Social Communities and Cellular Services

How can internet community services be best delivered to wireless users?

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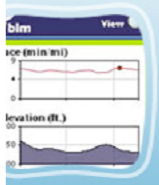




Outline

- Introduction to internet social communities
- Technical considerations for cellular access to internet communities
- Proposed approaches for improving the wireless experience
- Suggestions for future work

Internet Social Communities

Virtual Communities

- **Online social communities in the Internet world have their roots in Usenet**
  - Many of the Web 2.0 concepts we see today have origins in the old Usenet news groups
- **Many of the trends seen in online social communities have actually followed many of the observations in Lave & Wenger's seminal work (*Situated Learning: Legitimate Peripheral Participation* , 1990)**
  - How individuals transform from peripheral observers to active participants in communities
  - Originally targeting educational aspects of communities (e.g. the transition of a novice tradesman into an expert practitioner)
  - Concept is also know as *legitimate peripheral participation* (LPP)

Virtual Communities (cont.): How does LPP map to Web 2.0?

- **LPP describes a community participant's trajectory as going through 5 phases**
  - Peripheral, Inbound, Insider, Boundary, Outbound
- **Recent studies have indicated that the trajectory really applies**
  - In [1] on Wikipedia, the authors observe the trajectory of peripheral to "novice" (contrib. to one's own expert area) to "Expert" (focuses on Wikipedia as a whole)
  - Wikipedia's entry on Virtual Community [2] (ironically) applies all 5 phases of the trajectory to YouTube

[1] Susan Bryant et al, "Becoming Wikipedian: transformation of participation in a collaborative online encyclopedia", 2005 international ACM SIGGROUP conference on Supporting group work
[2] "Virtual Community," http://en.wikipedia.org/wiki/Virtual_community

What does this mean to the Cellular World?

- **Can the experience of internet social community can be replicated in wireless devices?**
  - In other words, can the user pass through the LPP trajectory (more or less)?
- **If we look at the 5 phases applied to YouTube ([2] from previous slide), we need to understand the technical challenges**
  - Peripheral – Observing the community and viewing content.
  - Inbound – Just beginning to engage the community. Starts to provide content. Tentatively interacts in a few discussions The user comments on other user's videos. Potentially posts a video of their own.
  - Insider (Regular) – Consistently adds to the community discussion and content. Interacts with other users. Regularly posts videos.
  - Boundary (Moderator/ Expert) – Recognized as a veteran participant. Connects with regulars to make higher concepts ideas. Community grants their opinion greater consideration. The user has become recognized as a contributor to watch.
  - Outbound (Legacy) – Leaves the community for a variety of reasons. Interests have changed. Community has moved in a direction that doesn't agree with. Lack of time.

Cellular Implementation of Online Communities – technical challenges (YouTube as an example)

- **Peripheral: observing content in the community**
  - Content descriptors can be accessed (e.g. featured video lists along with textual descriptors and thumbnails)
  - Content has to be renderable on a mobile device
    - In this case, are the videos sized to fit?
    - YouTube relies on embedded Flash video, so transcoding is necessary as most phones cannot display Flash
      - At present, a select set of videos is offered for YouTube mobile
- **Inbound: Uploading capability is critical in Web 2.0 model - mobile community apps that are simply view-only are incomplete**
  - YouTube has implemented an MMS (multimedia messaging) based system, but some operators restrict MMS payloads due to business considerations

- **Insider**
  - Uploading capability still unclear
  - Lack of access to all video content limits one from becoming an insider and participating in the full community
- **Boundary: similar limitations of lack of access to all video content on site**
  - Such a user may however work within the boundaries of mobile uploading so as to create mobile-optimized content

Technical Considerations: Developer Tools

What are online communities doing to address this?

- **Several community sites have provided web developers tools (developer API's) by which they can access content on the site but in another context**
  - e.g. Displaying information from a Facebook profile on another website
  - Access is typically handled by web service calls

myspace.com a place for friends

No API's yet
No uniform content creation guidelines
Mobile client available

WIKIPEDIA

API's from 3rd parties

YouTube™

Uniform content guidelines
Rich set of Developer API's
Video content can only be displayed via embedded Flash

facebook

Uniform content guidelines
Rich set of Developer API's

Can API's extend online communities to Cellular?

