

Designing an Architecture for Delivering Mobile Information Services to the Rural Developing World



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The Rural Developing World

4.8B people live in developing countries (many in rural areas)

Rural developing world people have many information and communication needs

- Manage finances
- Learn about business opportunities
- Access government services
- Access medical guidance
- Communicate with friends and family
- Transact with customers, suppliers

Mostly met by analog means

- Paper, fax, voice, physical movement / exchange



Rural Computing Challenges

Environmental challenges

- Temporally intermittent power
- Spatially intermittent connectivity
- Difficult roads and transportation
- Lack of buildings and infrastructure

User challenges

- Low purchasing power
- Limited educational opportunities
- Many languages and scripts
- Ubiquity of paper-based processes



8 Rules for Rural Computing

- Easy to Use: Deal with all classes of novice users
- Easy to Teach: Conveyed by *word of mouth*
- Easy to Distribute: Remotely, and person-to-person
- Easy to Share: Individuals cant afford devices
- Easy to Develop: Allow local content and applications
- Flexible: Language, culture, infrastructure varies
- Trusted: By both users and community
- Serving a Need: Technology is a big investment



Mobile Phones as Rural Computers

Hardware is a great fit for rural conditions

- Battery-powered, networked, low-cost
- Numeric keypad familiar to billions of users
- Immediate utility of voice communications



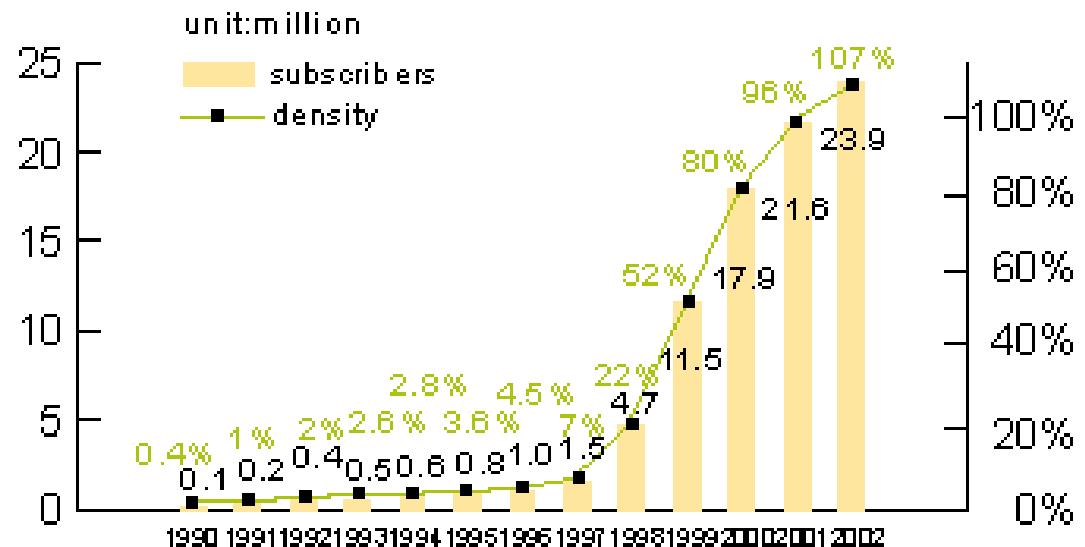
Mobile *agents* can collect data and provide services

- Common strategy for offering rural services
- Convenient for users / clients
- Leverage underemployed local workforce

