INVENTION DISCLOSURE

1. **Invention Title.**

Context awareness for seamless Wi-Fi Roaming

2. **Invention Summary.**

An apparatus that extends the client roaming decisions in Wi-Fi networks by the context of any information that could be considered relevant.

3. **Invention Description**.

a. Describe the invention in detail.

An Apparatus that enhances the criteria used by Wi-Fi stations to transition to other Wi-Fi network, or any other wireless network (Multi-band clients).
This apparatus is primarily for e.g., Wi-Fi – meaning networks where the client can actively decide when to switch to another network –, but can accommodate other wireless technologies where the base station takes an active role in selecting stations as brings the transition logic to a level above network transport.

Current Wi-Fi Roaming scenario

Seamless movement between Wi-Fi Networks that involve authentication is being addressed at the standard level but lacks of implementation support. [802.11r] while ratified in 2008, still see no broad implementation by Wi-Fi chipset vendors. Moreover, the standards do not deal with procedures to deal with the optimal time and location to transition to a different network to satisfy high quality of experience expectations. When looking at mechanisms to provide that same level of capabilities across different network access (Wi-Fi , 3G, LTE, WiMax, etc.) those options are even more remote of being a reality.
By context awareness this apparatus refers to:
Relevant real-time, fresh and historical information that could lead the mobile client to decide or being inform to execute, or initiate a procedure to move to different network to maintain online connectivity.

Claims of this invention.

1. The apparatus has an intelligent entity that collects, retrieve and use multiple criteria to command a client to move from the current network to another. The intelligent entity can reside in the mobile device, or a network location, or in both.
2. The apparatus collects and access information from multiple sources but not limited to:
    a. Crowdsourcing: Mobile clients publish periodically:
        a.i. Geographical coordinates of RSSI (both up/down links) and other quality metrics for the current network.
        a.ii. Applications types, average data usage, expectations
        a.iii. Personalized plans (agenda with future locations, current plan destinations – while on the go).

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   b. Geographical coordinates of fixed Wi-Fi access points (AP) by wireless locator providers

   c. Map street information

   d. Access Points usage and link capacities

3. The apparatus uses this information to help assess the best opportunity to change to a different network considering:
   a. Historic and fresh information about RSSI on proximity areas
   b. Mobility path forecasted or based on current navigation plan.
   c. Current network capacity on adjacent network locations.
   d. Current application needs and expected capacity while moving to other networks.
   e. Recent and historical data about previous roaming interactions on similar places.
4. Conceive separation of concerns and privacy. Personal information is used for best assessment of individual roaming triggers. General data (e.g., anonymous) is used for location and performance decisions.
5. The apparatus, or one of its components acts as a real-time and short-term predictable capacity and QoE measurements of networks and users.
6. The apparatus, or one of its components acts as a pre-settlement entity for hand-off and share cost distribution.
   a. After the roaming decision is taken, participants are notified with needed credentials to access the new network
   b. Charge settlements can be offered, or constrained based on real time demand/offer and user preferences.
7. The apparatus, or one of its components acts as a planning, performance and monitoring tool as it constantly optimizes the load and roaming actions based on published data. Identify spots of high usage with lack of infrastructure, detects seasonal and time based under and over dimensioned zones for capacity and roaming.

Below are few cases where the invention claims are described.

Current models (Wireless locators)

Figure 1 shows the screen of an application where free and paid access points are displayed for a geographical area (in this case San Francisco downtown, source http://www.jiwire.com).

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Figure 1 Wi-Fi locator mobile application

The user needs to decide between free and public access points in order to get connectivity, when the user is moving, connectivity loss can occur in a temporary or permanent manner

Figure 2 shows the same Wi-Fi location data being augmented by context information (Street data and RSSI information). The lines indicate roaming opportunities entities (between free Wi-Fi hotspots purple, between paid Aps – red, from free to paid (and vice versa) Aps –yellow). With the user location, the roaming opportunities are bound to the geographic location. Bubbles represents where an AP RSSI is strong, based on service standards. When a user is in between two APs the roaming link information can be used to predict the best place to make the transition. – The mobile client has little interaction with the other APs at the [802.11] level – assuming lack of support of [802.11u], [802.11k], etc., nor complex applications need to be supported in the client. – Roaming transactions are then based on best opportunity and previous successful events on same proximity. As those connections become successful its good ranking make them valid rules and the network depurates its own information (e.g., rank links low or high, or commands roaming in advance anticipating connectivity losses