- **API's can provide for more flexible access to site content, but …**
- **Current developer API's provide for a read-only experience**
  - Leaves mobile user in the periphery of the community
- **API effectiveness sometimes also sacrificed for privacy concerns**
  - Private information for individual users should not be accessed without the proper exchange of credentials

Extending developer API could provide for a User experience beyond the periphery

- **Viewing the most popular or featured content**
- **Viewing a specific user's content**
- **Uploading capability**
- **Community themeing**
  - Having dedicated links from to access community features directly
  - One click to access the community
- **Recommendations derived from community members**
- **Simple means of inviting friends to community, and sharing content**

Technical Considerations: Air Interface Limitations

Air Interface

- **Even with all the new forms of wireless access available in handheld devices, the air interface is often a limiting factor**
  - WiFi is not ubiquitous; community experience cannot be defined solely with 802.11 access characteristics in mind
  - Cellular has larger coverage, but 2G and even 3G access allows for limited quality-of-service (QoS)
- **Cellular access, given its coverage and penetration, should be the base air interface to define an LPP**
  - Otherwise each participant's ability to participate in the community is not uniform

Video Content Case Study – HSDPA (UMTS Release 5)

- **It is not clear that all the content available in an online community is renderable on a mobile device**
  - Transcoding is often necessary (e.g. FLV to MP4/AAC)
  - Content streams may still tax low throughput cellular connections
- **Video sharing however is critical to several virtual communities**
- **Video content taken directly on the handset should be readily shareable**
  - Video sharing is a feature of UMTS, but does not interoperate with any of the more popular online communities
- **Streaming lag is a problem**
  - Recent view of top 10 featured videos on YouTube (7/5/07) yielded an average 3:30 playtime (discussed later)

Problems with Streaming

- **Focus on UMTS Release 5, also known as *HSDPA* (High Speed Downlink Packet Access)**
  - Currently being deployed
- **Reliability ensured through *hybrid ARQ* (HARQ)**
  - Fast acknowledgments (ACK/NAK's) from handset allow for fast retransmissions
  - Turnaround time much quicker than TCP
- **HSDPA delay affected by the following**
  - Initial physical layer operating point
  - Maximum number of ARQ retransmissions
  - Error rate for acknowledgments: a NAK interpreted as an ACK

Problems with Streaming (cont.)

- **Using model provided in [1], can derive a bound on lag for file transfer over HSDPA**
- ***N-phase stop-and-wait hybrid ARQ* is used**
  - Several ARQ instances are initiated so that during the acknowledgment turnaround time no gaps in data transmission occur
- **Frame duration is specified as T**
  - A minimum time period of NT for a retransmission to occur upon detection of a frame error
  - N = 4, T = 2 ms for HSDPA

[1] Chatterjee, Mainak, Giridhar D. Manydam and Sajal K. Das. "Joint Reliability of Medium Access Control and Radio Link Protocol in 3G CDMA Systems." IEEE Transactions on Computers. Vol. 54. No. 12. December 2005. pp. 1584-1597.

Problems with Streaming (cont.)

