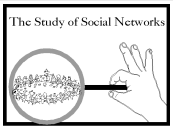
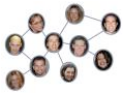
Social Networks & Arrays of Sensors
(selected topics)

March 20, 2007
Larry Rudolph

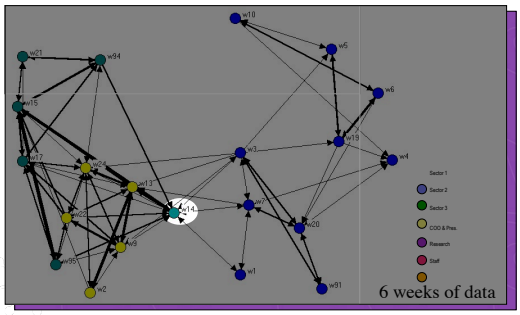
Social Networks



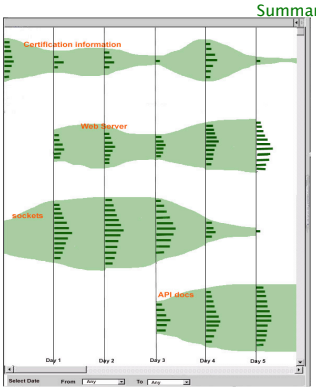
- **How does information flow in an organization**
  - Email logs (edge from sender to receiver)
  - Forums (edge from responder to requester)
  - Telephone logs
  - Anonymize the logs
- **Patterns in static or dynamic graph**
  - We can distinguish
    - *production mode (tree-like exchanges)*
    - *innovative mode (power-law static; oscillation in dynamic graph)*



Real communications cluster by category and by geography



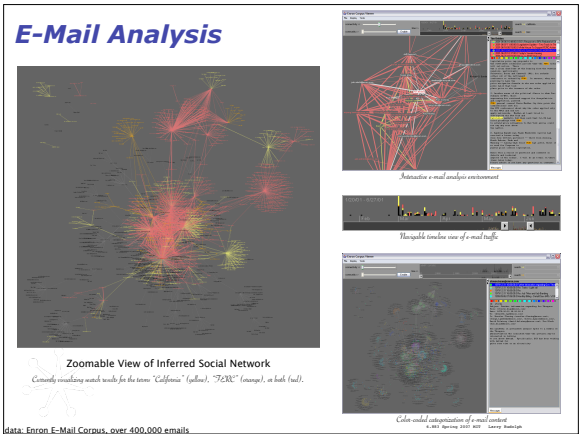
Content Summary



- The x-axis represents time
- Categories generated by the SOM are laid vertically
- Each green bar represents one message
- The thickness of each sub-topic indicates its activity on particular day
- The length in the x-dimension of each sub-topic = time duration of that sub-topic

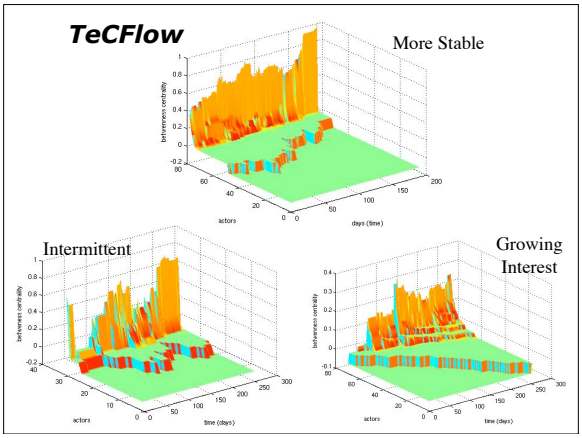
Visual Effects:

- Thickness = how active a subtopic is
- Length in x-dimension = the time duration of a sub-topic



One "success story" is our use of our visualization of the Enron e-mail corpus to flag Tim Belden as an Enron employee who should be investigated more carefully. We subsequently learned that he was arrested and convicted for manipulating California's energy market. More details on the analysis process here are available at http://jheer.org/enron/v1/. http://jheer.org/enron/v2/