But... mobile apps are hard to use and develop

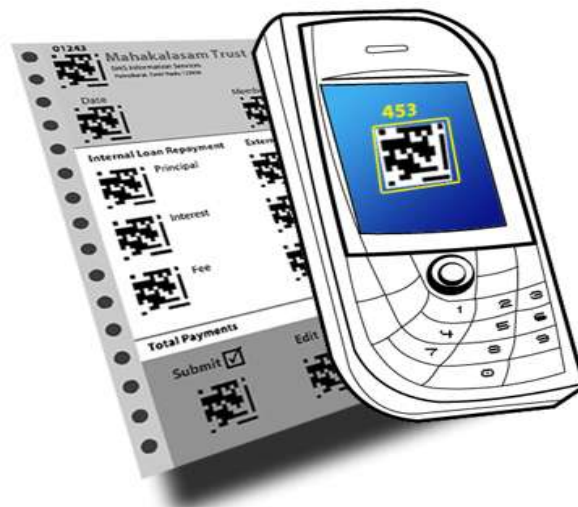


The Economist, Mar 10, 2005



CAM: Mobile Paper Programming Toolkit

CAMForms interactive forms



CAMBrowser
mobile phone app
to process forms

(452) 5552589-101 Record ID _____	
Loan Application Mahakalasa SHG Trust 7	
1 Date _____	3 Loan Amount _____
2 Account No. _____	4 Installments _____
5 Loan Purpose _____ _____	6 Submit
STAFF USE ONLY	
8 Approved? Yes / No	9 Comment _____ _____ _____

```
<function name="a_click">
  d = input_date("Date", "date.wav");
  i = input_int("Interest", "int.wav");
  p = input_int("Principal", "pri.wav");
  if (d & p & i)
    http_put("...");
</function>
```

CAMScript
scripting language
for form interaction

CAM: System Features

Navigation

- Barcodes and printed numeric strings used to access records and functions

Content - XML scripting language

- API for accessing phone features
- Audio, video - play and record



```
<function name="a_click">
date = input_date("Enter Date" "date.wav");
amt = input_int("Enter Amount", "amount.wav");
message_note("Say your name", "sayname.wav");
record_audio("name.wav");
if (amt != 0)
    email("tap2k@yahoo.com", "a="#amt, "name.wav");
</function>
```

Networking

- Synchronous
- Asynchronous



Leveraging Mobile Phone “Features”

Small screen - *Sequential interaction reduces decision-making*

Microphone / Speaker - *Audio feedback reinforces “dialog”-style*

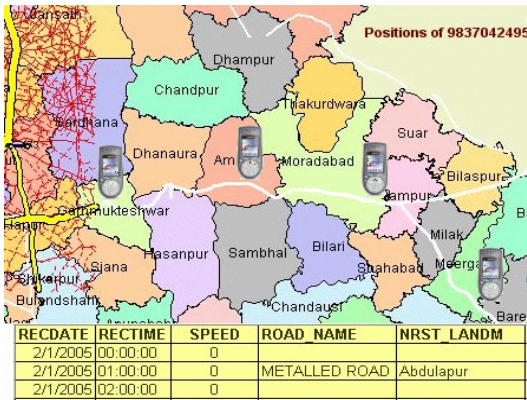
Camera - *Physical, paper-based navigation and data entry*

Numeric Keypad - *Reduces literacy and localization requirements*

Messaging - *Provides offline access; Reduces UI latency*



Some CAM Applications



Supply Chain Javid and Parikh - ICTD 2006

- Track distribution of products
- Manage inventory at rural warehouses
- Integrated with location tracking



