Gleevec (imatinib mesylate, STI571, CGP 57148) phenylamino pyrimidine class protein kinase inhibitor. Here we provide evidence for metabolic phenotypic changes in cultured K562 human myeloid blast cells after treatment with increasing doses of STI571 using [1,2-13C]glucose as the single tracer and biological mass spectrometry. Proliferation of Bcr-Abl+ K562 cells showed a 57% and 74% decrease while glucose label incorporation into RNA decreased by 13.4% and 30.1% in response to 0.68 and 6.8 mM STI571, respectively, through direct glucose oxidation, indicated by the decrease in m15/mn ratio in RNA. Based on the in vitro proliferation data, IC50 of STI571 in K562 cultures is 0.56 mM. The decrease in 13C label incorporation into RNA ribose was accompanied by the significant fall in hexokinase and G6P/DH activities, which showed a 27.8% and 36.4% decrease in response to 0.68 mM STI571 treatment, respectively. Transketolase activity, the enzyme responsible for non-oxidative ribose synthesis in the pentose cycle, was less affected and there was a relative increase in glucose carbon incorporation into RNA through non-oxidative synthesis indicated by the increase in the m2/m5 ratio in RNA. De novo palmitate synthesis and 13C enrichment of acyl-CoA was also significantly decreased after STI571 treatment in K562 cells. The restricted use of glucose carbons for de novo nucleic acid and fatty acid synthesis via altering metabolic enzyme activities and pathway carbon flux of the pentose cycle constitutes the underlying mechanism how STI571 inhibits leukemia cell glucose substrate utilization and growth. The administration of specific hexokinase/G6P/DH inhibitor and metabolite substrates or competitive enzyme inhibitor compounds, alone or in combination, should be explored for the treatment of STI571 resistant advanced leukemias as well as that of Bcr-Abl negative human malignancies.

MR: 9999991 <<< Study 10 of 20: Radiology - PA Chest (CR) >>> Close

MR: 9999991 <<< Study 7 of 20: Lymph node - nodular sclerosing Hodgkins #2 >>> Close

MR: 6999999 <<< Study 5 of 7: Pe >>> Close

BCR-ABL fusion gene structure diagram showing exons a1-a5 and b1-b5. RT-PCR products are shown for p190 (b2-a2), p210 (b3-a2), and p210 (b2-b3-a2).

RT-PCR Products: p190 (b2-a2) 180bp, p210 (b3-a2) 230bp, p210 (b2-b3-a2) 300bp.

Flow cytometry plots showing expression of various markers in Myeloid blasts and Blasts:

- CD45 (CD) vs CD33 (PE) - Myeloid blasts
- SS LOO vs CD33 (PE) - Myeloid blasts
- CD13 (FE) vs CD33 (PE) - Myeloid blasts
- CD34 (PC5) vs CD33 (PE) - Myeloid blasts
- CD34 (PC5) vs CD33 (PE) - Myeloid blasts
- CD19 (CD) vs CD33 (PE) - Blasts
- CD34 (PC5) vs CD33 (PE) - Blasts
- CD36 (FITC) vs CD33 (PE) - Myeloid blasts
- CD36 (FITC) vs CD33 (PE) - Myeloid blasts
- CD117 (PE) vs CD33 (PE) - Blasts
- CD20 (FITC) vs CD33 (PE) - Blasts
- CD56 (FE) vs CD2 (FITC) - Blasts
- CD56 (FE) vs CD2 (FITC) - Blasts
- cyCD3 (FITC) vs CD2 (FITC) - Blasts
- cyCD3 (PE) vs CD2 (FITC) - Blasts
- pos Tdt (FITC) vs CD2 (FITC) - Blasts
- pos Tdt (FITC) vs CD2 (FITC) - Blasts



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Methods - Technical

- Video conferencing
- Information system
- Application sharing
- Enhanced Telepresence



Video conferencing

- Polycomm
 - H.323 (IP)
 - TCP/UDP
 - 384K -> 2Mbps
 - Multipoint x 4
 - Integrated, good audio, separate mics



Tumor Board Information system

- Web based
 - Standard protocols
 - Enterprise security architecture
- Linux, Apache, MySQL, Perl, PHP, Python (open source platform)
- Enterprise clinical data repository linked through web protocol interface



Application Sharing

- T.120
- TCP
- Evolution:
 - VNC/SSH (-performance) ->
NM ->
PC Anywhere (+control, multipoint-) ->
NM (+multipoint)...
- T.120 multipoint



Results - Technical

- Distributed Conference
 - January 2001, and every two weeks since
 - Successful transfer to turnkey system
- Technical
 - Network performance
 - Contextual Inquiry
 - Video performance
 - Application Sharing performance



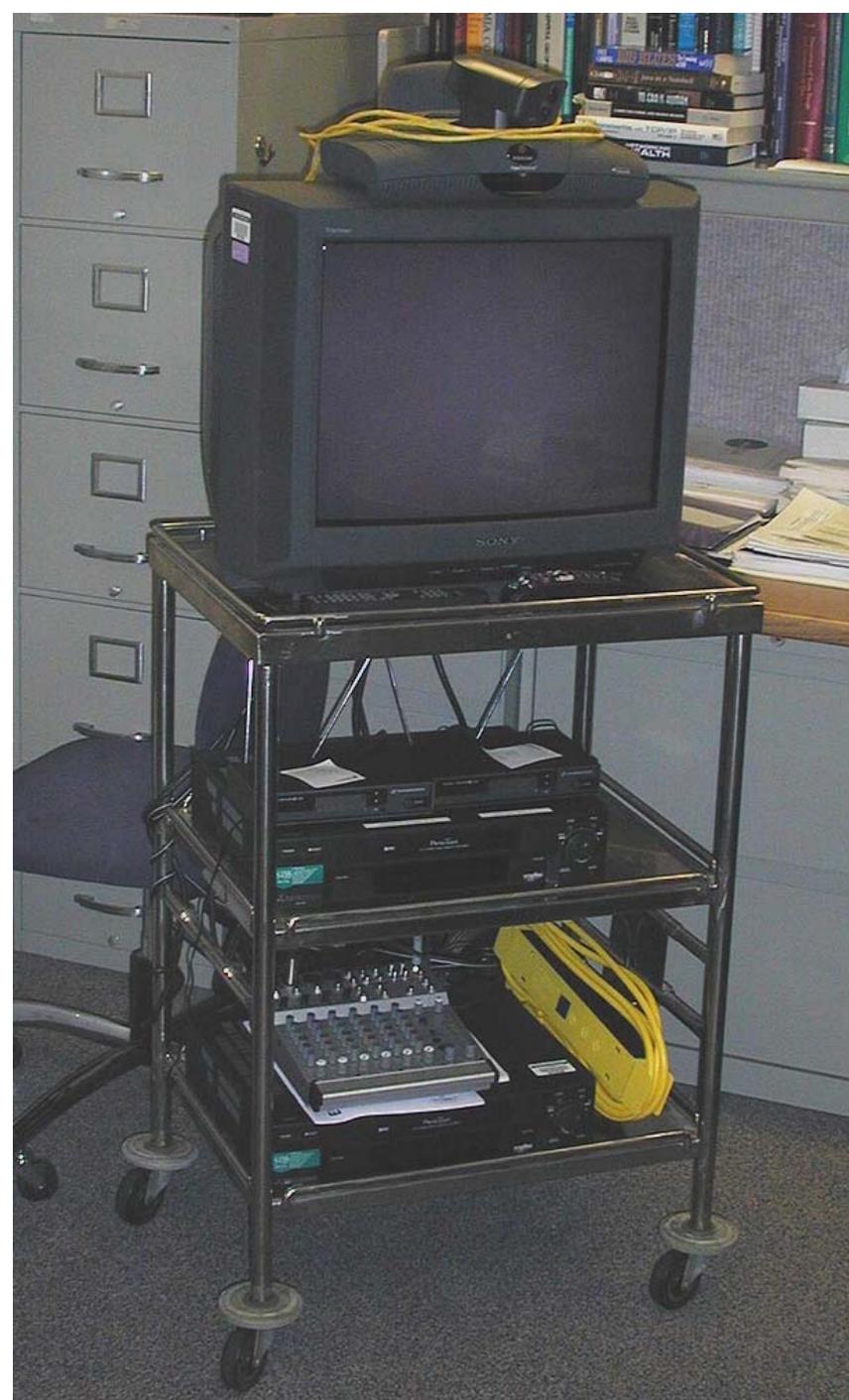
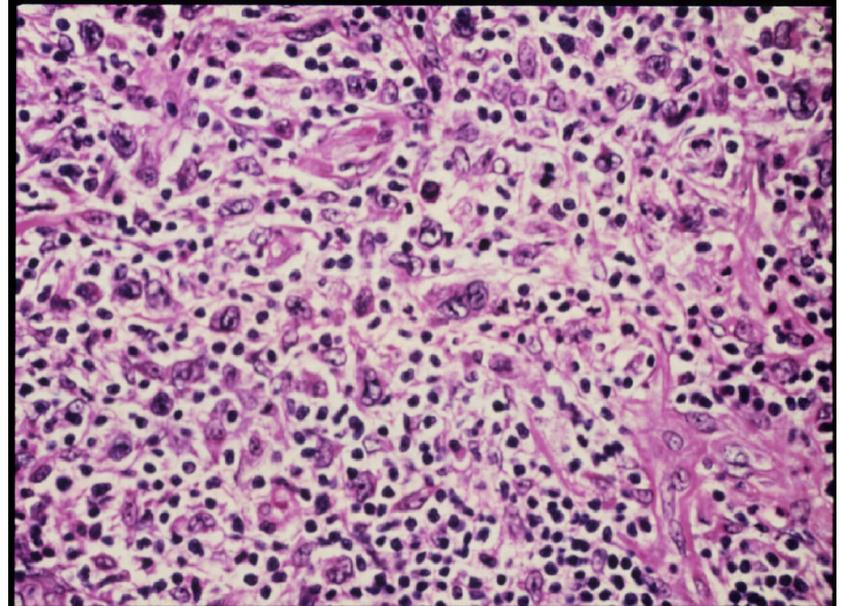
Patient: **Sue Jones** Age: **34** Sex: **F** MR: **9999991** Attending: **Press**

