Cloud Based Framework for Rich Content Mobile Applications

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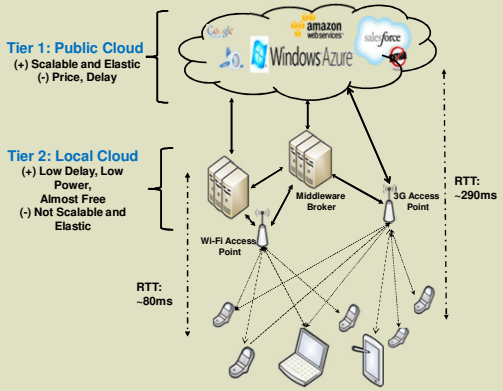
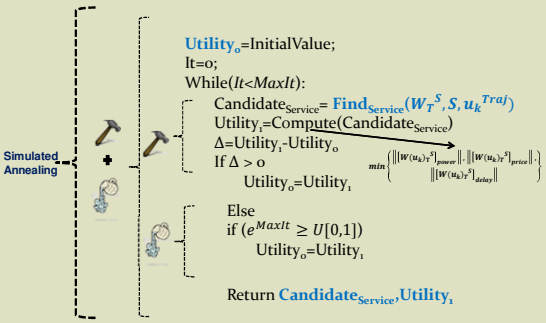
Motivation and Problem Statement

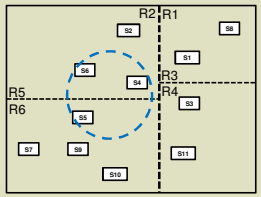
- Smart Phones have **limited resources** such as **battery**, **memory** and **computation**.
- One of the main bottlenecks in ensuring mobile **QoS** is the level of wireless connectivity offered by last hop access networks such as 3G and Wi-Fi.
- 3G exhibits:
  - ✓ **Wide area** ubiquitous **connectivity**.
  - ✓ **But long delay** and **slow data transfer**.
- Wi-Fi exhibits:
  - ✓ **low latencies/delays**
  - ✓ **scalability** issues; as the number of users increases the latency and packet losses increase causing a decrease in application performance.
- **2-Tier Cloud Architecture** could increase the QoS of Mobile Applications.

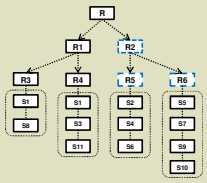


Cloud Resource Allocation for Mobile Applications (CRAM)

- Optimal resource allocation for mobile applications is **NP-Hard**, so heuristic is needed.
- **CRAM** uses the combination of two main best practices in heuristic:
  - ✓ **Simulated Annealing (Catching Global Optima)**
  - ✓ **Greedy Approach(Catching Local Optima)**
- It uses the following observation for pervasive environment that: **near user resources usually have better QoS.**
- Need Efficient way to **retrieve** information of **services** on cloud **in specific region.**
  Example Query: *"Retrieve all MPEG to AVI decoder services in distance R of mobile user "*
- **R-Tree** is an efficient way to answer these queries.



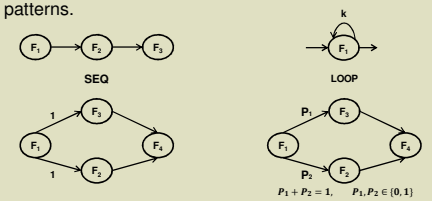




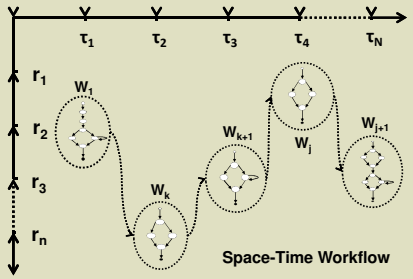
Find$^{S\text{-}CRAM}_{Service}$($w_T^S$,S,$u_k^{Traj}$)
--Only uses initial user location
Begin:
$i = 0$;
While($i \le max\_it$)
1. $radius = d_{th} + i \times d_\Delta$
2. $Service\_List = retrive\_ServiceList(W_T^S, S, radius, (u_k^{Traj})_{init\_loc})$;
3. $Assigned\_Services = assign\_Service(ServiceList, W_T^S, (u_k^{Traj})_{init\_loc})$;
4. If *Assigned_Services* satisfy constrains
5. return *Assigned_Services*
6. else $i = i + 1$;
5. $radius = d_{th} + i \times d_\Delta$
End While
Return Service list;

Space-Time Workflow

- To model mobile applications on **2-Tier Cloud architecture, workflow** concept from **SOA** will be used.
- It consists of number of **Logical** and **Precise** steps known as a **Function**.
- **Functions** could be composed together in different patterns.



- We extend this concept to **Space-Time Workflow** to capture **optimal mobile application.**
- In this optimization problem our goal is to **maximize the minimum saving of power, price and delay of the mobile applications.**



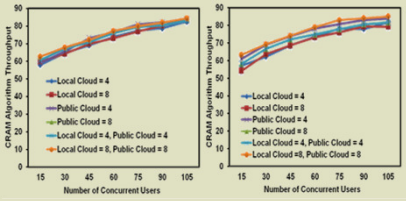
$$Fairness\ Utility(W(u_k)_T^S)$$

$$max\ min\left\{\begin{matrix}\left\|[W(u_k)_T^{Sp}]_{power}\right\|, \left\|[W(u_k)_T^{Sp}]_{price}\right\|, \\ \left\|[W(u_k)_T^{Sp}]_{delay}\right\|\end{matrix}\right\}$$

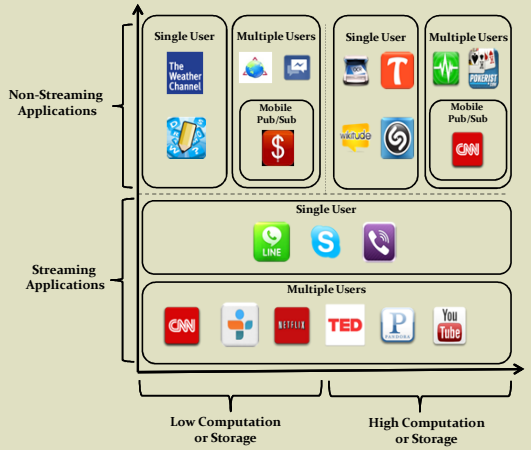
$$Subject\ to: \begin{cases}[W(u_k)_T^{Sp}]_{power} \le B_{power}, \\ [W(u_k)_T^{Sp}]_{price} \le B_{price}, \\ [W(u_k)_T^{Sp}]_{delay} \le B_{delay},\end{cases}$$

System Evaluation and Future Directions

- 3 **different classes** of mobile applications will be considered:
  - ✓ **Intensive Computing,**
  - ✓ **Streaming Application,**
  - ✓ **Mobile Pub/Sub.**
- Application profiling and simulation will be used to evaluate CRAM.
- When the number of users is high CRAM could achieve 85% of optimal solution.
- In future CRAM will be extended to use efficiently user trajectory.



Mobile Applications Ecosystem



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