Microfinance Parikh et al. - CHI 2006

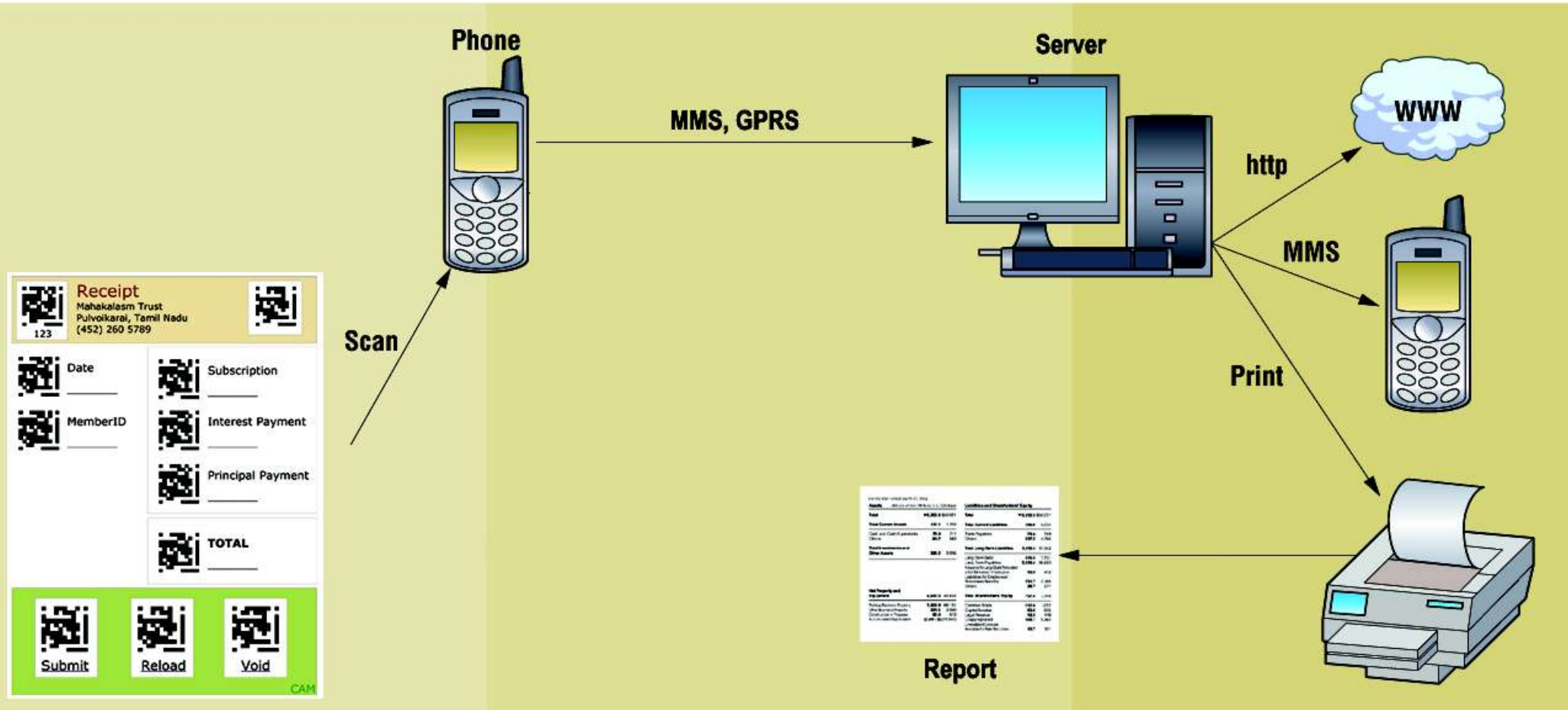
- Capture financial transactions
- Monitor clients and loans
- Reduce cost of service delivery



Health Monitoring

- Monitor disease outbreaks
- Link to electronic patient records

SHG MIS using CAM



- Online accounting and reporting service
- Conducting pilot in Tamil Nadu, India
- Reports will be provided to clients and bank

Task: Record rural microfinance transactions

- "Lab" and in-field testing
- Using barcode navigation
- Users: 14 field agents from villages
- Literate - 7th grade to college education

Results: Mobile phones are a usable solution

- Most learned system with 5-10 mins of practice
- Avg 30 secs per client (cut overall documentation time by ½)
- Less than 1% error rate
- All users described interface as *very easy* or *easy*



8 Rules for Rural Computing

- Easy to Use: Demonstrated for novice rural users
- Easy to Teach: Simple 1-step interaction model
- Easy to Distribute: Paper, Numbers, Messages
- Easy to Share: One agent can serve many villages
- Easy to Develop: XML-based scripting language
- Flexible: Mobile Phones, SMTP, Numbers, Audio, Images
- Trusted: Audio and video, linkage to paper records
- Serve a Need: Several economically relevant apps



Related Work

Paper / Tangible UIs – XAX (CHI 1993), Navicam (CHI 1995), Paper PDA (CHI 1999), Cybercode (DARE 2000), Cooltown (WWW 2001), A-Book (UIST 2002), Books with Voices (CHI 2003), PADD (UIST 2003), Visual Codes (Pervasive 2005), Semacode, Spotcode, QR codes

Mobile UIs – West (UIST 1999), PowerBrowser (CHI 2000), Dial-And-See (UIST 2005), WAP, SMS, IVR

Technology for Developing World – Grisedale et al. (CHI 1997), Daknet, TEK, TIER, DSH, \$100 Laptop, etc.

Mobile Microfinance Data Collection – Compartamos / Accion, SKS, HP Rural Transaction System

Conclusions

A new framework for rural mobile information services

- Leverage paper / mobile synergies
- Unique feature set for user / device / environment

Many potential applications

- Amortize costs across many users and services
- Browser will be released under an open source license

Lots of potential value

- Villages will benefit by managing information better
- World will benefit by building linkages with villages



Future Work

Which CAM applications can have the most Impact?