PMHx: **Stage IV nodular sclerosing Hodgkins '99, otherwise neg.**

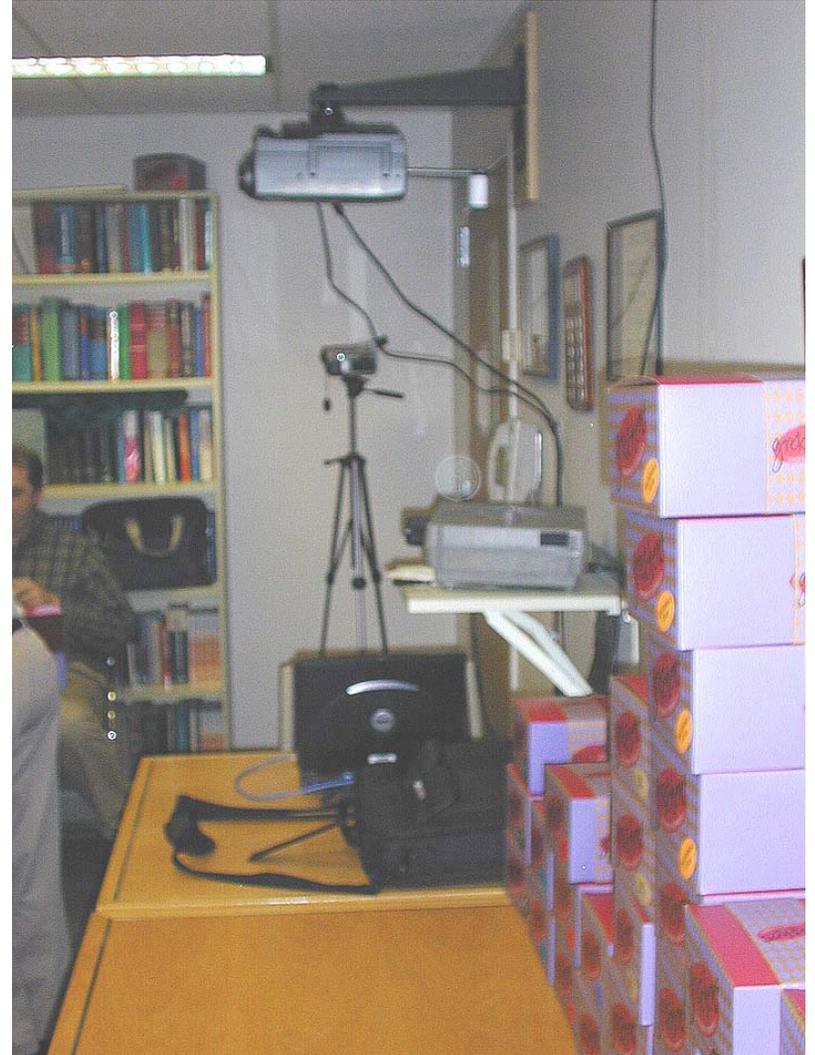
[| Conference Roster](#) | [| Return To Normal Window](#) | [| Home](#) | [| End Presentation](#)

Date	Description	Author
01-Dec-2000	Link to Mindscape Labs	chou
01-Dec-2000	Hodgkins - Reed Sternberg Cell	dc
01-Dec-2000	Hodgkins - CD15 immunocytochemistry	dc
01-Dec-2000	Lymph node - nodular sclerosing Hodgkins	dc
01-Dec-2000	Hodgkins - CD30 immunocytochemistry	dc
01-Dec-2000	Hodgkins - Reed Sternberg Cell (close up)	dc
01-Dec-2000	Lymph node - nodular sclerosing Hodgkins #2	dc
02-Dec-2000	Lymph node - Hodgkins lymphoma	dc
12-Dec-2000	Radiology - Lat Chest (CR)	stewart
12-Dec-2000	Radiology - PA Chest (CR)	stewart
30-Nov-2000	Patient History (PPT)	chou
12-Dec-2000	Radiology - Thorax CT (S2/I21)	stewart
14-Dec-2000	Gross Images - Utah	teaching
14-Dec-2000	Hodgkins Staging (U Utah)	teaching

MR: 9999991 <<< [Study 7 of 20: Lymph node - nodular sclerosing Hodgkins #2](#) >>> Close