Version 2 of the enron corpus viewer (formerly known as "enronic") introduces a stablized layout, temporal filtering, and multiple keyword search. A multiscale histogram timeline displays the distribution of e-mails over time, and an interactive time axis and range slider allow for the selection of specific time ranges. The slider window can then be dragged across time to view network dynamics at the desired granularity. Keyword searches highlight matching nodes and edges. Independent searches can be run simultaneously. The current design uses additive colors (e.g. yellow + orange = red) to present intersecting search hits. Furthermore, search hits also highlight in both the time histogram and the message viewer. Finally, though it noticeably slows down the total rendering speed, this design experiments with anti-aliasing to make for more readable and pleasing displays. In particular, it allows for a much more sensitive reading of the categorization pie charts when in a fully zoomed-out state.

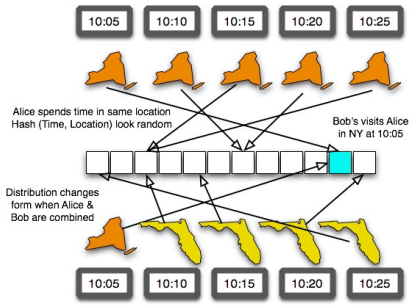


Face-to-face Information Flow

- Capture physical interactions
- Infrastructure & Privacy Challenges
  - Bluetooth beacons throughout environment
  - Cell phone knows its location from beacon
  - Easy to deploy ($30+AC outlet per beacon)

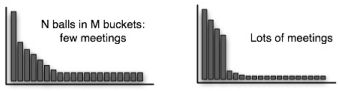
Privacy Concerns

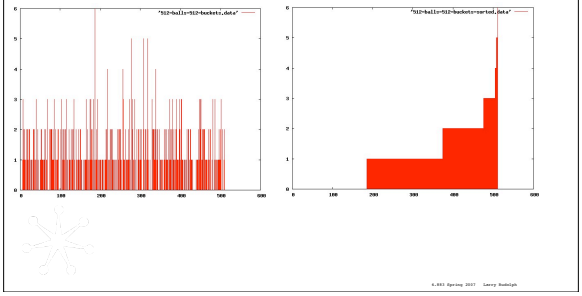
- People do not like to be tracked
  - Cannot tell if Alice spends times in Bob's office
- Phone records location every k minutes
- Universal hash of (time, location)
  - Appears like a sequence of random numbers
  - Distributed according to "n balls in m buckets"
- Server periodically gets sequence from phone
  - People at same place / same time
  - Can infer many meeting patterns from distribution
  - Cannot infer actions of any individual!

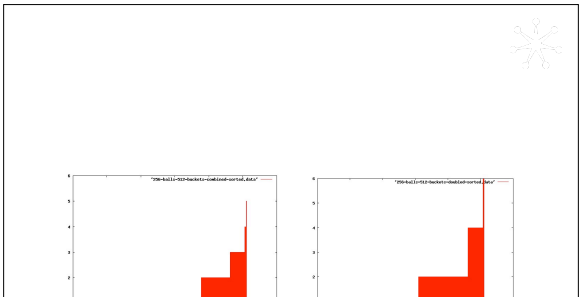


Physical Location Tracking

- Information vs Privacy Tradeoff
  - Probabilistic pattern of interactions, no individual information can be determined
  - Different hash functions (under phone control) can leak some individual location information
- Can be used to verify other data sets inferences
  - E.g. hours worked from email logs
- Infer lots from how patterns change over time




"512-ball1-512-bucket1.data"
"512-ball1-512-bucket1-sorted.data"


"256-ball1-512-bucket1-combined-sorted.data"
"256-ball1-512-bucket1-doubled-sorted.data"