- **Probability of acknowledgment error is f**
- **Average delay per frame is**

$$D = \sum_{i=1}^{M} (Cp)^{i-1} pNT + (Add_m) MNT$$

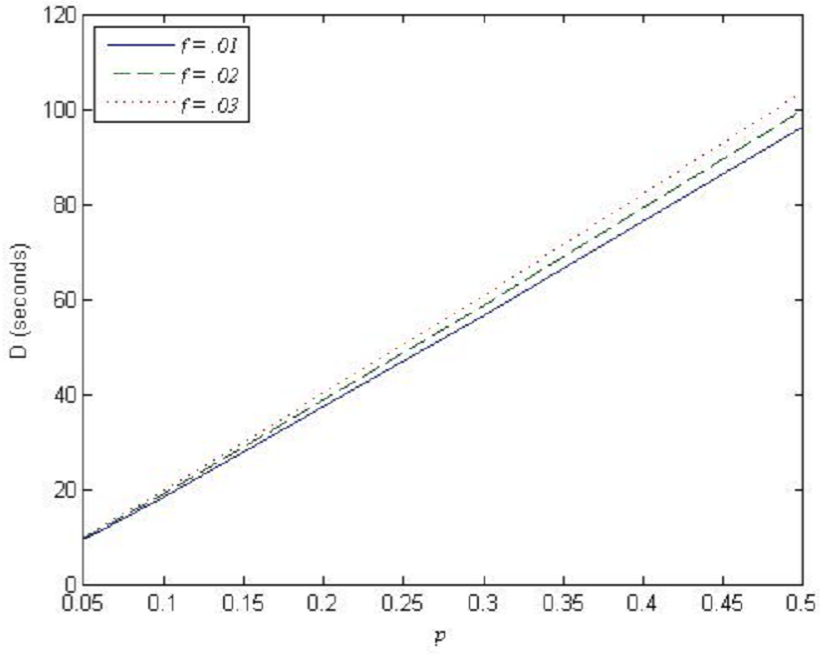
where

$$Add_m = \sum_{i=0}^{M-1} fp(Cp)^i (1-f)^i + p(Cp)^M (1-f)^M$$

- **File size can be defined as F and the rate of transmission in bits/second is R; no. frames to transmit are** $K = ceil\left[\frac{F/R}{T}\right]$

Problems with Streaming (cont.)

- **Overall lag to transmit this file can be defined as $L = DK$**
- **Assume single code HSDPA transmission at 16 QAM at a forward error correcting code rate of ¾, the physical layer data rate is 708 kbps**
  - C = .1 for this case
  - Examine for different values of f and M = 4
  - 4 minute, 128 kbps streaming video



Proposed Approaches for Mobile Community

Mobile Communities and LPP

- **Mobile online communities are certainly possible, but existing online communities must adapt**
  - Improve content accessibility
  - Ensure uploading experience so as to allow users to transition from periphery
- **If an online community does not extend to mobile, than should mobile-specific communities be emphasized?**
  - Certainly, but technology enablers should still be available

Necessary Technology Enablers

- **Community content can be developed with limitations of cellular access in mind**
  - Limited phone memories combined with over-the-air delay means that content size should be accounted for using
    - Spectrally-efficient encoding
    - Extended memory when possible
- **Real-time communication may not always be possible**
  - Off-peak download along with custom applications can be used for content delivery

Necessary Technology Enablers

- **Uploading**
  - Uploading not an insurmountable problem, but SMS/MMS and email based approaches are clunky
    - OTA lag due to delivery over common access channels
    - Delay in implementing upload
    - Artificial limitations in payload size
    - In [1], the authors observed the GPRS lags for 30 KB and 70 KB MMS transfer times over a deployed network was 5-9 and 6-12 minutes respectively
      - Mobile-to-mobile, so not exactly apples-to-apples comparison
      - Nevertheless, SMS/MMS delivery times may not always be guaranteed
  - Uploading could be better handled via web service calls (e.g. HTTP Posting) or even IP socket connection
  - Recent 3G deployments (1X-EV-DO rev A and HSUPA) should be leveraged to improve uploading experience

[1] D. Griffin and F. O'Reilly. "Integrating SIP, presence and FTP to provide wireless multimedia messaging." IEEE Wireless Communications and Networking Conference 2004. March 2004. pp. 2581-2586.

Developer API's

- **API's need to progress beyond read-only access to content**
  - Uploading capability a must
- **Online communities can ensure branding and proper use of API's through their terms-of-service, e.g.**
  - Define additional user credentials for uploading to prevent hostile access
  - Ensure branding through use of icons (e.g. "Powered by …")

Suggestions for Future Work

- **Intelligent handset agents can be used to limit over-the-air exchanges**
  - Proactively fetch content during off-peak times
  - Content is accessible on-demand
  - Will memory be an issue?
- **End-to-end experience for uploading needs to be characterized**
  - How long does each method take (SMS/MMS, email, HTTP, IP Socket, etc.) before user contributions reflected within community?
- **Social communities for educational purposes – what technology enablers can improve the experience?**