The Digital StudyHall

Components
- repository, phttp, EdTV

Workflows
- content capture, homework feedback
- Pedagogy research

Recurring themes
- Any-to-any communication, high bandwidth, sharing, customization, cheap, solve education problems

Principle 1: cost realism
- Schools in Bihar, Madhya Pradesh, Uttar Pradesh, and Rajasthan:
  - 63% leaking roofs
  - 58% no drinking water
  - 89% no functioning toilet
  - 27% no blackboard
  - 8% none of the above
- Weigh the cost of ICT against the above
- Cost realism crucial for scalability
Principle 1: cost realism

- phttp: low-cost network
- EdTV: low-cost networked displays
- Workflows: e.g.: minimize printing
- Cost of “wiring” a village school < $1000
- Cost of “wiring” a child < $5
- (Not included: operational cost)
- Compare this against:
  - Average daily income per person: $1 - $2
  - Not uncommon: a rural family spends 1/5 of income sending one kid to school
  - A village teacher’s daily income: $1 - $4
  - A text book in the village: $0.3

Principle 2: build “systems” that solve problems

- A lot more than connectivity
- “workflows” and pedagogy
- Work with people:
  - Headquarters staff
  - Teacher training institute volunteers
  - Village teachers
  - Students as students
  - Students as teachers
Outline

- Introduction
- The learning eBay
- phttp
- Content capture
- EdTV
- Homework
- Pedagogy
- Other applications
- Conclusions

A “Learning eBay”

- Allows distributed participants to “plug themselves in”
- Matches supply and demand
- Service offerers: both volunteers and professionals
- Flexible time and location commitments by participants
- “Open source” model

- “Out-sourcing” model
- Bridge regional resource differences
- Encourages specialization, fosters efficiency
- Uniform standards and quality
- Lessen public/private school gap?

- A source of helpers: volunteers from a teacher training institute
- Volunteers: exposure to technology and real-life training
- Source of helpers: good higher-grade students
A “Learning eBay”

- Repository accessible via conventional web interface
- Repository accessible via Postmanet-enabled http (phttp)

User-generated Content Management

- Trend: blogs, pictures, video, music, wikis
- Web sites that allow ordinary people to build and share “content:” grass-roots media hybrid

Content Management Systems

- Drupal
- Plone
- Moodle

- Browser-based interface
- Publishing of stories, blogs, multimedia files, etc.
- Hierarchical classification, indexing
- Running polls, forums, downloads
- Collaboration
- Managing users and groups (permissions)
- Administration: customization and maintenance

Repository Implementation

- In the longer run: based on open source content management systems
- With modifications to work on phttp, and
- Potentially education-specific customizations
Recurring theme: any-to-any communication

- Customized content, customized schedule
- Build “systems,” not just providing connectivity

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Low-latency low-bandwidth link

- India cell phone tele-density: 2.5% as of 2003
- Directional 802.11: a tower alone costs $2500
- Our current choice: packet radio (ham radio)
- Pro: range, cost; Con: low bandwidth

Phttp-enabled repository

- Put requests, replies, and server script fragments on DVDs
- Supported operations:
  - Pull, push, send, browse (directory hierarchy), and search

Source: http://smallwonderlabs.com
Difference from offline browser

- Offline browsers
  - Eventual connection, no support for server scripts
- Phttp
  - May never be connected, explicit migration of server script fragments

DVD Robot

- Why DVDs? Capacity, cost, weight, …
- Robot automation

DVD Robot

- Why DVDs? Capacity, cost, weight, …
- Robot automation

phttp: (a) publish

- Mass-produces boot-strap DVDs
- DVDs contain identical metadata plus some scripts
- Minimal manual intervention
**phttp: (b) data reaches a village**

- Data automatically copied from incoming DVD onto local disk
- DVD erased
- No manual intervention beyond DVD insertion

**phttp: (c) village interaction**

- Village staff has access to two views
  - Subset of repository content
  - Locally available content

