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Changing User Behaviour in Future Services

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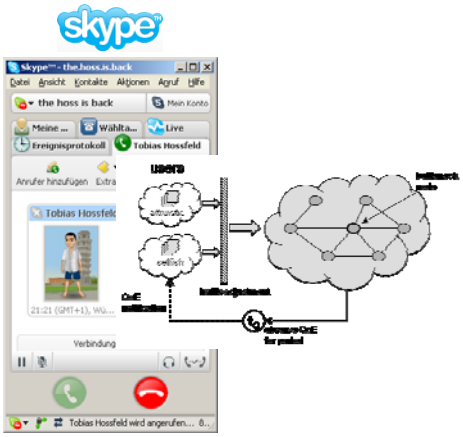
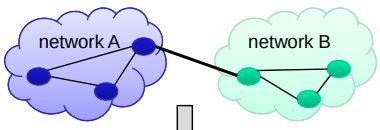
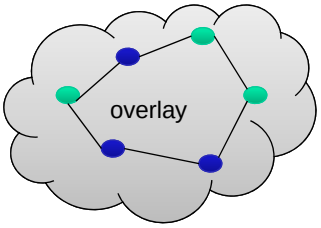
New Trends in Telecommunication Systems



Edge-based applications

Multi-network services





Quality of experience

Motivation

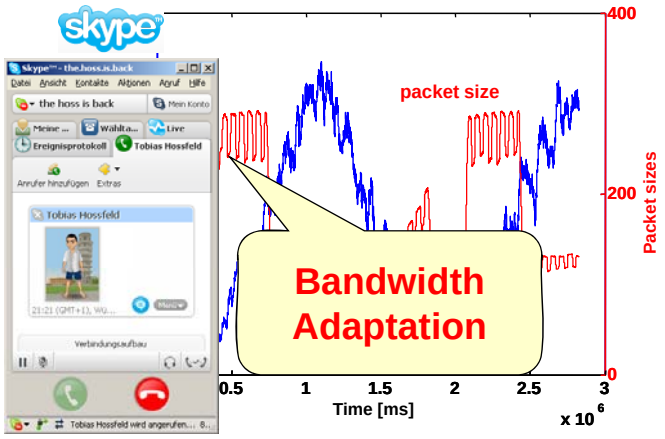
- We look at current applications to estimate future applications
  - Skype VoIP telephony
  - P2P content distribution
- Future services/platforms will be
  - designed mainly by the edge and
  - controlled by overlay
- Observation of changes in user behaviour important for
  - performance evaluation of future services
  - network dimensioning
- More applications are expected with changing user behaviour

Impact of User Behaviour

- Impact of edge-based application and overlay on user behaviour
  - application maximizes QoE at network costs
  - dimensioning of network more challenging
  - e.g. Skype bandwidth adaptation
- Users contribute to service, share resources
  - churn: user join and leave the system as they desire
  - more selfish applications and users expected
  - e.g. P2P content distribution
- More dynamic behaviour patterns
  - popularity of service/content: flash crowd arrivals
  - users' impatience: e.g. in overloaded or polluted systems

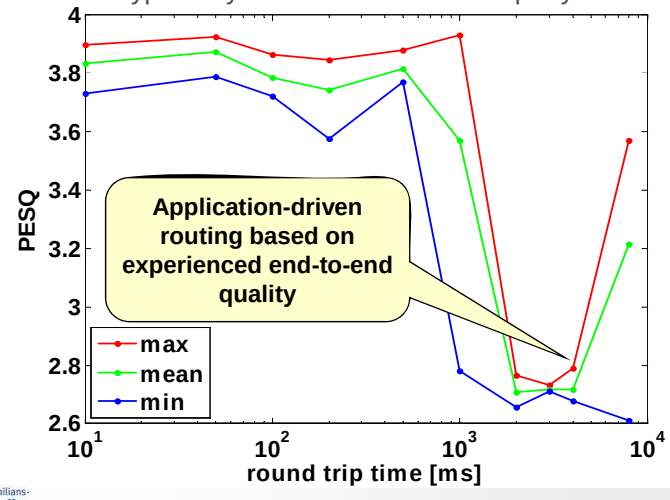
Intelligent Application: Bandwidth Adaptation

