Application Assisted Power Management in Multiplayer Mobile Games

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Introduction

Parallel growth Converge to next "Killer" application

- Online games – phenomenal increase in market share
- The number of cell phone users continues to escalate
- Multiplayer Mobile Games – Next "Killer" application?!!

Usability Constraint:

- High Power Consumption
  - Processor load, Continuous NW traffic, Display intensity

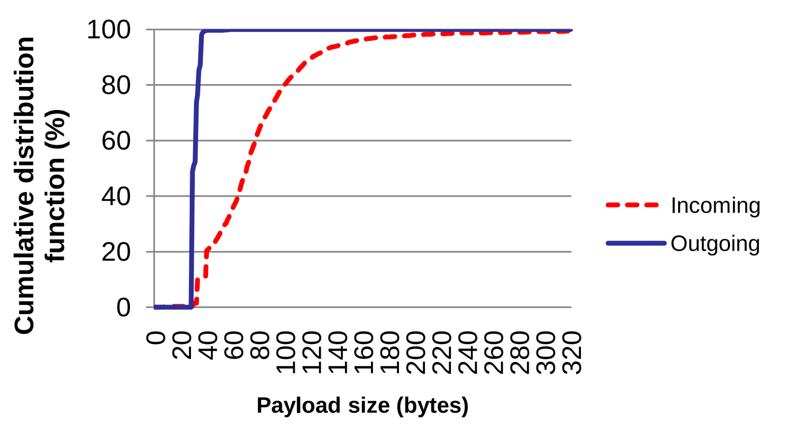
Objective:

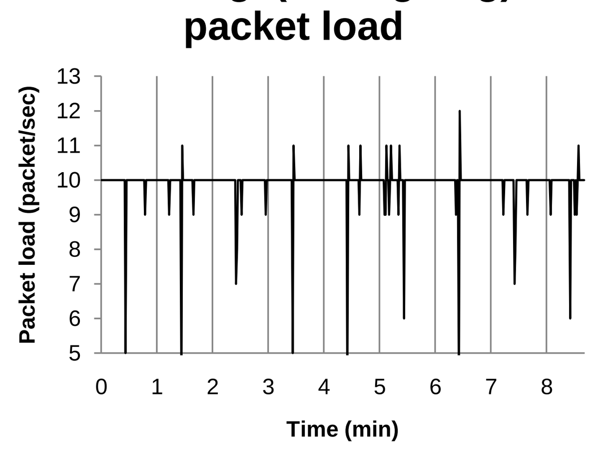
- Develop an energy saving scheme for multiplayer mobile gaming

Characteristics of Networked Games

Game

- Average bandwidth per client 7Kbps
- Average packet rate (incoming and outgoing): 20 pps
- Very small packet size, Average: 24 DATA +8 UDP + 20 IP Bytes





