

# Mobile-Initiated Handoff Amongst Disparate WLAN and Cellular Systems

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# Mobility Scenario

- Mobile Node (MN) provisioned by a Wireless Service Provider (WSP) called the Primary WSP
- Primary WSP has Service Level Agreement (SLA) with other service providers including WLAN operators
- MN has multiple disparate interfaces to communicate with
- Even though Mobile IPv4 is being used as an example at the Layer 3 for this contribution, the mechanisms proposed could be used with any other Layer 3 technology

# Mobile IPv4 to Support Mobility

- Mobile IP introduces new network entities
  - Home Agent (HA)
  - Foreign Agent (FA)
  - Mobile Client running on the Mobile Node (MN)
- Scenarios of network connectivity for MN
  - From Home Network
  - From Visitor/Foreign Network (any network other than Home Network)

# Mobile IPv4 to Support Mobility

- Home Agent is the anchor point for the MN if it is in a Visitor Network
- Foreign Agent provides the current point-of-attachment for the MN to the network
  - If FA not present, MN can operate with a co-located Care of Address (CoA)
- Mobile Client implements the mechanism to initiate a mobility session and maintain it until it is explicitly terminated by the client or physical media exists for communication

# Mobile IPv4 to Support Mobility

- Mobile IP helps in maintaining Layer 3 session across networks
- An IP address assigned by the Home Network is used to maintain a continuous session across networks
  - IP address may be private or public
  - IP address may be statically or dynamically assigned
- **But existing Mobile IP based mobility algorithms not sufficient for make-before-break handoff mechanisms (similar to CDMA 2000 soft handoff); Current mechanisms include**
  - **Based on Advertisement Lifetime**
  - **Algorithm based on Network Prefixes**

# Types of Handoff

- Network-Initiated Handoff
  - Good for Intra-Network handoff
    - For example, within 3G systems
  - Need mechanisms to identify handoff conditions as well as communication between corresponding network elements
    - Inter Base Station/Access Point communication
    - Inter RNC communication
    - Inter PDSN communication
    - Inter SGSN/GGSN communication
- Mobile-Initiated Handoff
  - Discussion of this talk

# Mobile-Initiated Handoff System Selection Algorithm (SSA)

- Monitor continuously all interfaces available at the MN
- Define WSP determined preference rules
- Define User determined preference rules
- Define for each interface with High and Low watermark signal thresholds for handoff initiation/termination
  - Avoids ping-pong effect of moving between interfaces

# Continuous/Periodic monitoring of Interfaces

- Interfaces can be monitored for the following:
  - Interfaces being active/inactive
    - Such as Wire line interfaces
  - An interface being viable is based on Radio Link Conditions such as Pilot Ec/Io, RSSI, etc.
  - Network System loading conditions
    - Either obtained using higher layer signaling
    - Or broadcast periodically by the network
  - Service Quality in terms of data bit rates obtainable from various systems
  - Cost of an interface



# Preference Management

- Mobile Client be equipped with preference management configuration tool
  - WSP preferences
  - Mobile User preferences
    - For example: If Mobile User provisioned by a 3G service provider then 3G service provider provisions user to access both 3G and WLAN systems (either through Service Level Agreements with WLAN operators or operating these networks themselves)
    - In absence of WSP preferences, user preferences take precedence
    - A UNION of the two determines the final decision matrix
  - Preference Management Matrix extended to multi-dimensional matrix depending of number of disparate interfaces, MN has access to simultaneously

# Example 1: A two dimensional Preference Management Matrix for two interfaces

Rules set by WSP:

$3G_{High}$  is preferred over  $802.11_{High}$

$3G_{Medium}$  is preferred over  $802.11_{Medium}$

$3G_{Low}$  is preferred over  $802.11_{Low}$

- Algorithm translates into a decision matrix

	$3G_{High}$	$3G_{Medium}$	$3G_{Low}$	$3G_{Unavailable}$
$802.11_{High}$	3G	802.11	802.11	802.11
$802.11_{Medium}$	3G	3G	802.11	802.11
$802.11_{Low}$	3G	3G	3G	802.11
$802.11_{Unavailable}$	3G	3G	3G	Work offline or sleep

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# Example 2: A two dimensional Preference Management Matrix for two interfaces

Rules set by WSP:

802.11<sub>Medium</sub> is preferred over 3G<sub>High</sub>;  
and 802.11<sub>Low</sub> is preferred over 3G<sub>Medium</sub>

- Algorithm translates into a decision matrix

	3G <sub>High</sub>	3G <sub>Medium</sub>	3G <sub>Low</sub>	3G <sub>Unavailable</sub>
802.11 <sub>High</sub>	802.11	802.11	802.11	802.11
802.11 <sub>Medium</sub>	802.11	802.11	802.11	802.11
802.11 <sub>Low</sub>	3G	802.11	802.11	802.11
802.11 <sub>Unavailable</sub>	3G	3G	3G	Work offline or sleep

# Signal Thresholds windows for each Wireless Interface

- Maintain High Watermark and Low Watermark Signal Thresholds for each wireless interface
  - Handoff is initiated through the interface only if signal is above the High Watermark for that interface and precedence rules allow a handoff
  - Similarly, users current interface is terminated and handoff to another available interface is the current system is below a Low Watermark and precedence rules allow a handoff to another system

# Maintaining List of SLAs

- For single accounting/billing from user perspective it is necessary that Service Level Agreements (SLAs) to exist between primary service provider and roaming operators
  - List of providers with which an SLA exists between the primary service provider and other operators could be obtained
    - Periodically obtained dynamically
    - Statically at the time of initial configuration of a user
    - Through a third-party consolidator of such databases

# Summary

- Mobile IP based mobility algorithms inadequate for make-before-break handoff
- New Mobile-Initiated algorithm
  - Provides make-before-break mechanism
  - Provides Preference Management
    - Preference matrix comprise of User Preferences and WSP Preferences
    - Provides a mechanism such that a WSP that provisions the MN gets priority over user preferences for various parameters
    - A UNION of user and WSP preferences determines the client configuration