**phttp: (c) village interaction**

- Locally stashed scripts allow interactions
  - Browse, search, download requests, upload requests
- Requests and data to be uploaded are buffered on local disk

**phttp: (d) data leaves village**

- Requests and data buffered on local disk automatically burned onto previously erase DVD
- No manual intervention beyond removing DVD from the box and handing it to the postman
phttp: (e) data arrives at headquarters

- (1) robot copies data from incoming stack to local disk buffer
- (2) erases stack to form a blank DVD stack

phttp: (a) data leaves headquarters

- Robot generates new outgoing stack of DVDs, using the blank stack and images, generated in previous step
- Outgoing DVDs contain different content

The key is transparency

- What’s wrong with doing phttp manually?
- It’s only 6 villages after all
The key is **transparency**

- Transparency and efficiency needed for:
  - Scale up
  - Handling exceptional events
  - Splitting server scripts

Complement with low-latency network

- Catalog of metadata
- Small requests, acks, NAKs, retransmission requests, etc.

Other phttp servers

- Asynchronous services
- With possible synchronous refinements (google)
- Some service-specific scripts executed at both ends
- Lots of service-neutral infrastructure shared

Recurring theme: any-to-any communication

- Customized content, customized schedule
- High-bandwidth
- Cheap
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Content

- Flash courseware: good, but time- and labor-intensive
- Need to reach “critical mass” quickly or we may never will

Lecture capture

- Replaying captured lectures, by itself, will not suffice, but
- It can be an important part of a bigger solution
- (We will talk about other parts of the solution)

Real-time MPEG4 encoders

- 720x480 (DVD quality), DivX codec
- 30fps generates 1GB/hour
- 5fps generates 250MB/hour
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- 720x480 (DVD quality), DivX codec
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- 5fps generates 250MB/hour

Screen Capture Movie

- 1024x768, DivX codec
- 5fps, 100kbps, 50MB/hour

Still camera: periodic shutter release

- 2048x1360
- 6 seconds per frame, 180MB/hour

Processing

- Passive capturing
- Modest post-processing
  - Breaking down into coarse-grained snippets
  - Annotation
  - Potential aid by lecturer during lecturing
- Staging lectures for captures
  - In Hindi
  - Volunteers from the teacher training institute
Mix and match snippets

- Simple editor that makes “super objects” out of sub-segments of existing objects

Other content

- Homework and feedback (more later)
- Asynchronous question and answer sessions
- Student-authored content
- Contributions from elsewhere
- Multiple centers of content accumulation
  - A peer-to-peer architecture of the repository

Recurring Theme: any-to-any communication

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The display problem

- Additional computer displays
- Projectors
- Expense and power consumption

EdTV components ("output")

- Graphics card with RCA/S-Video output
- Small TV signal transmitter
- A 12-inch TV set burns 20W

EdTV ("output")

- Graphics card with RCA/S-Video output
- Small TV signal transmitter
- A 12-inch TV set burns 20W
EdTV (“output”)

- Extra graphics cards, sound cards, and transmitters for extra channels

EdTV leaving the classroom

- Kids work during the day
- (50% attendance during mango-picking season)
- Customize EdTV schedule: catch up at nights
### EdTV leaving the classroom

| “Same Language Subtitling”  
| Literacy skills of “early literates” low  
| Builds on people’s existing knowledge of lyrics: anticipate subtitles and read along, inherent repetitions help  
| General idea of leveraging popular culture  

| Song and dance by school children  
| “Same Language Subtitling”  
| Helps illiterate (or semi-literate) parents to learn  
| Why would this be engaging?  
| A “holistic” education to raise kids’ enthusiasm for schools  
| Parents’ enthusiasm of seeing their own kids on EdTV  
| Kids’ intrinsic desire to perform  
| Competition and prize to further raise interest (“village idol”)  
| Village-customized, as opposed to national TV  
| Other “applications” later…  