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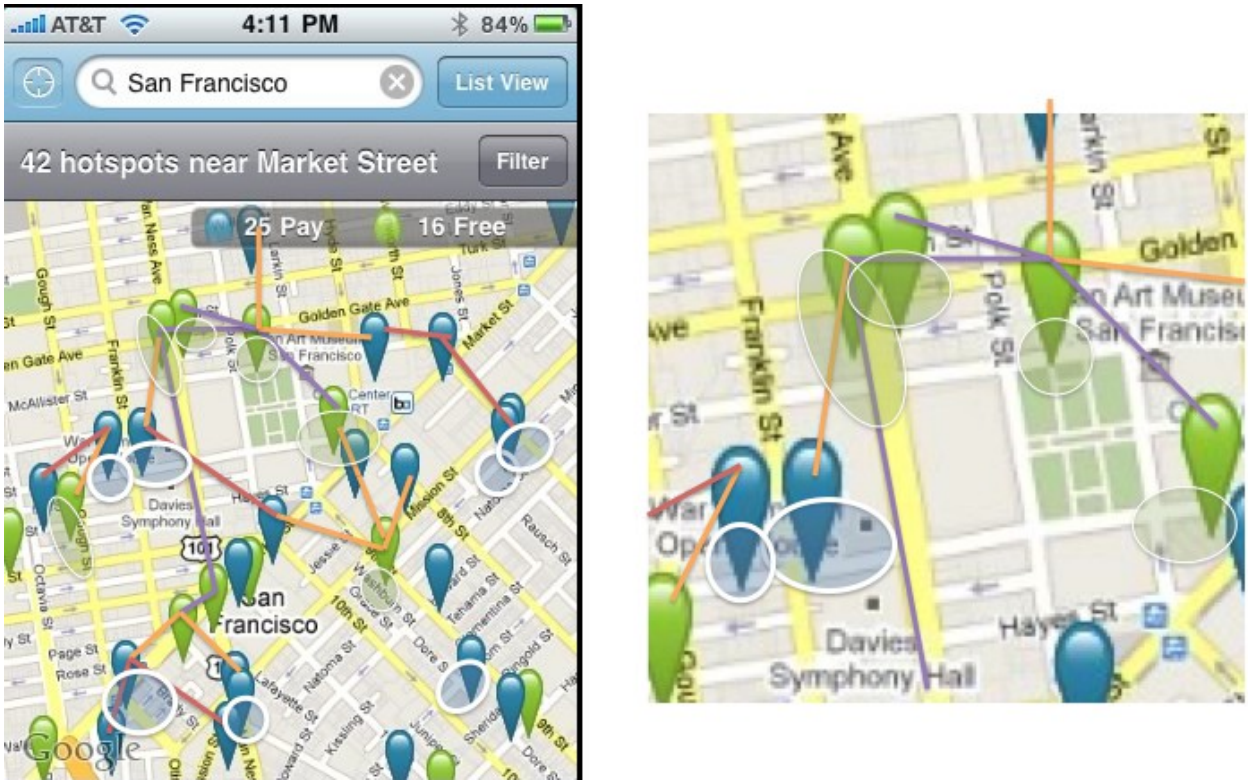

Figure 2 – Augmented Data Context – crowdsourcing of performance data

Figure 3 shows a person doing a walk routine at lunchtime and listening to Internet radio.

Its destination is marked in the map and the user have told the system its final destination,

The system recommends to street passing on front of the San Francisco Art Museum rather than taking the Golden Gate Ave (as he/she usually does) to hit one more Wi-Fi AP. Since the user is listening to Last.fm, the system also estimates loosing connectivity before arriving to the museum AP, hence, Last.FM might at some point buffer the current song and potentially another song in advance, or play a song from the same type from the user local user in anticipation of a lost connection.

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REFERENCES

[802.11] Telecommunications and information exchange between systems—
Local and metropolitan area networks— Specific requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications, IEEE, 2007

[802.11k] Telecommunications and information exchange between systems—
Local and metropolitan area networks— Specific requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment 1: Radio Resource Measurement of Wireless LANs, IEEE, 2008

[802.11u] Telecommunications and information exchange between systems— Local and metropolitan area networks— Specific requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment 9: Interworking with External Networks, IEEE, 2011

b. Why was the invention developed? What problem(s) does the invention solve? How is it better?

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Today Wi-Fi roaming capabilities are very limited to define the interfaces and protocols used to switch between access points (e.g., [802.11r]) with proper authentication. There are no solid criteria to decide when to switch from one access point to another at what time in order to offer a satisfactory customer experience by means of stable. This solution attempts to fill that gap with generic principles worth to disclose for free usage by the patent owners.

c. Briefly outline the potential commercial value and customers of the invention.
Mobility is a next frontier for the high-speed data and content distribution; a market that is in its early development. As Service providers extend the HSD home/office access with mobility, a seamless switch between mobile networks is needed to offer a great customer experience and minimize applications and content disruption.

This invention provides with unique principles and capabilities to either offer in a private, public, federated or as a wholesale business opportunities to differentiate from competitors in a very large and profitable market.

4. **HOW is this invention different from existing products, processes, systems?**
The large number of networks and operators offering mobile HSD have limited the options for interoperability beyond authentication between networks. All those solutions follow the low level procedures to gain access to other networks, and perhaps limited to the yet complex authentication procedures and agreements; or current solutions require the clients to perform those actions manually, with the consequences of loss on productivity, and inadequate customer experience.

By using contextual data and smart decision automation the operators can offer to mobile clients accurate yet dynamic strategies to guarantee effective roaming, while keeping loose coupled authentication and roaming.