Project	**IEEE 802.20 Working Group on Mobile Broadband Wireless Access** <**http://grouper.ieee.org/groups/802/20/**>
Title	**Mobile-Controlled Handoff for MBWA**
Date Submitted	**2003-03-06**
Source(s)	Samir Kapoor 135 Route 202/206 South Bedminster, NJ 07921 Voice: 908-997-2000 Fax: 908-947-7090 Email: s.kapoor@flarion.com
Re:	IEEE 802.20 Session#1 Call for Contributions
Abstract	This contribution discusses the merits of mobile-controlled handoff and the design implications for MBWA systems.
Purpose	For informational purposes only
Notice	This document has been prepared to assist the IEEE 802.20 Working Group. It is offered as a basis for discussion and is not binding on the contributing individual(s) or organization(s). The material in this document is subject to change in form and content after further study. The contributor(s) reserve(s) the right to add, amend or withdraw material contained herein.
Release	The contributor grants a free, irrevocable license to the IEEE to incorporate material contained in this contribution, and any modifications thereof, in the creation of an IEEE Standards publication; to copyright in the IEEE's name any IEEE Standards publication even though it may include portions of this contribution; and at the IEEE's sole discretion to permit others to reproduce in whole or in part the resulting IEEE Standards publication. The contributor also acknowledges and accepts that this contribution may be made public by IEEE 802.20.
Patent Policy	The contributor is familiar with IEEE patent policy, as outlined in Section 6.3 of the IEEE-SA Standards Board Operations Manual <http://standards.ieee.org/guides/opman/sect6.html#6.3> and in *Understanding Patent Issues During IEEE Standards Development* <http://standards.ieee.org/board/pat/guide.html>.