### EdTV is not TV

| TVs have a bad reputation as an education tool  
| TVs are “mass media devices”  
| Small number of content producers  
| Massive number of passive content consumers  
| One-way: no interaction  
| Computer displays: “personal media devices”  
| Any-to-any communication  
| Content production: freedom of who, what, when  
| EdTV: a compromise in between  
| Much closer to the “personal device” end  
| Village-, teacher-, and student-specific customization  

| Consider example:  
| Song and dance by school children  
| “Same Language Subtitling”  
| Helps illiterate (or semi-literate) parents to learn  
| Villagers can’t put their kids on national TV  
| But they can be on EdTV  

EdTV is not WebTV

- Similar parts of the philosophy:
  - Leverage large install base of legacy devices
  - Leverage familiar usage metaphor
  - Introduce new applications and services
  - Keep cost down
- Different:
  - EdTV not as personal as WebTV
  - Not meant for the same kinds of applications

EdTVs are not kiosks

- Similar part of philosophy:
  - Aggregate demand
- EdTV advantages:
  - Access from the convenience of homes
    - Open a portal, or bring a face, into a poor household, for new applications and services
    - Will speculate on some later
  - Sharing
- EdTV disadvantage:
  - No privacy
  - But even that could be a plus...

Architecture for demand aggregation

- Bottom tier: cheap, pervasive, specialized, simple, familiar metaphor plus new services
- Middle tier: shared, more expensive, more general, more capable, expendable data
- Top tier: professionally managed, “ultimate truth” of data
Extending EdTV range

- Used VCRs, balloons, directional 802.11, ...

EdTV “input” devices

- A ham “remote”: a simple transmitter that emits several command signals: a couple bucks
- Same ham receiver at base-station that handles both:
  - Input from ham remote, and
  - Input from long-distance communication with headquarters
- TV and radio control signals: ways of bridging the last mile

EdTV “input” devices

- Walkie talkies, microphone, voice recognition
- Use Hindi
- Paid $20 for the pair but can do better

EdTV “input” devices

- Walkie talkies, microphone, voice recognition
- Use Hindi
- Paid $10 apiece but can do much better
Low-tech “input” devices

- Replace voice recognition with human “operator” (a DJ)
- Determine local EdTV schedule at a “town hall” meeting

The Kothmale Community Radio (Sri Lanka)

- Locals request information
- Radio “DJs” browse the net
- Does translation
- Broadcasts in daily program
- Provides printouts

EdRadio

- Radios even more pervasive
- Direct computer-to-air (can be without Kothmale human operator)
- Customized local content: songs sung in schools, teaching English, recordings of “town hall meetings,” kids being “DJs for the day,” text-to-voice of content relevant to locals, …

Recurring theme:
any-to-any communication

- Customized content, customized schedule
- High bandwidth
- Build “systems,” not just providing connectivity
- Cheap
Goal: start schools where there's none

- Assume minimum staff expertise beyond operating equipment
- Minimum interaction needed: homework graded by outside staff

Obvious solution too expensive

- Village
  - Scan homework in
  - Transmit to headquarters
- Headquarters
  - Print it out
  - Grade it on paper
  - Scan it
  - Transmit back to villages
- Village
  - Print it out
- Problems
  - Expensive computer papers
  - Expensive printer cartridges
  - Some printing ok, but not massive amount of printing

The homework workflow (1): digitizing

- Camera instead of scanner: speed, versatility, portability, simple power requirements
- Microphone: digitize voice questions
- Webcam: video for a personal touch, not strictly necessary
The homework workflow (1): digitizing

- Scribble homework on paper as kids used to
- (cheap papers available)
- Decent resolution

The homework workflow (2): transmission

- Phttp ideal for this purpose:
  - Homework intrinsically asynchronous
  - Large bandwidth, virtually free: good for rich media

The homework workflow (3): grading

- Step 3A: download submissions

- Step 3B: Batch image editing software + tablet pen
The homework workflow (3): grading

- Step 3B: Batch image editing software + tablet pen

- Step 3C: produce a feedback video with screen capture
  - "Collective" feedback
  - Individualized feedback
  - Both types are customized
  - Voice annotation optional: can automatically produce voice-less video

