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Z25 Adaptive and Mobile Systems
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MoB: A Mobile Bazaar for Wide-area Wireless Services

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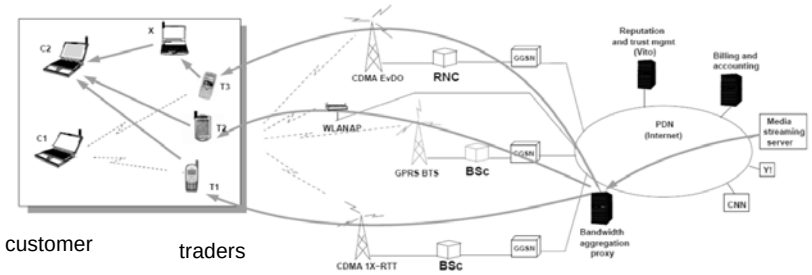
Motivation of the Paper

- Growing usage of mobile devices
  - various types and form factors, e.g., PDAs, smartphones, portable PCs
- Increased availability of wireless data networks
  - Higher bandwidth cellular data networks
  - 802.11 WLAN hotspots
- Intermittent Internet connectivity
  - WLAN coverage is spotty, more so for ***public*** hotspots
  - Cellular coverage also not ubiquitous
    - often suffers from high latency, low bandwidth, link stall, etc.

Mobile Bazaar

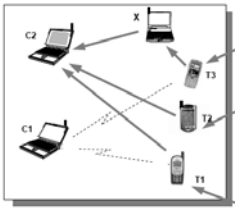
- Decouples infrastructure providers from service providers
- Enables fine-grained competition
  - Choice of provider not only coarse grained (choice of mobile phone provider once a year)
  - Users can resell unused resources (user1: idle mobile phone connection; user2: laptop experiencing slow bandwidth with its provider)
- Service interaction
- Flexible composition of services

Services in MoB



- Goal of MoB: enable incentive-induced service collaboration between independent mobile devices.
- Example: bandwidth aggregation service

Services in MoB



- Example, in detail
  - Customer device is a wireless user (C_1) that is stationary in either
    - static public environment (e.g., coffee shop or shopping mall)
    - mobile environment (e.g., moving bus or train)
  - Typically surrounded by other networked devices (e.g., cellphones, laptops, PDAs)
    - 3G-enabled cellphone (T_1)
    - PDA with an 802.11 wireless interface (T_2)
  - C_1 discovers nearby T_1, T_2, T_3. Then connects to a subset T_1, T_3 and purchases their available bandwidth.
- Devices T will receive a payment for their services
- Interaction are pair-wise and single hop

Examples

- Location determination
  - Mobile users with navigation tool needs to know position. Does not have GPS. Could purchase this info from others in range traders which have GPS
  - Web proxy caching: user browsing through cellular link (expensive and slow) might want to check if context is available in neighbors in range. Traders can cache copies
  - Peer to peer search: same concept as above for files (caching of files locally)

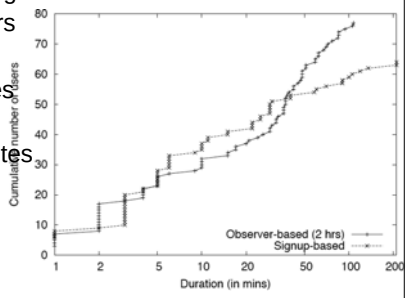
Pricing and Reputation

- Laissez faire approach (prices left to individuals)
- Open marker economics will dictate that traders will price based on competition

- Needed:
  - Reputation and trust management system
  - Billing and accounting system
- Both third party services

Study of applicability

- An environment with many opportunities of collaboration between in-range devices
- A study of resource sharing opportunities
  - How long a user stays in a coffee-shop?
  - Two different measurement techniques
    - Time-sheet at the counter, sign-in and sign-out
    - On site observer monitoring for two hours
  - Results
    - More than 2/3 spent more than 2 minutes
    - At least 50% spent 10+ minutes
    - A significant fraction spent over 30 minutes
  - Conclusion: significant opportunities of long-lived MoB interactions



Architecture

- Clients
- Traders
- Third-party services: accounting/billing/reputation& trust

- Clients can also be traders

Modes of Operation

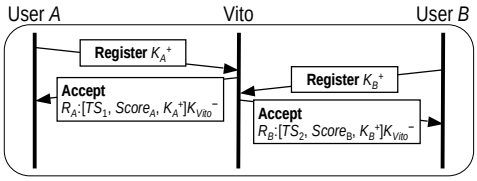
- Incentives based (no trust assumptions)
  - Clients and traders use a central repudiation system to examine past history and derive trust. Financial incentives are used to provide service
- Incentive based with trust assumptions
  - Financial incentives for the trade and both parties trust each others (if successfully being interacting previously). No central management.
- Altruistic
  - Perfect trust, no financial incentives (friends)

Reputation and trust management

- Vito (eBay based)
  - After a transactions, client and seller provide a reputation feedback
    - Cheating would cost money
- Vito is centralized and on the Internet
  - Each user receives a reputation certificate (timestamped) indicating both successful and non transactions of the user
  - During trade the parties check these certificates
  - Price can depend on reputation
  - Trades happen independently from Vito (maybe disconnected)
  - While trading they exchange certified reputation
  - Later, they upload their feedback scores into Vito
  - Vito periodically distributes updated certificates
- System does not need to use Vito