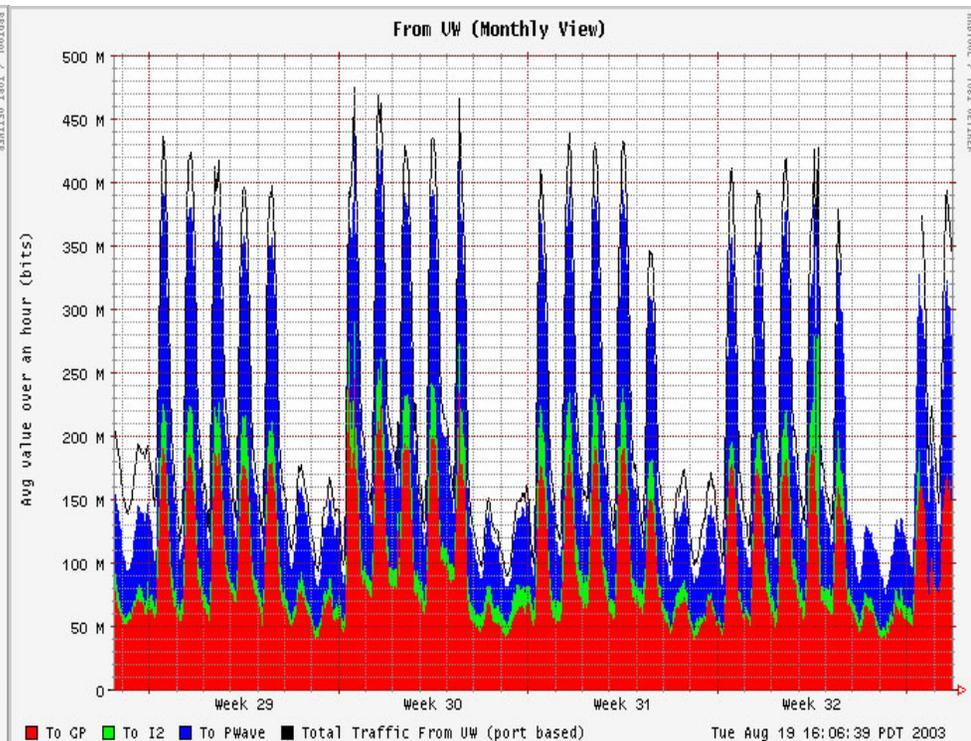
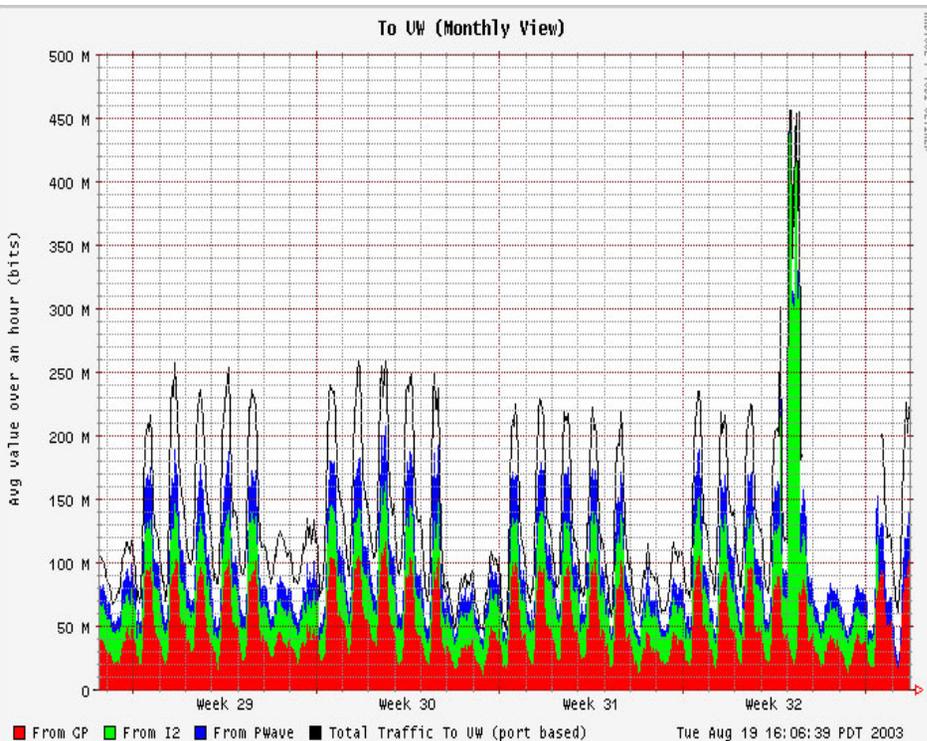


UWMC Side



UW Networking

- Peak average out 450mbits/10gbits
- Peak average in 250mbits/10gbits



Aug 15

Network Measurement

- Excellent Capacity - iperf
 - Typical 60/100 mbps
 - Typical 9/10 mbps
- Performance:
 - Break-ups
 - Dropped video/disconnects
 - User dissatisfaction



Networking Issues

- Goal: Instrument the network & assess
- Achieved:
 - Keep system operating through a variety of challenges
 - Network/switch – configuration
 - Firewall – administrative
 - Router patch bugs, etc.
 - Cracked fiber connection
 - Close cooperation with C&C people!

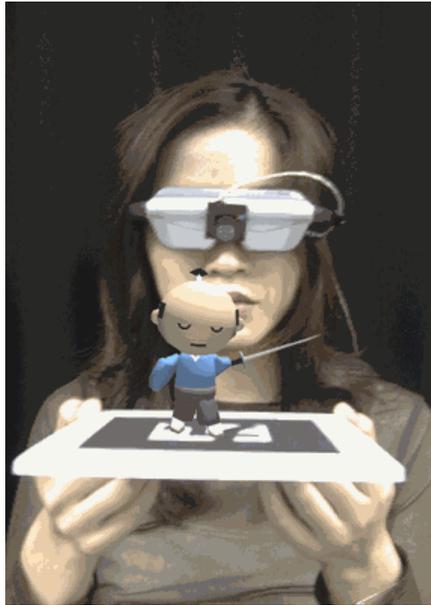


Telepresence - provide a greater sense of “being there”

- Tele-Immersion
- Shared space
- Vision-based pen input
- Augmented reality/mixed reality

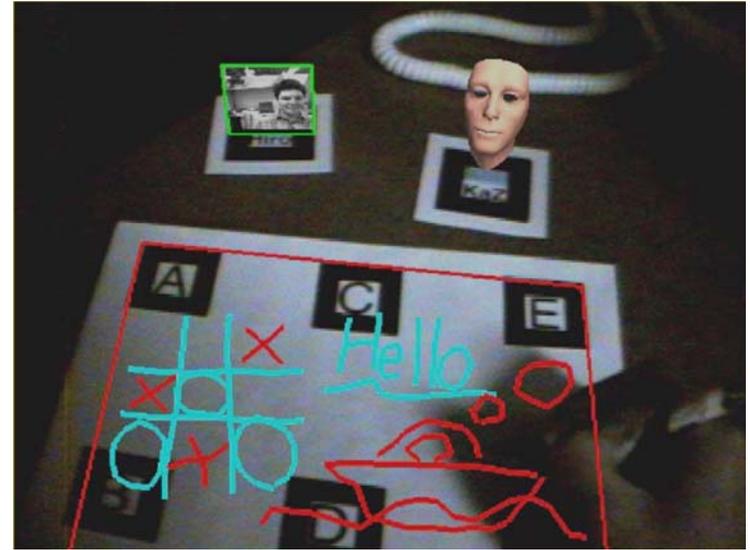


Shared Space



Mixed Reality
Visualization and
Vision-Based
Pen Input

Telepresence



Augmented Surfaces



Image Annotation/Comparison



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Methods – Clinical Practice

- Visited and observed 11 tumor boards
- Four were observed in detail
- Review Contextual Inquiry
 - Tool to look at software/technology design and implementation using observations and interviews
 - NGI team lead by Judith Ramey, chair of Department of Technical Communications in the College of Engineering
- Review conference experience of clinicians, esp. hematopathologists in Lab Medicine



Contextual Inquiry and Design

- Work Modeling
 - Work models provide a concrete & ‘objective’ representation
- Consolidation
 - See common structure inherent in work people do
- Work Redesign
 - Team invents improved ways to structure work: vision; use data to see what technology can be inserted to support the new work practice
- User Environment Design
 - Ensure that structure is right for user and manage the work of the project across engineering teams
- Mock-up and Test with Users
 - Prototype system, test the structure and user interface; redesign mock-up (iterative feedback)