- Step 3D: upload feedback, push to villages
The homework workflow (4): feedback

- Collective feedback played to all students on EdTV in classroom
- Use it to instigate group learning
- Individualized feedback “scheduled” at convenient times on EdTV
  - In-classroom, or even during evenings
  - Pause, rewind, zoom, etc. might prove useful
  - Review graded raw images if necessary
- Showcases customized content/control of EdTV

Possibly complemented by:
- Some amount of printing
- Standardized “answer books” prepared ahead of time (also printed on cheap papers)
- Combine low-tech and high-tech

Implications (1): better experience

- Not only comparable to what urban kids receive,
- But also better than existing homework feedback experience: more personal, richer
- Same workflow useful for less structured question/answer sessions

Implications (2): content reuse

- Permanent storage, reuse, and sharing of prior interactions
Implications (2): content reuse

- Two kinds of interactions:
  - **Instant feedback, but not specific**
  - **Specific feedback, but not instantaneous**

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- **Pedagogy**
- Other applications
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Two different questions

- Given a reasonably competent teacher, can any technology better a blackboard?
- Where there’s no teacher at all, how do you make the most out of what you have?

TVs as an education tool

- Early promise of TVs as an education tool
- Subsequent results mixed
- Conventional TVs: inflexible---not good at capitalizing unexpected, unplanned opportunities
- Characteristic weakness of television:
  - Lack of personal interaction
  - Does not adjust to individual differences
  - Tends to encourage a passive form of learning
- Difference between “mass media” and “personal media:” a theme of this class

“Tutored Videotape Instruction”

- Education research shows effectiveness of:
  - Fostering interpersonal discourse,
  - Social construction of knowledge.
  - Better than broadcast of information
- Common sense behind TVI (1970s)
  - Lectures provide depth and continuity
  - Discussions make lectures respond to individual needs and differences
• Stanford -> Santa Rosa plant of HP
• Minimally edited videos of unrehearsal lectures
  – Easy to make

“Tutor” job:
– Initiate and encourage stopping the videotape for discussions
– Rely on dynamic interaction to stimulate intrinsic interest
– Interfacing with on-campus instructor

TVI details:
homework and exams

• Students required to complete the same homework
• Homework returned to Stanford in about 1 week
• Graded by the same teaching assistant
• Required to come to the campus to take the same exams

TVI: tutor qualifications

• Important:
  – Sensitive to students
  – Ability to draw them into fruitful discussions
  – Interest in helping students
  – Personal interest in the subject
  – Some competence
  – Compensation
  – Being a good liaison with the “parent” school

• Not important
  – Recent exposure to the course
  – Good performance in the course
• Tutors shouldn’t be in a position of authority
TVI details

- Group size: 3-10 optimal
- Some training for teachers and tutors
- Unrehearsed, unedited video tapes have advantages, compared to scripted content
  - Also showed disadvantages in later experiences
- Need to take care of administrative details in a timely fashion

TVI results

- Caveat: data do not yet permit a rigorous statistical test

**TVI results**

**TVI results**

- Hawthorne effect
  - Later experiences suggest that a Hawthorne effect was present for about 5 weeks, 1/3 – ½ of a term
  - The superior TVI performance consistent for many years
- Data do not yet permit a rigorous statistical test
- Can’t generalize to subject areas other than engineering and science
- Further extended to include plants in San Diego and Albuquerque

- TVI students drawn from the same population as the other non-campus students
Analysis of TVI

- “Information transfer” metaphor being supplanted by “constructivism”
- Public conjecture and feedback from others help refine ideas, often via controversy
- Acts of articulation encourage formation of conceptual framework
- Formation of positive group dynamic: encouragement, tutoring, sharing, communication and team skills
- Increased level of attention and motivation

Conclusions

- Although not sufficient by themselves, captured lectures are a good foundation
- Instigating interaction can significantly enhance effectiveness
- Successful instigation can be effected with relatively simple means
- Group learning can play a key role
- TVI draws on the substantial (if latent) interest in tutoring

Ambition

- What’s the ultimate scalability bottleneck of the Digital StudyHall?
  - Not computers
  - Not bandwidth
  - Probably not even money (to some extent)
  - It’s the skilled man power!
- Ultimate ambition:
  - To turn every kid into both a teacher and a student
  - The ultimate peer-to-peer system!