Benefits of Mobile-Controlled Handoff for MBWA

Samir Kapoor

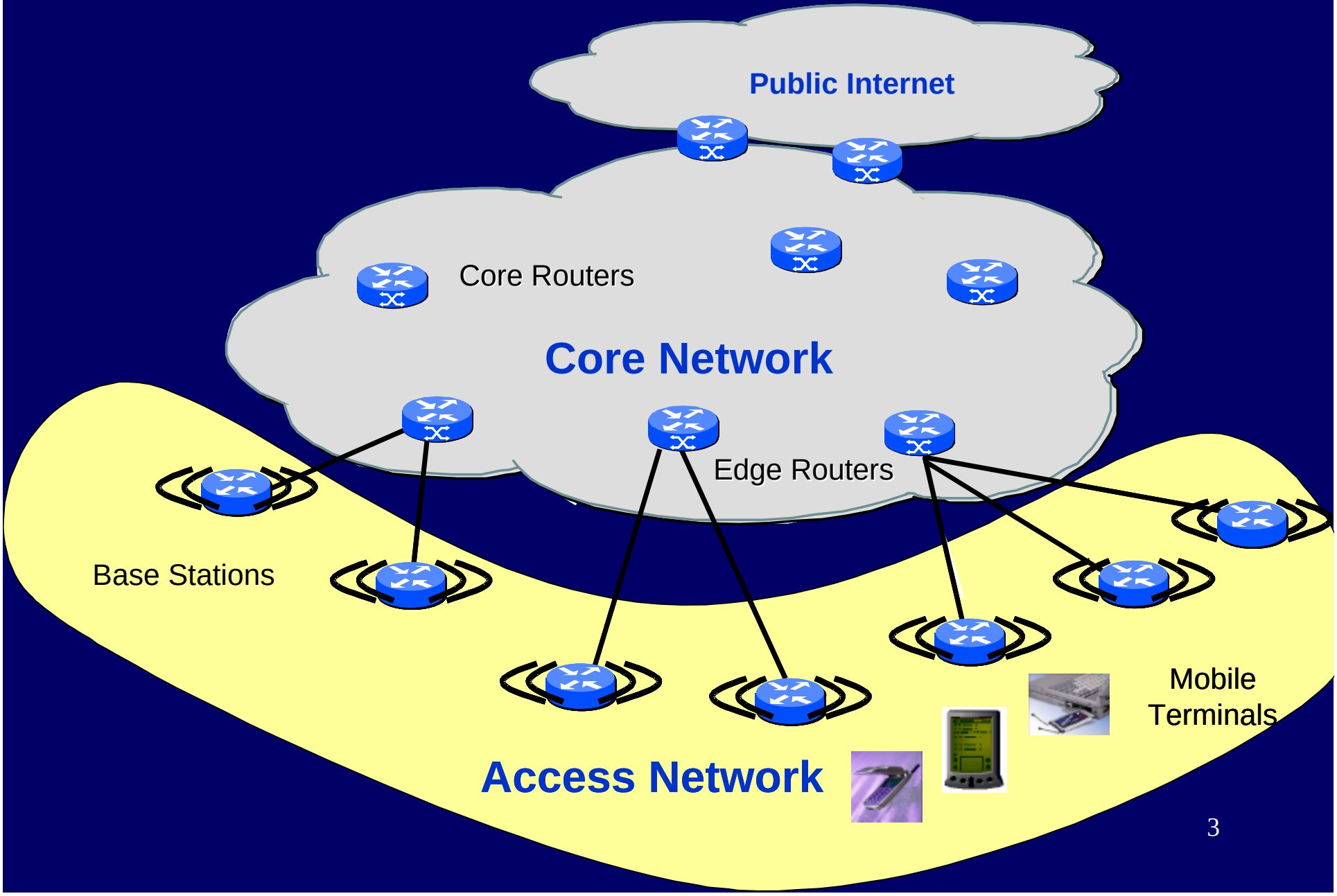
IEEE 802.20 MBWA

March 10-13, 2003

Outline

- Overall System Architecture
- MBWA desired characteristics for handoff
- Mobile-controlled handoff benefits
- Comparison with Network-controlled handoffs
- Mobile-controlled handoff mechanism
- Relationship with Mobile IP
- Key points

True Packet-Switched Cellular Architecture



Desired Characteristics for Handoff: Overall System

- Distribute handoff control consistent with IP architectures
- Optimize for DL/UL packet-switched data traffic
  - "packet aware" handoff algorithms
- Eliminate/minimize packet loss, packet re-ordering and delay at handoff with vehicular mobility
  - Transparent to applications
  - Provide seamless user experience
  - Maintain robust link at all times
- No PHY layer synchronization between BSs
  - Simplify access network design and implementation
  - Only Inter-Base Station control message exchanges ("context transfers")

Desired Characteristics for Handoff: Air-Interface

- Minimize MAC/Network layer signaling overhead
  - Optimization crucial for high speed handoffs
- Minimize latency for handoff decisions
  - Mobile acts without delay
- Minimize Interference
  - Mobile terminal in best position to monitor relative DL quality of multiple Base Stations
  - Mobile knows UL interference it will cause to multiple Base Stations

Drawbacks of Network-Controlled Handoff Approach for MBWA

- Implicitly assumes “dumb-mobiles” and “smart-network”
  - Was better suited for circuit-switched networks
  - Does not fit well with IETF decentralized mobility mgmt protocols such as Mobile IP
  - Limitations on scalability and flexibility
- Requires new “Network Handoff Controller” entity in layer above Base Stations
  - Architectural impact
  - Having distinct mobility controller and base stations creates artificial separation between handoffs and other PHY/MAC/LLC activities
  - Requires re-invention of complex, fault-tolerant system for coordinating handoffs
  - Requires re-invention of “inter-handoff-controller” protocols

Network-Controlled Handoff Drawbacks (continued)

- Significant overhead and latency for handoff signaling
  - Transport to/from Base Stations and Mobiles
  - Latencies worst under congested and high interference conditions
- QoS issues
  - To ensure QoS for network-controlled handoffs, need to have centralization and tight coupling of handoffs with radio resource management
  - This results in significant architectural changes, complexity and signaling overhead
- Limitations on inter-technology handoffs
  - Only mobile has knowledge of multiple networks
  - Policy-based handoffs still need to be mobile-controlled