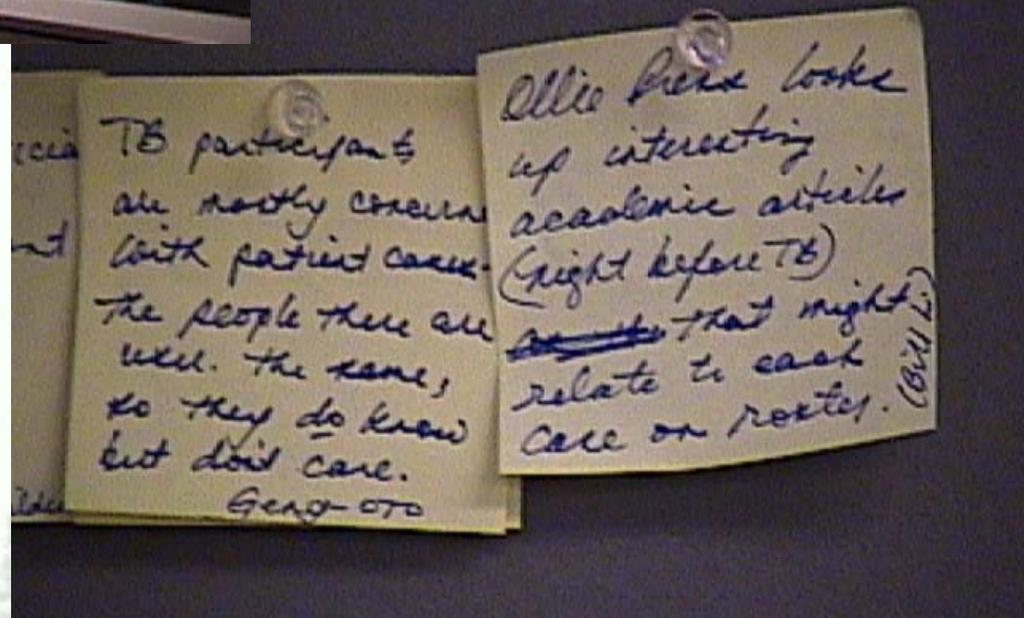
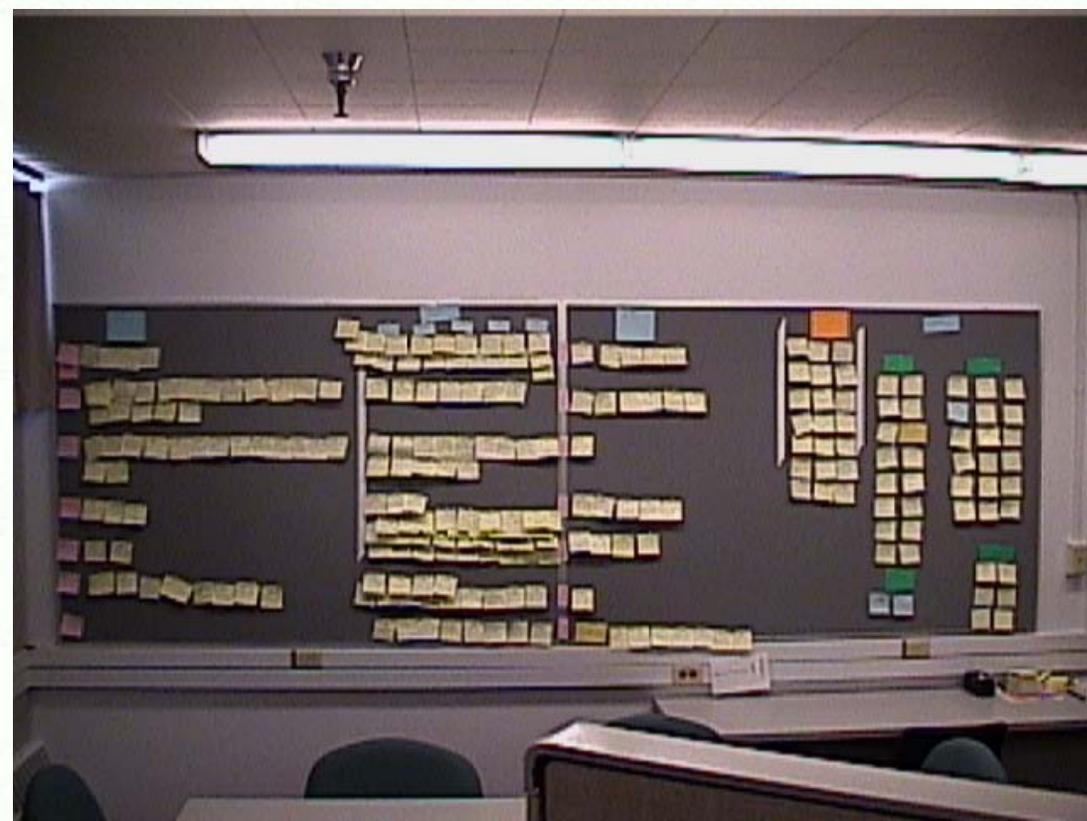


Contextual Inquiry/Design Team

- User-centered design (ethnographic field research methods)
 - Social roles, hierarchy, relationships, interactions, artifacts
 - Information handing/use, views/attitudes towards technology
- 'Unobtrusive' observations
 - Handwritten notes → Sticky notes → Affinity diagrams → Data Wall
 - Videotaping of activities
 - Timeline of activities, Accounted for roles, QDA (NUD*IST)
- Invasive inquiries
 - Interviews with users and technical teams
 - Surveys of participants



“Data Wall”



Two Survey Types

- General participant group ranking (quarterly):
 - Various data sources available in the conferences
 - Reasons and motivations for attending
 - Satisfaction and experience of hardware/software and how they impact their participation
- Studies comparing issues associated with the single and multi-site conferences including:
 - Medical complexity
 - Variety of viewpoints presented
 - Timeliness of information presented
 - Source of pedagogical information



Conference Participant Survey

Conference Participant Survey

HenOne 10/19/01

Demographic Information

Are you (circle one): attending fellow resident medical student nurse

Other (please specify) _____

What is your primary affiliation? (circle one) SCCA FHCRC HMC UWMC Referring/external

What is your subspecialty? (e.g., Medical Oncology, Hematopathology) _____

How many times have you attended this conference before? (circle one) 0 1 2-5 6-20 more

At which site did you attend today's conference? (circle one) SCCA UWMC

Please rank the five most important data sources (1 = most important) for this conference.

- | | |
|--|---|
| _____ Anatomic pathology photos | _____ Journal articles |
| _____ Chart (MINDscape) | _____ Lab values and test results |
| _____ Chart (paper) | _____ Protocols (e.g., SWOG) |
| _____ Clinical pathology (flow cytometry, hematology, including hematopathology) | _____ Radiology images |
| _____ Documentation from referring lab or clinic | _____ Tissue pathology projected slides (excluding hematopathology) |
| _____ Documentation from referring MD | _____ Verbal reports from other caregivers |
| _____ Email printout of summary of case | _____ Verbal reports from patient |
| _____ Group discussion of case | _____ Other (specify) _____ |

Please complete the section below about your reasons to attend.

Reason to attend	1=Very important	2	3	4	5=Not important	does not apply
To present my own patient	1	2	3	4	5	does not apply
To hear about a patient similar to mine	1	2	3	4	5	does not apply
To hear about an unusual case	1	2	3	4	5	does not apply
To discuss my patient informally	1	2	3	4	5	does not apply
To interact with my colleagues	1	2	3	4	5	does not apply
To meet with colleagues from other institutions	1	2	3	4	5	does not apply
To learn	1	2	3	4	5	does not apply
To teach	1	2	3	4	5	does not apply
Other (specify)	1	2	3	4	5	does not apply

Please complete the reverse side.

Conference Participant Survey (second page)

Please circle the most appropriate response.