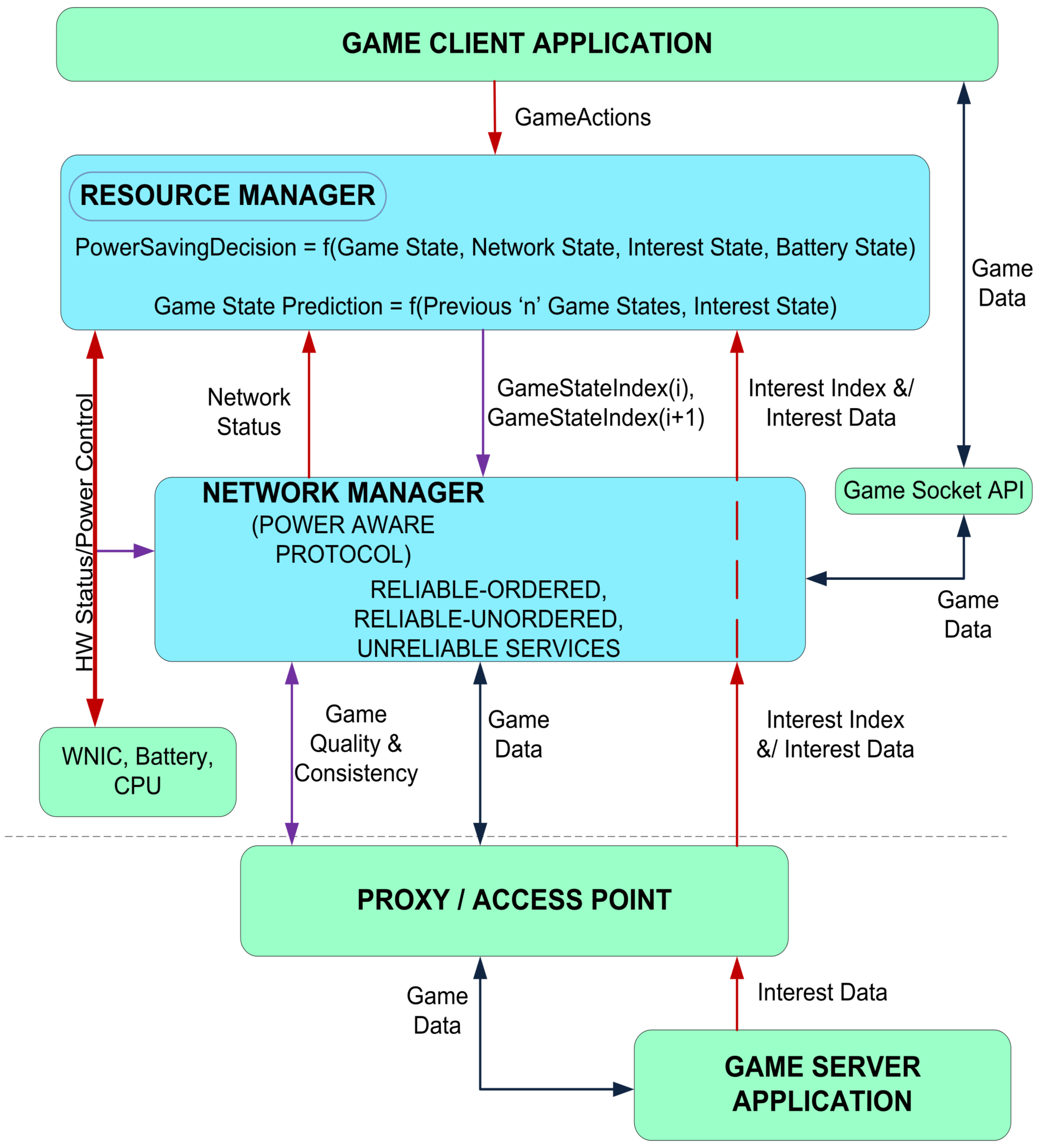
* Based on *Quake Mobile* and *Armageddon Mobile* (5-20 players) in our test bed

Saving WNIC Power consumption

Safe sleep mode

- Acceptable latency - 200 ms for FPS and 1500 ms for RPG (slow speed) with Dead Reckoning.
- Challenge 1: When to sleep without affecting the quality of game play?
  - When the actions are not significant for the quality of the game play.
- Challenge 2: How long is the sleep duration?
  - Long duration effects the quality of game
  - Short duration will result in more overhead power consumption
- Complex algorithm results in adverse results!

Architecture & Information Flow



Algorithms

Game State

$$GameStateIndex_i = f(w_{i1}.gameActionIndex_i, w_{i2}.interestIndex_i)$$

Network State

$$NetworkStateIndex_i = f(latency_i, bandwidth_i)$$

Interest State

$$InterestStateIndex_i = f(AoI_i, GameZone_i, AvatharProximity_{i-k...i}, NPC\ Proximity_{i-k...i})$$

Battery State

$$BatteryStateIndex_i = f(remainingBatteryLife_i)$$

Game State Prediction

$$GameStateIndex_{i+1} = f_1(w_{i1}.gameActionIndex_{i+1}, w_{i2}.interestData_i)$$

$$where,\ gameActionIndex_{i+1} = f_2(interestData_i, w_{i5}.gameActionIndex_i, w_{i6}.gameActionIndex_{i-1}, w_{i7}.gameActionIndex_{i-2}, \ldots, w_{i8}.gameActionIndex_{i-k})$$

- High probability for important actions,
  - When the Avatar is near another Avatar or NPC
  - When Avatars and NPCs are approaching the player
- Avatar will have different actions in different zones

Results & Conclusion

Average Amount Energy Saved in Various Modes:

- With current implementation in Android platform (*Mobile Armageddon* - RPG game)
  Full Mode (**35%**), Secured Mode (No Server Hints -> **20%**), Black-box Mode (No Application Hints -> **13%**)

We have:

- Learnt about Characteristics of Network Gaming
- Developed Linear Prediction Algorithm to predict "Importance of Game State"
- Developed Algorithm for Power Management using Application & Environment hints
- We have developed an API extension for existing game engine to learn about the entire game state for RPG games