Operations in MoB

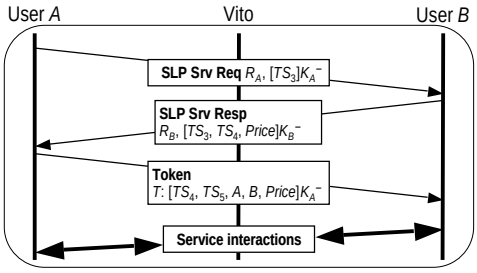
- User *A* registers using its public key, K_A^+
- Vito issues a reputation certificate R_A
  - This certificate is signed using Vito's private key, K_{Vito}^-
  - It includes a timestamp TS_1
  - Contains positive and negative feedback counts for *A*, $Score_A$
- Vito does not keep state for *A*
- Equipped with the reputation certificate, *A* can engage in trades with other users



A and B independently register with Vito

Operations in MoB

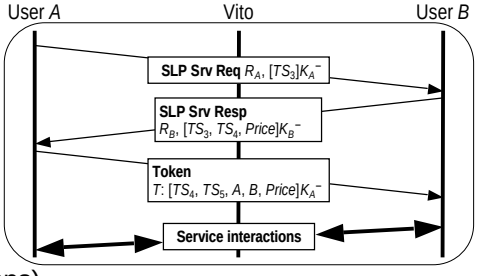
- Services are discovered and advertised using the Service Location Protocol (SLP)
- To request a service in its wireless vicinity *A* multicasts a *Service Request* to 239.255.255.253:427
  - TTL is chosen to be 1, since in MoB service interactions are pairwise



A and B interact, no need to access Vito

Operations in MoB

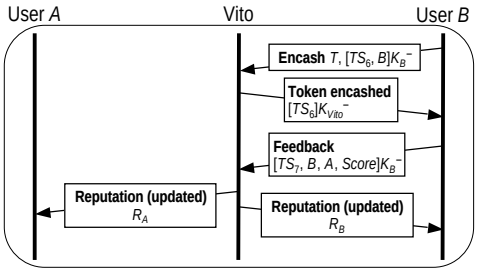
- Consider the scenario
  - *A* multicasts a *Service Request* for a 30Kbps forwarding service
    - It includes *A*'s reputation
  - *SLP Service Agent B* responds with a service description (25Kbps) and a price quote
    - It includes *B*'s reputation
  - *A* sends a *Service Acceptance Notification* to each of his chosen traders
    - It includes a timestamp and payment amount
  - *B* starts operating as a NAT device for *A*



A and B interact, no need to access Vito

Operations in MoB

- Scenario (cont'd)
  - *B* presents token *T* to Vito
    - Vito charges *A*
    - Vito credits *B*
  - This is counted as a positive feedback for *B* from *A*
    - *B* is charged a transaction fee for the gained positive reputation
  - Once *B* receives credit it'll typically report a positive feedback for *A*
  - If *A* was dissatisfied, it'll explicitly report negative feedback for *B*



Nightly reputation and billing updates

Design Decisions

- Trader (*B*) uploads its own positive feedback
  - Positive trader feedback benefits itself in future trades
  - Thus, beneficiary is responsible for uploading feedback
- Trader uploads positive customer (*A*) feedback
  - Positive customer feedback contingent upon encashing of the token
  - The service token indicates the trade price and is signed by *A*
  - Vito will check *A*'s balance and inform *B*
  - Based on this response, *B* rates *A*
  - Studies show that expectation of a reciprocal positive rating encourages voluntary feedback

Design Decisions

- Customer uploads negative feedback for trader
  - Obviously trader has no incentive to reduce its positive reputation
  - Trader has no recourse if malicious customer always reports negative feedback
  - Same shortcoming in eBay
  - Mitigating assumption: customers may be selfish but not malicious
    - When they received good service will not rate negatively

Design Decisions

- Customer pays prior to receiving service
  - If we had let the customer pay after receiving service
    - He might default the payment
    - The trader wouldn't have a proof of the transaction and no further recourse (recall, the token is the payment)
  - If customer pays first
    - If trader encashes the service token, it in fact claims to having provided the service
    - If trader defaults in provisioning, customer can provide negative feedback

Design Decisions

- Transaction fee charge
  - A transaction fee is an incentive for the reputation service provider
  - Also implies no one can build up reputation for free
    - Otherwise, construct multiple colluding identities
    - Perform transactions between these identities
    - Report positive feedback

Evaluation of the Reputation Management Model

- Challenges to making a reputation system really robust
  - Sybil attacks: a user with bad reputation acquires a fresh identity
    - Newcomers are always distrusted
    - Unless they paid their dues, e.g. registration fee
    - Alternative, require use of real names or prevent acquisition of multiple pseudonyms
  - Collusions: a group of users collaborate and rate each other positively
    - Avoid by using a transaction fee for reputation reporting

Evaluation of the Reputation Management Model

- Challenges to making a reputation system really robust (cont'd)
  - Decentralized reputation management
    - Current centralized solution might not scale
    - Also may be desirable in many scenarios to decentralize
    - Some approaches have been proposed in the context of P2P networks
      - they exploit pre-trusted peers

Legal Aspects

- Many services are traded between only two entities
- However, many times a client acts as a reseller
- This may raise legal issues
  - For example, 3G cellphone resells bandwidth to nearby laptop
  - Many ISPs prohibit reselling bandwidth
  - This is because they have no financial incentive
  - This may be solved by providing incentive-sharing techniques between MoB participants
  - An compensation agreement between the cellphone user and the 3G network operator may be negotiated
  - May be hard to enforce

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Related Work

- 7DS peer to peer system (disconnection)
- ORION p2p query/routing
- MAR different wireless medium
- CAPS virtual caches
- Incentives: Hubaux