- Huge potential in microfinance and related areas
- Security, Trust, Privacy, Transparency

Which of our results can be applied for Other Naïve Users?

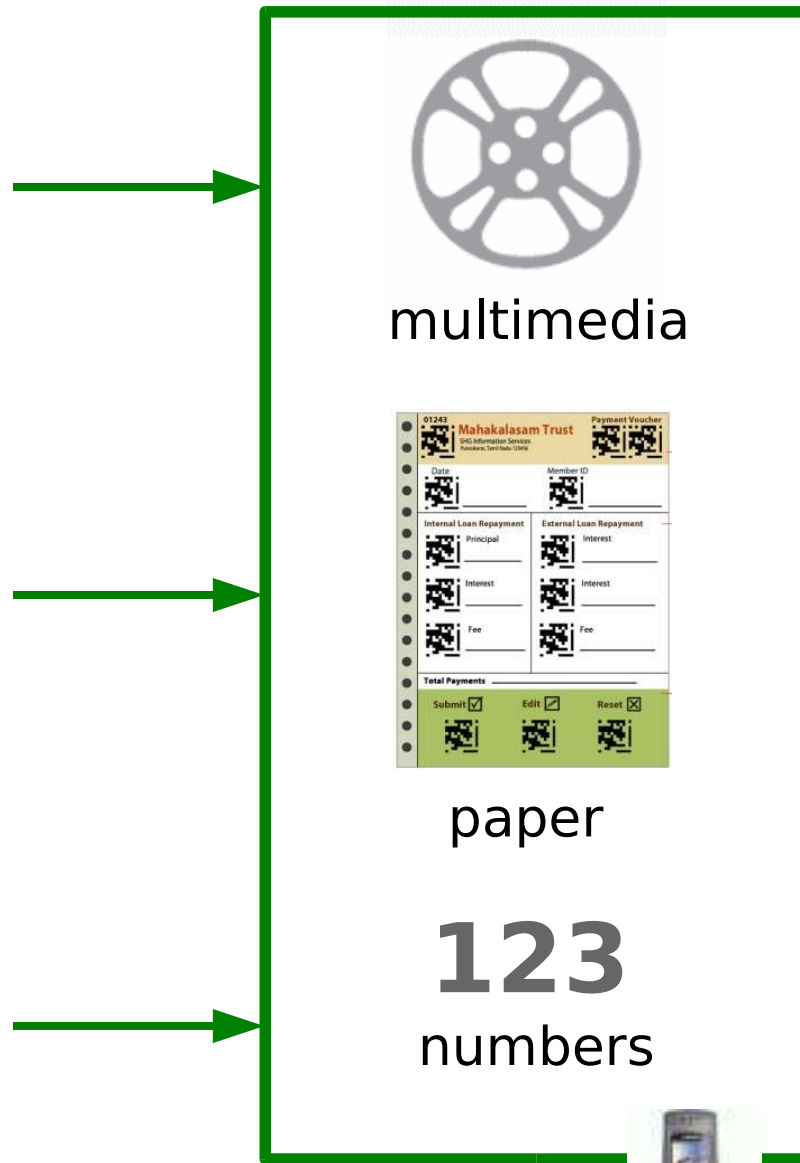
What does our system imply for Mobile Device Design?

Can we make it easy to Offer Knowledge-based Services?

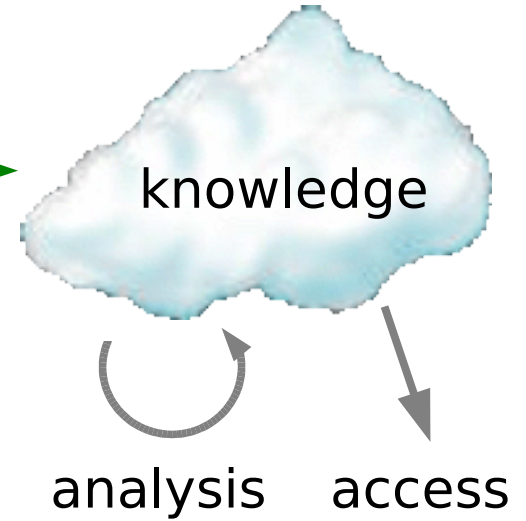
How does this all contribute to Sustainable Development?



Vision: Breaking the Information Chains



CAM



Thanks for all the Fish

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