1. The picture quality of the clinical images (CT, path slides, etc.) for my purpose at this conference was:	Acceptable 1 2 3	Not Acceptable 4 5 does not apply
2. The quality of the video met my communication needs:	Acceptable 1 2 3	Not Acceptable 4 5 does not apply
3. The quality of the audio met my communication needs:	Acceptable 1 2 3	Not Acceptable 4 5 does not apply
4. To what extent did you feel included in the conference?	Acceptable 1 2 3	Not Acceptable 4 5 does not apply
5. To what extent did you feel that the people in the other room were included in the conference?	Acceptable 1 2 3	Not Acceptable 4 5 does not apply
6. Making eye contact with participants in the other room was:	Easy 1 2 3	Impossible 4 5 does not apply
7. I made eye contact with a participant in the other room:	Frequently 1 2 3	Never 4 5 does not apply
8. I was able to understand what was going on in the conference:	All Of The Time 1 2 3	None Of The Time 4 5 does not apply
9A. I made a public comment in today's conference: YES NO	Comfortable 1 2 3	Not Comfortable 4 5 does not apply
9B. Adding comments to today's discussion felt:	Very Likely 1 2 3	Not At All Likely 4 5 does not apply
10. How likely would you be to attend at this site in the future?	Very Likely 1 2 3	Not At All Likely 4 5 does not apply

11. Compared with a conference with everybody in the same room, I felt it was:

Easier to hear the discussion	Neutral	Harder to hear the discussion
1 2 3 4 5	3 4 5	4 5
Easier to follow the discussion	Neutral	Harder to follow the discussion
1 2 3 4 5	3 4 5	4 5
Easier to take part in the discussion	Neutral	Harder to take part in the discussion
1 2 3 4 5	3 4 5	4 5
Harder to get distracted	Neutral	Easier to get distraction
1 2 3 4 5	3 4 5	4 5

12. What would improve your experience of this multi-site conference? (Please comment)

13. How could the audio-visual elements of the conference be improved? (Please comment)

Please return the survey at the conference, or mail to Brent Stewart, 357115

Results – Clinical Practice

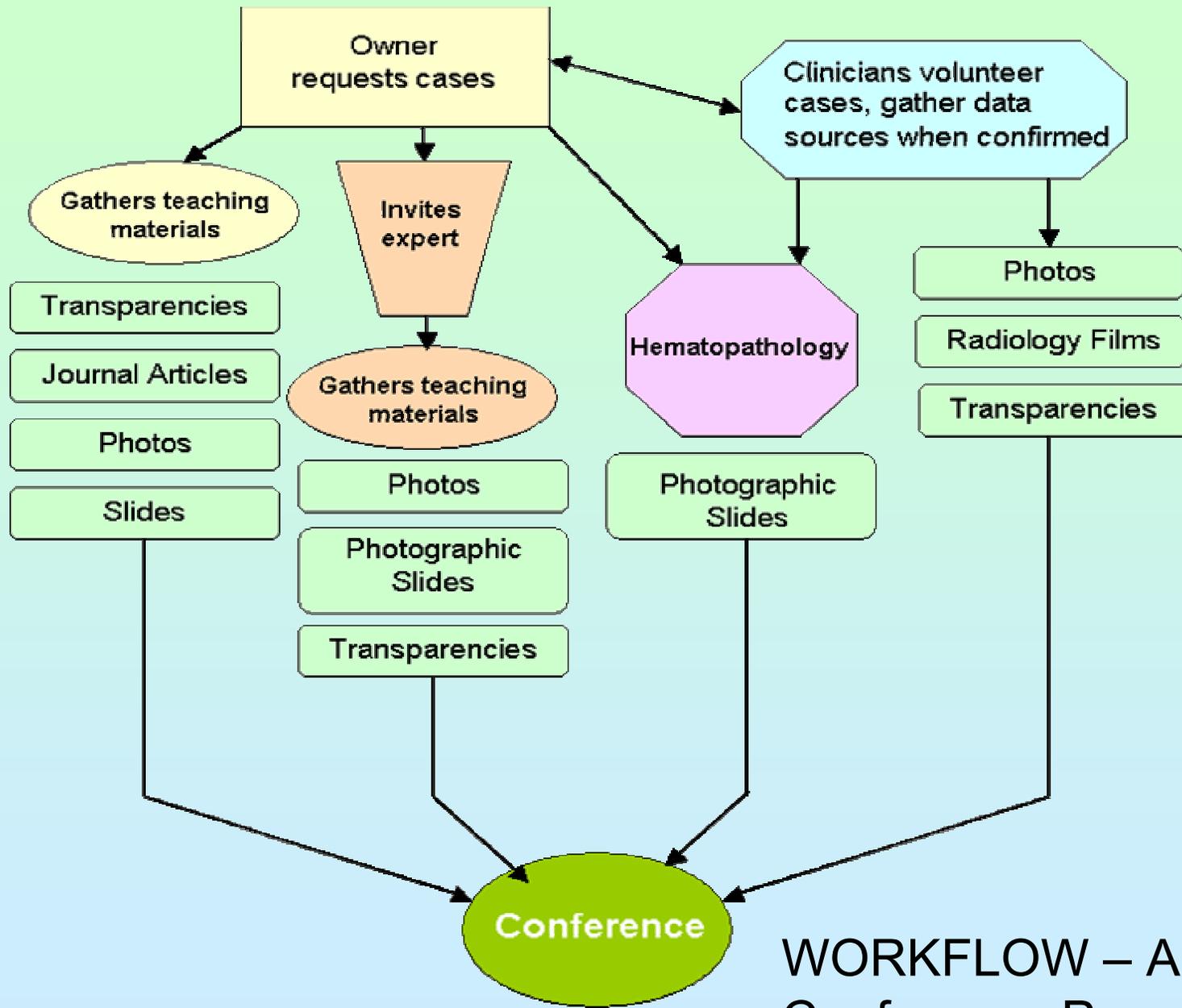
- Hematology Oncology conference became testbed
 - Large number of practitioners at SCCA and UW
 - Timeliness of change
 - Opportunity to use contextual inquiry tools and NGI technology



Workflow of Analog Presentation Before Feb. 2001

- Clinicians identify cases for presentation by Wednesday
- Pathologists obtain slide material
 - Outside cases require 24 hours to get slides
 - If inside case, retrieve slides from files
- Review glass slides and photograph findings on 35mm film
- Develop film – send to photography by 1PM Thursday; film back by 5PM (~4 hours)
- Prepare slides for Friday noon presentation