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DTVI

- DTVI: connecting TVI participants virtually
- Study involving 700 university students
- DTVI as good as TVI

TVI at UW

- Intro CS classes at UW -> community colleges
- Community colleges assign grades and grant credit
- Windows Media Player showing Powerpoint slides plus a small video window of the instructor

UW: assignments

- Centralized grading model, using emails
- Pros
  - Want the model to work at places where there's no staff support (not the case)
  - Economy of scale
  - Uniform standards
  - TVI model: tutors shouldn't have grading authority
  - Instructors initially happy
- Cons
  - Instructors already had authority
  - Significant delays
  - Grading problems (misgraded problems, delays) magnified
  - Hard to recruit TAs
  - Students become resentful
  - Instructors don't have a feel for student performance
- Stanford vs. UW: who assigns grades and credits

Homework for us

- Bigger difference
  - UW: community college graders vs. UW graders
  - New village schools: no grader vs. Lucknow graders
  - Necessity vs. luxury: lower bar to pass
- Significantly richer feedback experience
  - Not just feedback from a different place, but better feedback
- Homework feedback becomes part of the interaction instigation process
- Nevertheless, need to be sensitive to the UW homework issues
**Things that piss people off**

- Excellent negative experiences, BTW!
- Bottom line: many many factors that can affect the effectiveness!
  - Be careful when assigning blame
- Time pressure: 3 hrs → 4.5 hrs
- Instructor mannerism
- Tutor effectiveness
- Errors and delays in homework grading
- Less live assistance
- Perception and expectation
  - The “opposite” of Hawthorne effect: 2nd class citizens

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**TVI and StudyHall**

- Challenges:
  - Different audience
  - Different subjects
  - Unstructured “discussion” may not work
- Resources:
  - Digital technologies beyond pause-and-resume
  - Skilled and cooperative headquarters staff
  - A digital repository that “remembers everything”
  - Village staff of varying levels of skills

**Example types of instigations for the StudyHall**

- A 5-minute in-class quiz
  - Conducted in headquarters lectures
  - Graded and feedback provided on the spot
  - All captured and replayed
  - Same quiz administered in villages
- Homework feedback (in rich media, as discussed earlier) integrated into regular lectures
- Village staff as “pattern recognizers” in a “program”
Interactions in StudyHall

- Encourage students to help students
- Harvest “leaders”
  - But be careful not to produce consistently passive followers
- Harvest upperclassmen
- Communication between urban and rural students
- Foster positive group dynamic
- Encourage social, artistic, entertainment exchanges

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How people learn: the three key principles

- Consider pre-existing models of thinking
- Frequent formative assessments
- Address deeper conceptual frameworks, not just facts

Disconnect between research and practice

- Research: not always in realistic settings
- Practice: teachers, parents, administrators, policy-setters, have their own obligations
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<thead>
<tr>
<th>&quot;Committee&quot; recommendations</th>
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<tbody>
<tr>
<td>• Conduct research in teams that combine researchers and practitioners</td>
<td>• Development and maintenance of an interactive communications site</td>
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<tr>
<td>• Video-taped model lessons</td>
<td>– Provides information about design principles of effective curricula</td>
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<td>– Evaluate video-taped model lessons</td>
<td>– Submit video-taped lessons. Evaluate in terms of the principles of learning</td>
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<td>– Understand group processes</td>
<td>– Comprehensive evaluation process, not just rank-order of curricula</td>
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<td>– Use them as “anchors” for teacher training</td>
<td>– Connect the site to teacher training colleges</td>
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<td>• Provides support, feedback, and an opportunity for discussion</td>
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<td>• Partnerships (and people relationships)</td>
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<td>– Develop ongoing relationships between “labs” and a student body</td>
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<td>• Aided by the use of a videotaped record</td>
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<td>– Investigate the potential benefits of collaborative learning, and understand its potential</td>
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<td>drawbacks</td>
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<td></td>
<td>– Invite teachers to think of themselves as scientists</td>
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<td>– Involve parents and other community stakeholders</td>
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<td>– Influence local governments</td>
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<td>– Influence the media and the public</td>
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<td>• Initial stage: grants and donations</td>
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<td>• An “open source” model</td>
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<td>• Turning over the operation to local entities</td>
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<td>• “Cross-subsidize” with synergistic for-profit applications</td>
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The “Health Care eBay”