- *Example:* Skype and time-varying packet loss
- Packet sent every 30ms, independent on packet loss
- Packet size adapted according to experienced QoS

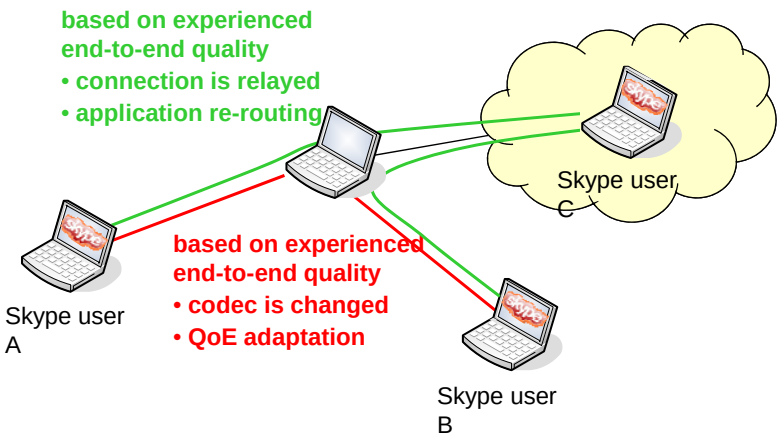


Dynamic Scenario: QoE and RTT

- RTT>500ms results in strong QoE degradation
- If RTT>4s Skype relays connection over third party machine



Application-driven QoE Adaptation and Routing



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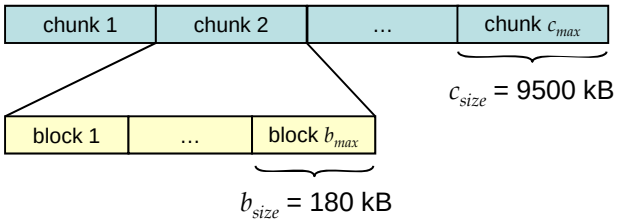
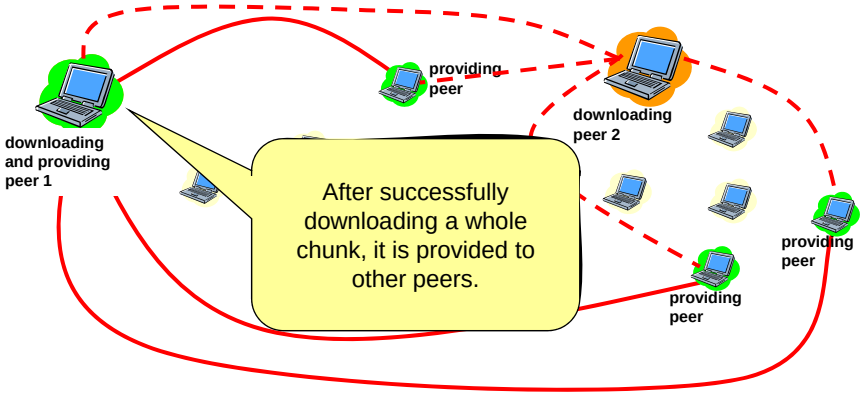
File Structure in P2P CDN

- While downloading, peers upload already received parts of file
- File is split into chunks of 9.5 MB and blocks of 180 kB
- Complete chunks are shared and requested per block



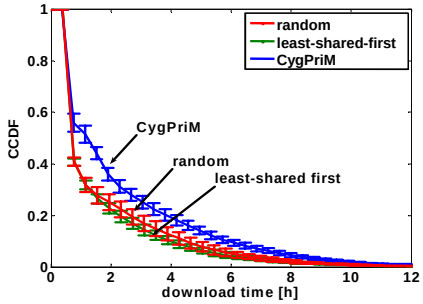
P2P Content Distribution

- Main feature is **multiple source download.**
- Peers issue several download requests for the same file to multiple providing peers in parallel.
- Providing peers serve the requesting peers simultaneously.