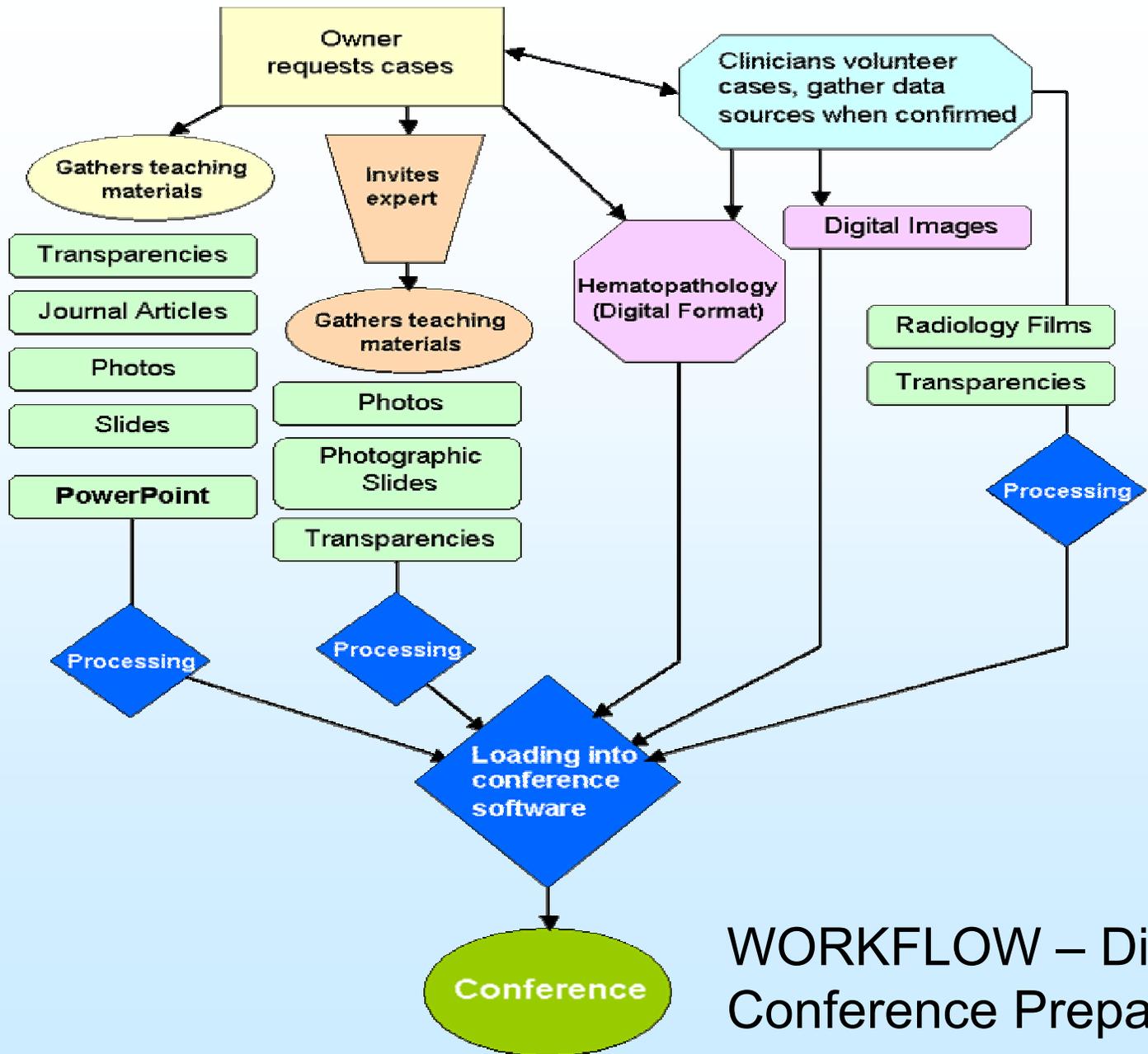


WORKFLOW – Analog Conference Preparation

Digital Conferencing

- Tumor Board software developed to support digital presentation
- Software anticipated “divided” conference
- Early Tumor Board software was labor intensive and added 2-4 hours Thursday eve
 - 35mm slides were digitized and enhanced with Photoshop.
 - Early presentation software was buggy and awkward. Improved through contextual inquiry.





WORKFLOW – Digital Conference Preparation

Digital Microscope

- Digital camera installed May 17, 2001
- Pathology fellows and residents used camera for May 18 conference
 - Little difference in technology
 - Electronic images accepted even though slightly lower quality
 - Immediate feedback on image
- Flow cytometry scattergrams printed and scanned; display poorly otherwise