Dangerous Idea: box
Safe Idea: cylinder
or
Wand = User Interface

Harry Potter's digital wand
Larry Rudolph

Good use for Boxes

- A box is a good shape for storage
  - people
  - shoes
  - circuit boards

Poor use for boxes

- hard to hold a box
- fingers like to curl

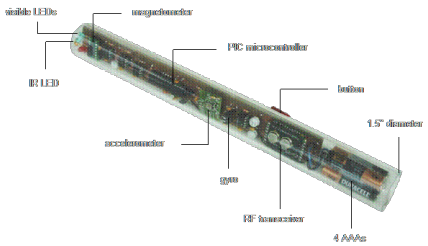
Mobile Device Form

- Wand, stick, staff, cylinder
  - Gandalf's Staff
  - Harry Potter's Wand
  - James Bond's Pen

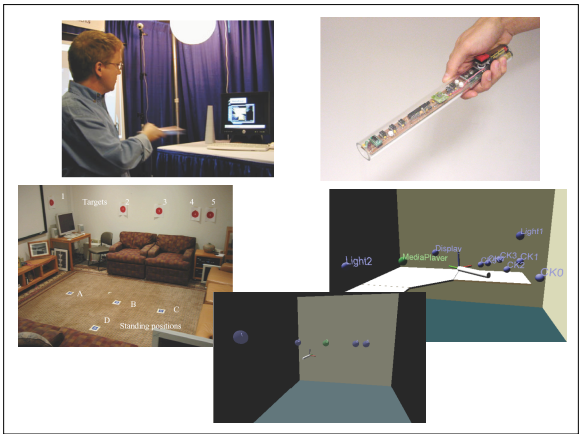
The computer science of Harry's wand

- **Point it at something, then shout some Latin-like command**
  - Location, Object, Speech recognition
    - *camera, microphone, ghost sensors*
- **Torch, Zapping, Images**
  - lasers and electricity

XWand



- Andrew Wilson (Microsoft Research)
- UI for Intelligent Spaces



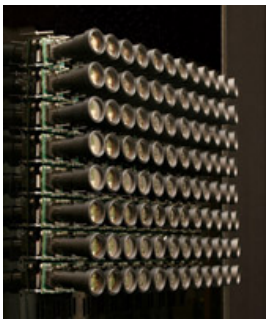
Critique of XWand

- Need to be in an immersive, instrumented space
- Does not work everywhere, e.g. on trains such as the "hogwarts express"
- Why not simply use a hand with better camera tracking algorithms?

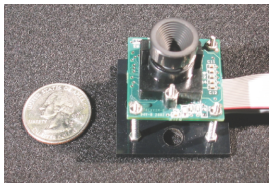
Bring your own environment

- Environment should have lots of
  - input sensors
  - output actuators
- Cylinders are nice form factors for arrays of sensors & actuators

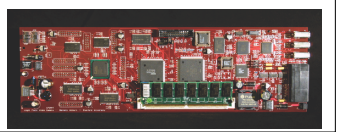
Camera Arrays



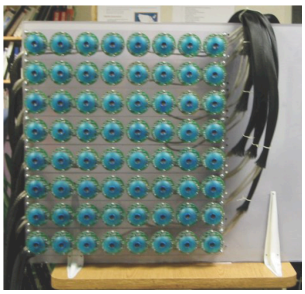
Camera Array



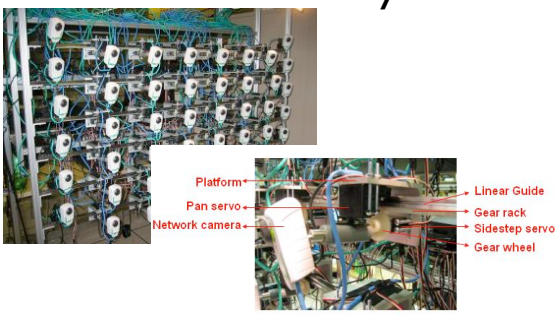
- Camera's are small, say 1 square inch
  - a dozen per foot
- Processing: if we wait .. will be ok



We have (had) one too



Self-reconfigurable Camera Array

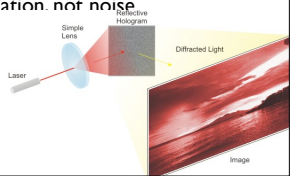


Array of projectors

- Need small ones
- Need ones with low power
- Lasers!