Mobile-Controlled Handoff Benefits

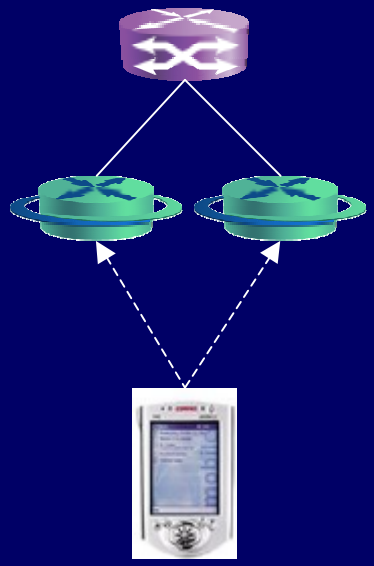
- Overall System benefits
  - Handoff decisions are completely decentralized
  - Highly scalable
  - More fault tolerant
  - Ideally suited for pure packet-switched networks with distributed control and intelligent end devices
  - Harmonious with IP-based mobility mgmt protocols e.g. MIP
- Air Interface Benefits
  - Reduced latency and overhead for Mobile-Network parameter reporting and inter-BS coordination
  - Superior inter-sector/cell interference control

Outline

- Overall System Architecture
- MBWA desired characteristics for handoff
- Comparison with Network-controlled handoffs
- Mobile-controlled handoff benefits
- **Mobile-controlled handoff mechanism**
- Relationship with Mobile IP
- Key points

Mobile-Controlled Handoff Stages

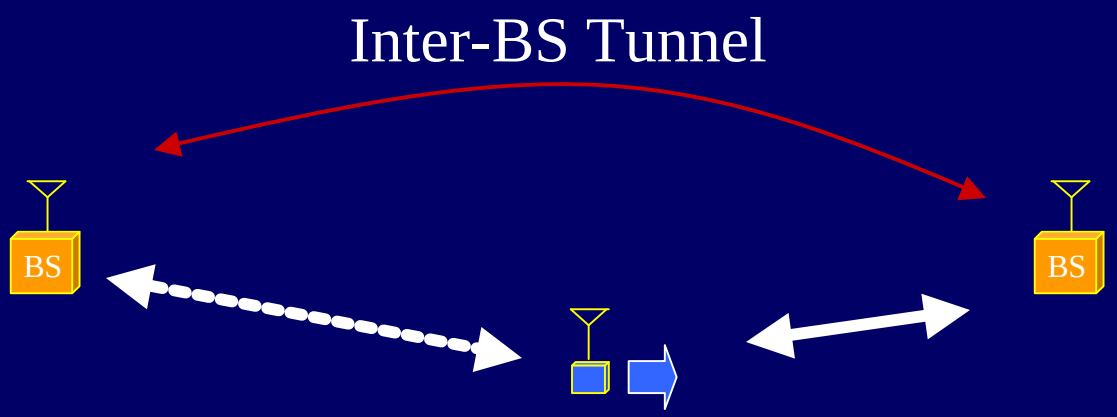
- Base Station Selection
  - Mobile maintains candidate Base Station Lists
  - Entry and Exit criterion for list based on
    - Relative DL channel quality from multiple Base Stations
    - Relative UL interference Mobile can generate for multiple Base Stations
    - Mitigating “ping-pong” based on relative powers (ratio and duration)



Mobile-Controlled Handoff Stages (cont'd.)