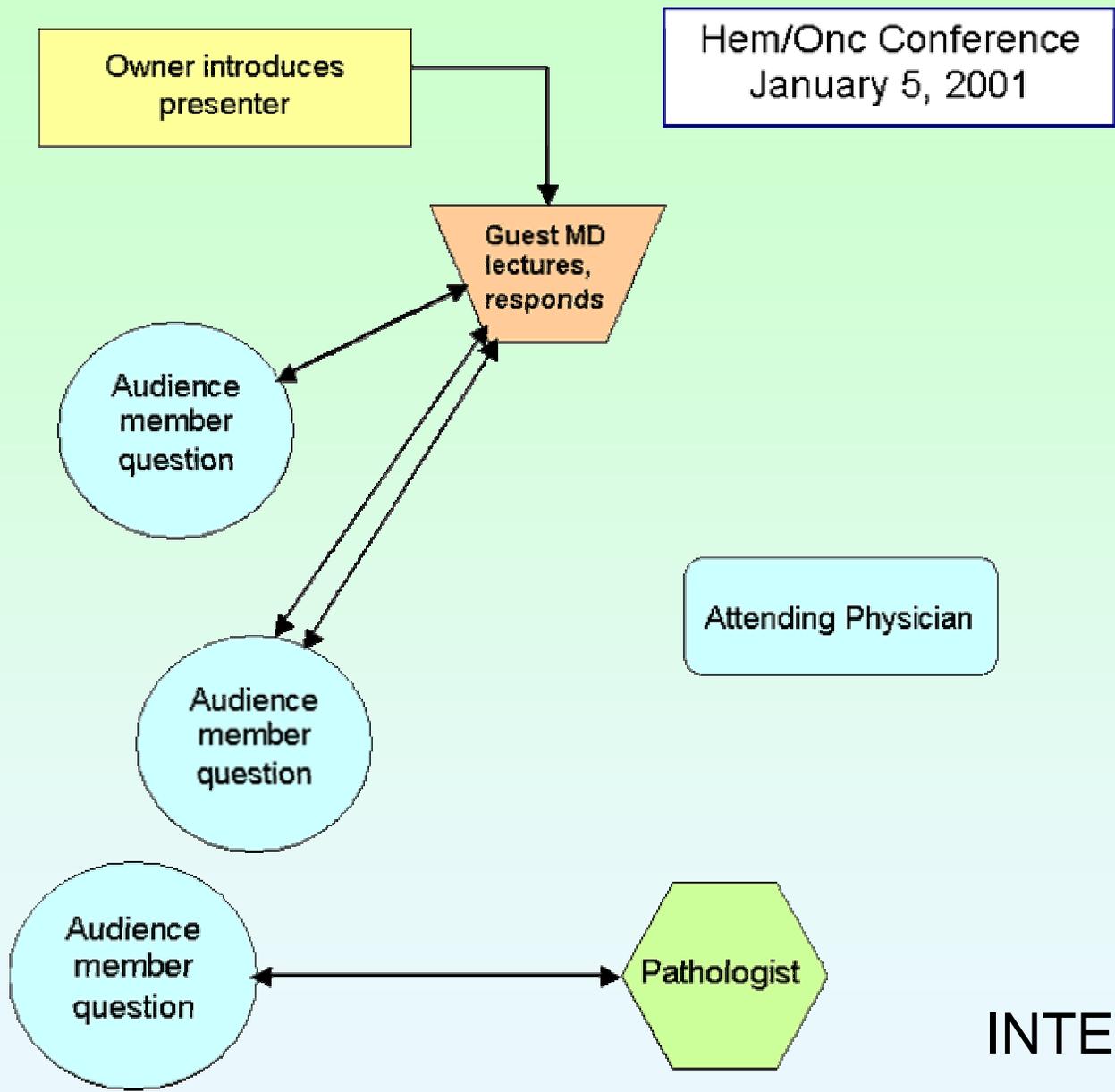
Olympus DP11 Camera + BH2 Microscope



Changes to Conference

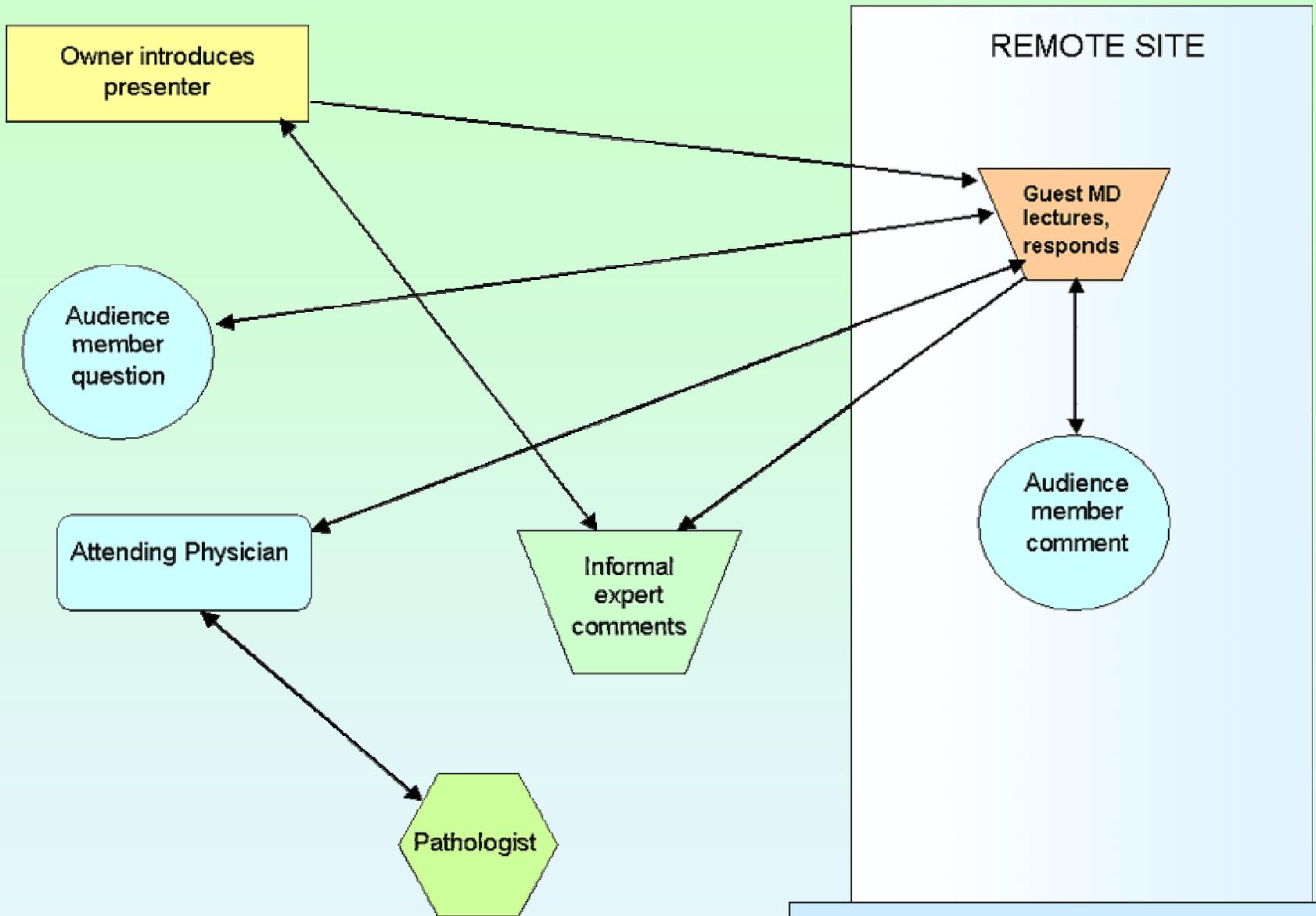
- Negative impacts
 - Digital Tumor Board has speeded up process
 - Early path residents objected to faster pace
 - Decreased preparation time before conference
 - Images often loaded Friday AM before conference
- Positive impacts
 - Digital camera is faster overall
 - Tumor Board software allows presentation review by both presenter and faculty
 - Transition to dual site conference uneventful in March, 2001





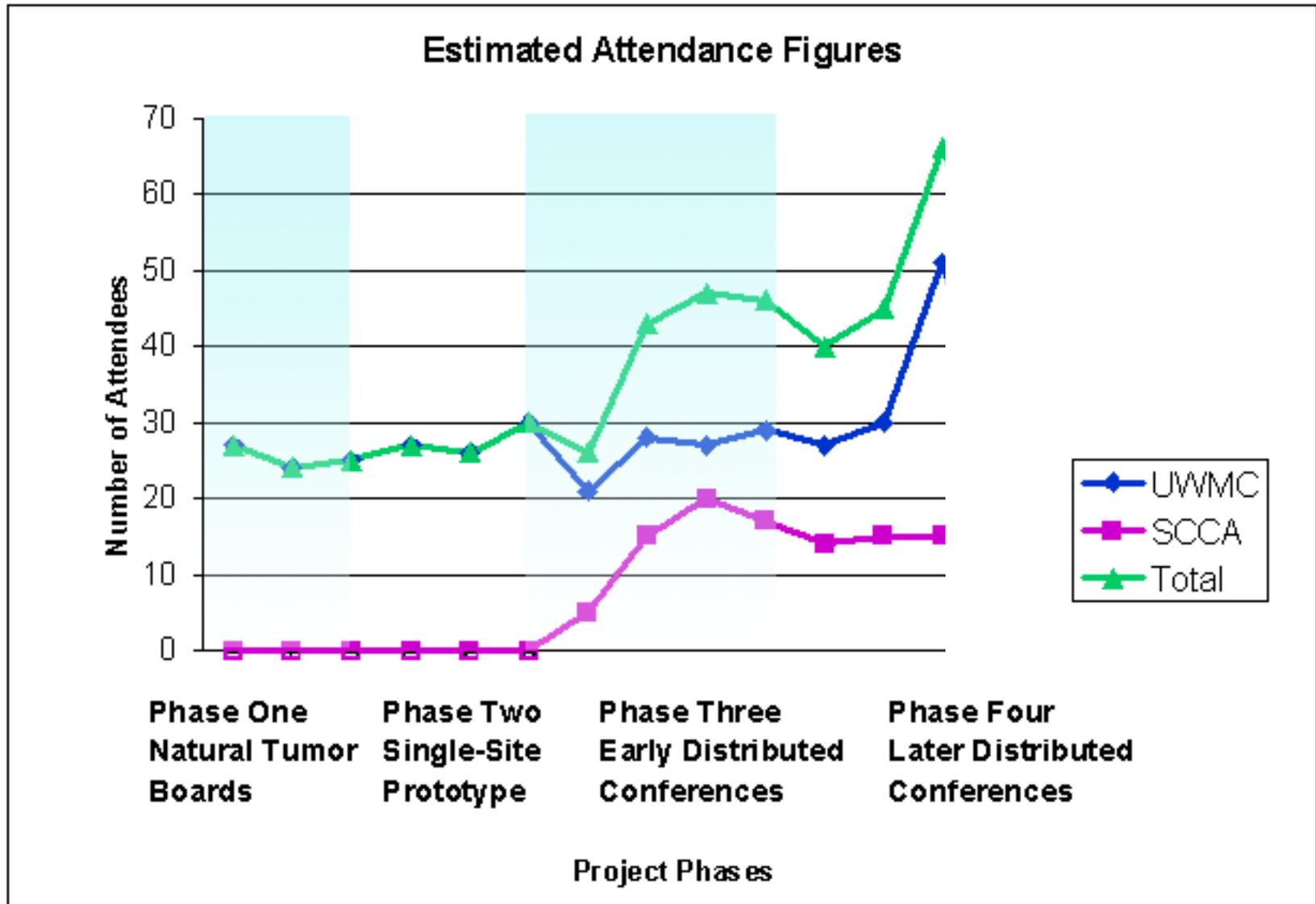
Hem/Onc Conference
January 5, 2001

INTERACTION MAP
Jan/2001



INTERACTION MAP
August 6, 2001

Conference Attendance



Survey Result Analysis (1)

- Results through quarterly surveys administered over a 22 month period:
- Access to Expertise
 - 63% attendees reported that access to transplant-related expert opinion had increased over the course of the study
- Time Saved
 - *Physicians reported an average savings of 1.25 hours commute time per conference*