Altruistic User Behaviour

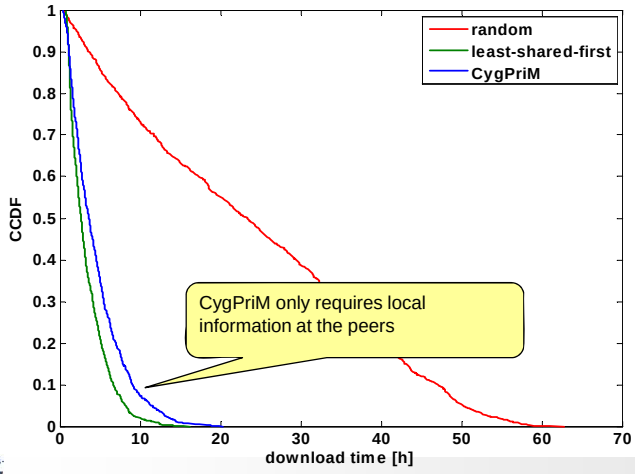
- Best-case scenario: **all peers** finishing file transfer will **serve as uploading peers**
- CygPriM cooperation strategy developed which enables data exchange between peers with minimal signaling overhead



- **No significant impact** of cooperation strategy if peers are willing to contribute, i.e. **altruistic peers**.

Comparison for Leeching Scenario

- Selfish user immediately leaves system after downloading file
- Cooperation strategy has big impact on download time



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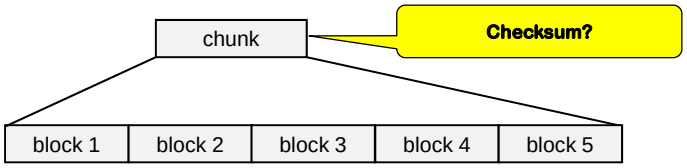
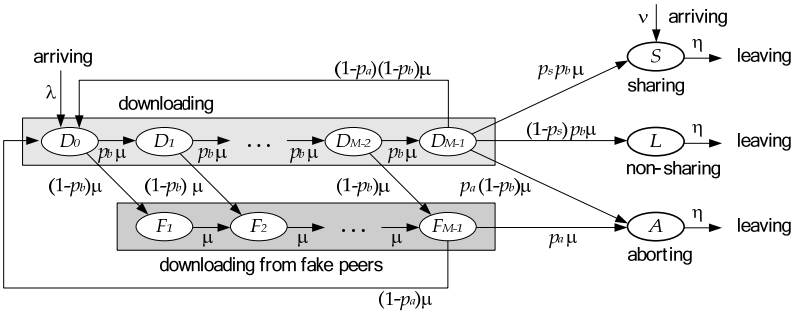
Pollution of System

- Content can be manipulated by peers: pollution/poisoning
- Fake peers distribute corrupted blocks
- Checksum is computed after receiving a whole chunk
- Corrupted chunk has to be downloaded again

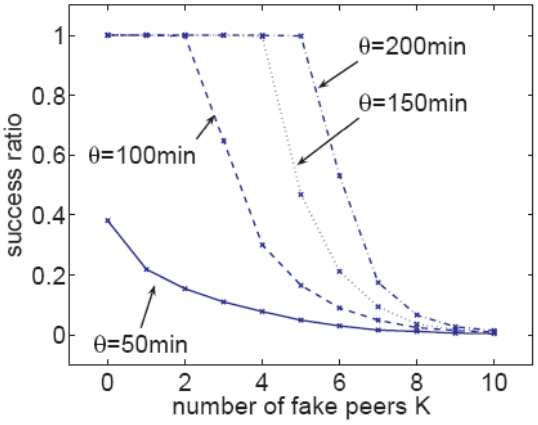


Fluid Model for Transient Analysis



- When each block is downloaded:
  - transition rate between states is μ
  - Probability to download not corrupted block is p_b
- After completion of M blocks, error check is performed
  - In case of error, whole attempt is repeated with probability p_a
  - Otherwise file is shared with probability p_s

Comparison of Success Ratio



- Small number of fake peers sufficient to stop file dissemination, patience increases success ratio

Conclusion

- We look at emerging applications
  - Selfish user: example Skype and P2P content distribution
  - Cooperative users in a community helping each other to shorten download time
  - Appearance of malicious users from the edge
- Network dimensioning is more complex
- User behaviour modeling more demanding
- Estimate future user behaviour patterns from current observations