- PHY sync
  - Mobile scans, detects and locks onto new Base Station
- PHY Layer exchange
  - Contention-based access, Request air-link resources
- MAC layer exchange
  - Ideally contention-free for this and all higher-layer signaling
  - Mobile allocated airlink resources, authenticated, authorized, registered
  - Provides L2 triggers for mobility mgmt. protocols (e.g., MIPv4)
- Network Layer exchange
  - Specific to the mobility mgmt. protocol
  - Mobile prepares to send/receive IP traffic (e.g., DHCP)

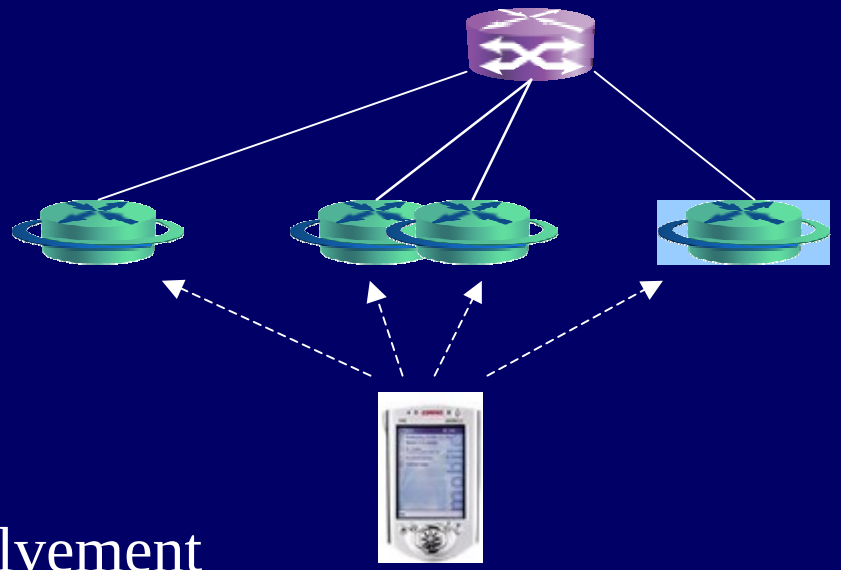
Mobile-Controlled Handoff Types



- Break-before-Make
  - Mobile maintains PHY and MAC connectivity with one Base Station at a time
- Make-before-Break
  - Mobile maintains PHY and MAC connectivity with more than one Base Station
- Inter-BS data transfer and signaling protocols can ensure seamless mobility via minimal packet loss, re-ordering and delay

Various Handoff Scenarios

- Within MBWA
  - Inter-cell
  - Inter-sector
  - Inter-carrier
- Inter-technology
  - Limited PHY/MAC involvement
  - Handoff decision best with Multi-mode Mobiles
  - Generally policy-based
  - Significant back-end involvement (billing, accounting, authentication, key management, roaming agreements etc)



Higher Layer Mobility Management Protocols

- PHY/MAC layer handoff mechanisms must enable flexibility in selection of higher layer mobility management protocols, e.g.,
  - Mobile IP (MIPv4, MIPv6)
  - Emerging host routing solutions
- Should also provide mechanisms (e.g., signals or triggers) to optimize higher layer mechanisms
  - MIP fast handoff
  - Context transfer
- Note that IP design philosophy places complexity/intelligence in the end systems
  - E.g., Mobile IP is mobile-controlled!

Key Points

- Mobile-Controlled Handoff is ideally suited for a packet-switched MBWA air-interface
  - Eliminates centralized “handoff controller” logical entity
  - Overall network architecture is simpler, more scalable and more fault tolerant
  - All handoff intelligence distributed at Network edge (Base Stations and Mobiles)
  - Harmonious with IETF Mobility Mgmt protocols such as Mobile IP
  - Consistent with multiple handoff scenarios (inter-sector, inter-cell, inter-carrier, inter-technology)
  - Uses inter-BS signaling
  - Requires no inter-BS synchronization

Key Points (Continued)

- Should precisely tailor handoff mechanism for MBWA
  - Handoff is the single most important aspect in delivering seamless user experience to end-user under vehicular mobility
  - Mobile-controlled handoff approach is efficient and fast
- Complexity and multi-faceted nature of finely-tuned handoff mechanism suggests:
  - Each system's air-interface requirements, architecture and optimization criteria are significantly different
  - Inter-technology seamless roaming is best harmonized at network and application layers