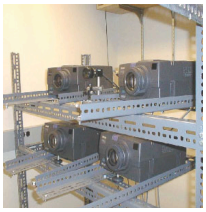
Display Holograms

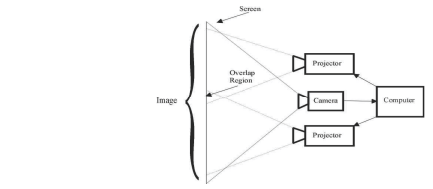
- Blue-Optics (start up)
- laser, lens, hologram on chip
- key insight, reduce noise variation, not noise
- array output?

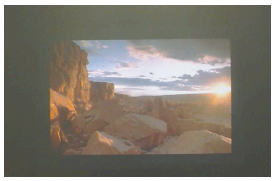


Scalable self-calibrating display technology for seamless large-scale displays

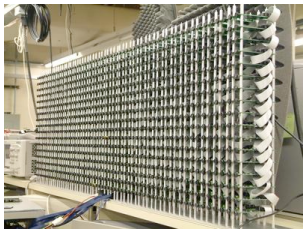
- MIT thesis by Rajeev Surati (under TK)
- Projector array
- Self-calibration via camera







Microphone Array



- < camera
- CSAIL & others
- Need fixed, large spacing
- Virtual microphone(s) placed anywhere

Speaker Array

- Virtual sound placed anywhere
- Many for personal use
  - home theater
- Yamaha (CES'05)
  - 42 speakers

Laser Array

- LIDAR (laser array accurately detect objects in front of autonomous car)
- Laser's within all pointing forward. Mirror defects then outward -- hologram Lens have them all forward focused
- Parallel communication
  - My favorite: two ships passing at sea

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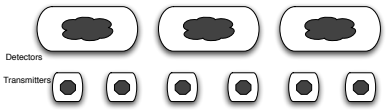

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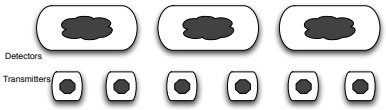
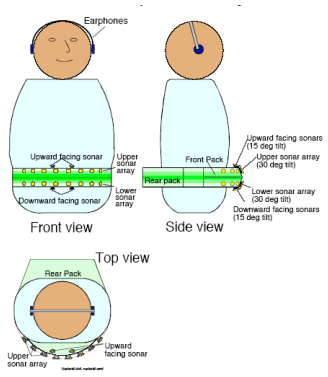


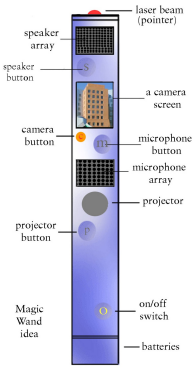
Sonar Array

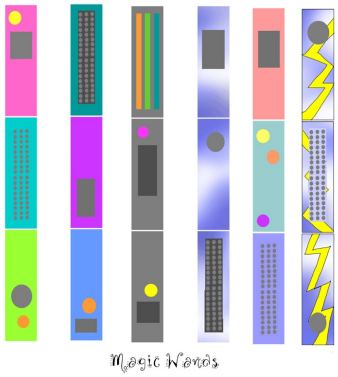
- Multi-sensor travel aid for the blind (Borenstein)



But it all together

- Sally O'Lee's visualization initial view





If I had a cylinder, I'd ...

- Talk long distances wirelessly
- Burn through walls with laser's
- Shock my enemies with static elect.
- Wave it around in a field to recharge
- Play DDR by opening it up & lay flat for 2-d array

Dimensions

- Size:
  - Pen (is there enough spread?)
  - Wand (will it get too hot?)
  - Staff (my choice; interleaved spiral arrays)

Discussion

- Please attack my 1/2 baked proposal
- Would like to form study group
  - array sizes (optimal numbers)
  - processing needs
  - heat & power requirements
  - can we build a prototype?
- Maybe transform mouses into mice?