- Similar challenges as faced by education
  - Lack of trained professionals in rural areas
  - Stark tradeoff of how to spend resources
  - Bill Gates: “poor people need medicine and not computers.”
  - Not necessarily a zero-sum game: value of early care
- A health care eBay, similar to the learning eBay metaphor
  - More of an information delivery mechanism initially
  - Problem with means such as pamphlets: lack of interaction and pinpoint relevance
  - Combine asynchronous and synchronous interactions

Precedents and What’s New

- Existing remote diagnosis systems and emailing doctors
- Pervasive communication mechanism
- Cheap and high-bandwidth
- A globally accessible “clearinghouse” that matches “supplies” and “demands”

Potential advantages

- Harvest “fine-grained” volunteerism (potentially from overseas)
- A good browse and search interface for prioritizing, organizing, and improving efficiency
- Easy access to early care can reduce the cost of the health care system
  - Due to extreme pervasiveness of a communication mechanism
A voice mail application

- The poor spends disproportionately more on communication
- Variations of voice/email have always proven compelling
- What we do: turn your TV into a voice mail phone

A voice mail application

- Use a walkie talkie to “activate” a recording mode
- Have what is spoken captured verbatim
- The bits go out on one of the radio or postal links
- Incoming voice played over TV

A voice mail application

- With EdTV: convenience, without: privacy
- With Postmanet: cheap, pervasive, infinite bandwidth, With radio: low latency
- The repository abstraction: easy to build the app

A shopping application

- An example shared EdTV experience
- A human “DJ” surfs a shopping site
- Villagers jot down desired transactions using paper and pencil
- Next day: villagers hand the papers to the DJ, who performs data entry

The Digital StudyHall
A shopping application

- Information “hookup” prior to exchanges of physical goods and services
- Can be done by a third-party transporter

Shopping: EdTV is not TV

- Regionally customized content
- Requires no infrastructural support:
  - No phone, no conventional network, no cooperation with existing TV stations

Shopping: EdTVs are not kiosks

- Convenience: Couch potatoes, not “kiosk” potatoes
- Postmanet: cheap and improved experience due to high bandwidth, appropriately asynchronous
- Shared experience

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The “big picture”

- Components: repository, phttp, EdTV
- “Workflows:” content capture, homework feedback
- Pedagogy research

Synergy: phttp + repository

- A simple distributed file system analogy
- Generic abstraction that can support all manners of shared applications (without a conventional network)

- A network analogy: a “network with memory”
- Why not direct peer-to-peer transfer between villages?
Synergy: phttp + repository

- A simple distributed file system analogy
- A network analogy: a “network with memory”
- Why not direct peer-to-peer transfer between villages?

Synergy: phttp + EdTV

- A natural two-hop “network”
- The phttp “hop”: pervasive, high-bandwidth, cheap, asynchronous
- The EdTV “hop”: cheap end devices, bridging last mile

Synergy: phttp + EdTV

- A natural two-hop “network”
- The phttp “hop”: pervasive, high-bandwidth, cheap, asynchronous
- The EdTV “hop”: cheap end devices, bridging last mile

Synergy: repository + EdTV

- The repository abstraction makes it easy to build shared EdTV applications, like voice mail
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Recurring themes

- Any-to-any communication, high bandwidth, sharing, customization, cheap, solve education problems