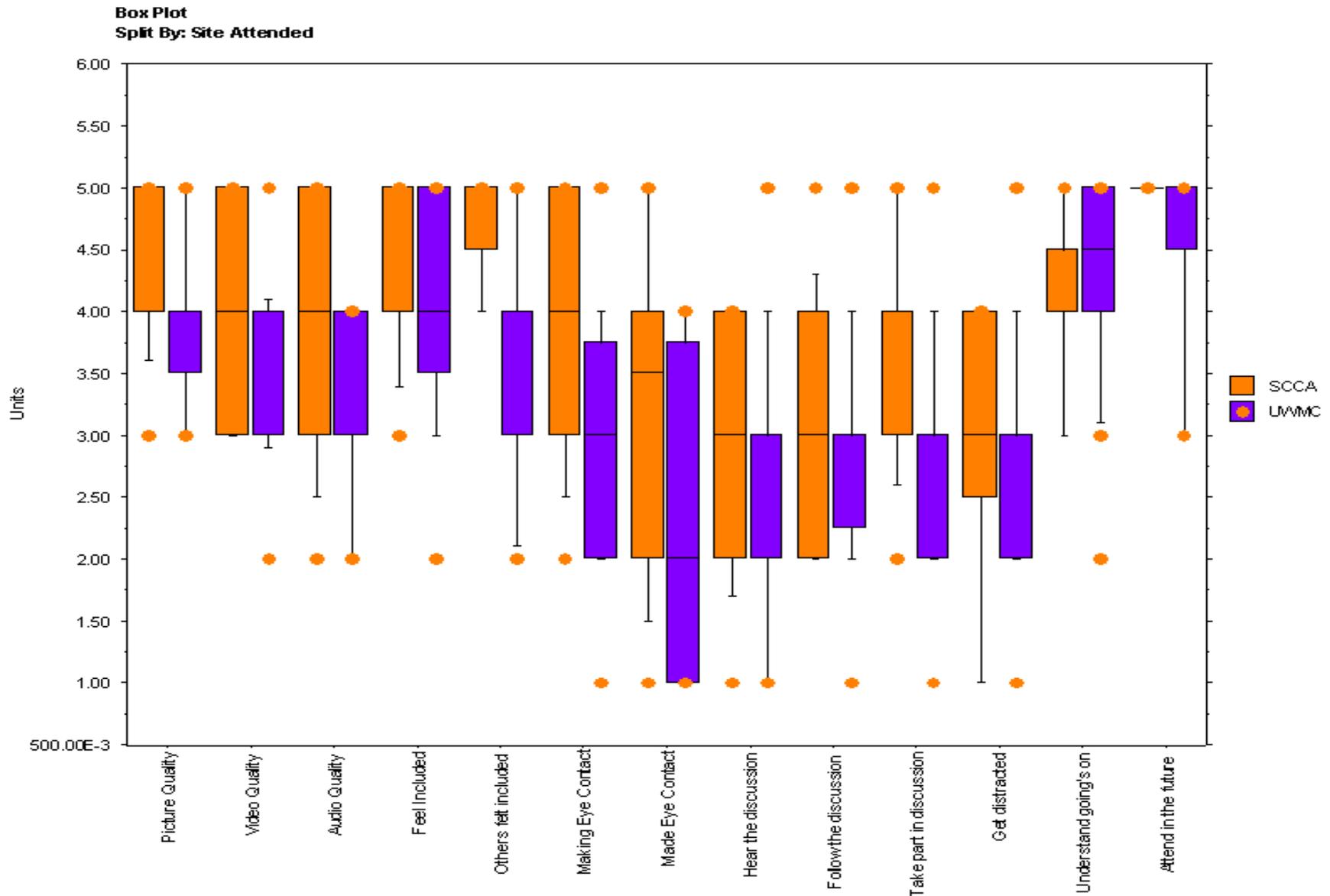


Survey Result Analysis (2)

- Comfort with technology
 - 86% of participants revealed that they were “not at all likely” to travel to the distant site for conference
- Usefulness of information
 - 68% reported that the usefulness of information had increased versus the old single-site format
- Learning something useful for the future
 - 66% reported that such learning was more likely in the multi-site setting
 - 34% reported no qualitative difference between single or multi-site formats



Quality and Telepresence



Transitioning to Users and Staff

- Main Goal: keep developed tools in use beyond end of contract period
- Hematopathology residents, fellows and attendings were quickly trained since July of 2001
- Oncologists run the conferences themselves as of March 2002.
 - Only a few enter their own presentations
 - Facilitated the oncologists to create PPT presentations and load their own materials, including radiographic images
- Several “how-to” Quick Guides and an extensive Users Guide were created
- AV personnel trained in setup and management of system



Transitioning to Users and Staff

- This successful hand-off of the operation and technical aspects of the conference is a prime achievement of the project. The conference has been operational for almost a year without significant changes and minimal support.



Lessons Learned

- Rolling evaluation of the usability, content and utility of the system helps prioritize future enhancements and
- Gradual introduction of new technologies allows users to master each transition towards the targeted design



Corollary A: Technology Must Be Familiar

- We experimented with telepresence objects (whiteboard, augmented reality, virtual reality, etc.). Clinicians reacted negatively.
- Digital microscope readily accepted
- Microphones readily accepted



Corollary B: Making Technology Transparent Is Challenging

- Transition to AV support personnel went well, but requires a “cart”
- Software was rewritten (Fred Brooks Mythical Man Month rule – write one to throw away)
- Nothing is simple about networking
 - 100 mb/s required a direct cable to the switch – via the closet didn’t work.
 - Network device autonegotiations don’t
 - Changes in firewalls, routers and switches
 - MSBlast traffic?
 - The politics of firewalls



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Key Results

- Leverage advanced networking to:
 - Increased conference attendance
 - Experts
 - Learners
 - Avg 1.25 hour time savings (travel)
 - 66%: distributed “learning more likely”
 - Sustainable, with help



Implications

- Methodological developments
 - Application to clinical domain of:
 - Information Artifacts and Channels
 - Iterative Contextual Inquiry
- Impact on tumor board
 - CSCW tools for clinicians
 - Group to group setting



TBIS Demos

- NLM Collaboratory Demo
 - Privacy issues -> “mock conference”
- The “mock” conference consists of two cases, a deidentified composite of multiple, representative, “real” cases
 - A pregnant Native American woman with Stage IV nodular sclerosing Hodgkins disease
 - An Asian-American man with chronic myelogenous leukemia
- Access to the demonstration Web server with cases:
<https://secure.cirg.washington.edu/tb/>



Internet2 Health Sciences Advanced Application Forum - March 2001



8/27/2003

65



Publications (Technical)

- **Web Tools for Distributed Clinical Case Conferencing.** Lober, WB, Li H, Trigg LJ, Stewart BK, Chou D. Proc.AMIA Symp. 2001; 959.
- **Tumor Conferencing Tools for Regional Collaborative Cancer Care Using the Next Generation Internet.** Stewart BK, et. al., Proc. AMIA Symp. 2001; 836.
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Conclusions

- Research Areas
- Expanded Domains



Research Areas

- Reuse of materials
 - Clinical consultation, re-admits, conference review
 - Teaching files
- Expanded Telepresence
- Multipoint
- Multibandwidth Adaptive Delivery



Expanded Domains

- Clinical
 - Case Conference Information System
- Public Health
 - Advanced Collaborative Infrastructure for Public Health Emergency Management (ACIPHER)



Next Steps

- scale NGI to ACIPHER - **Advanced Collaborative Infrastructure for Public Health Emergency Response**
- Extension of NGI to public health disasters
 - Aim 1 – Security infrastructure
 - Aim 2 – Network aware applications
 - Aim 3 – Knowledge model
 - Aim 4 – Tools for presentation and collaboration
 - Aim 5 – Assessment and evaluation



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Fred Hutchinson Cancer Research Center
University of Washington
Children's Hospital & Regional Medical Center

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Questions?

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