IP Networking Untethered

Alan O'Neill

Flarion Technologies

Link Layer Wish List

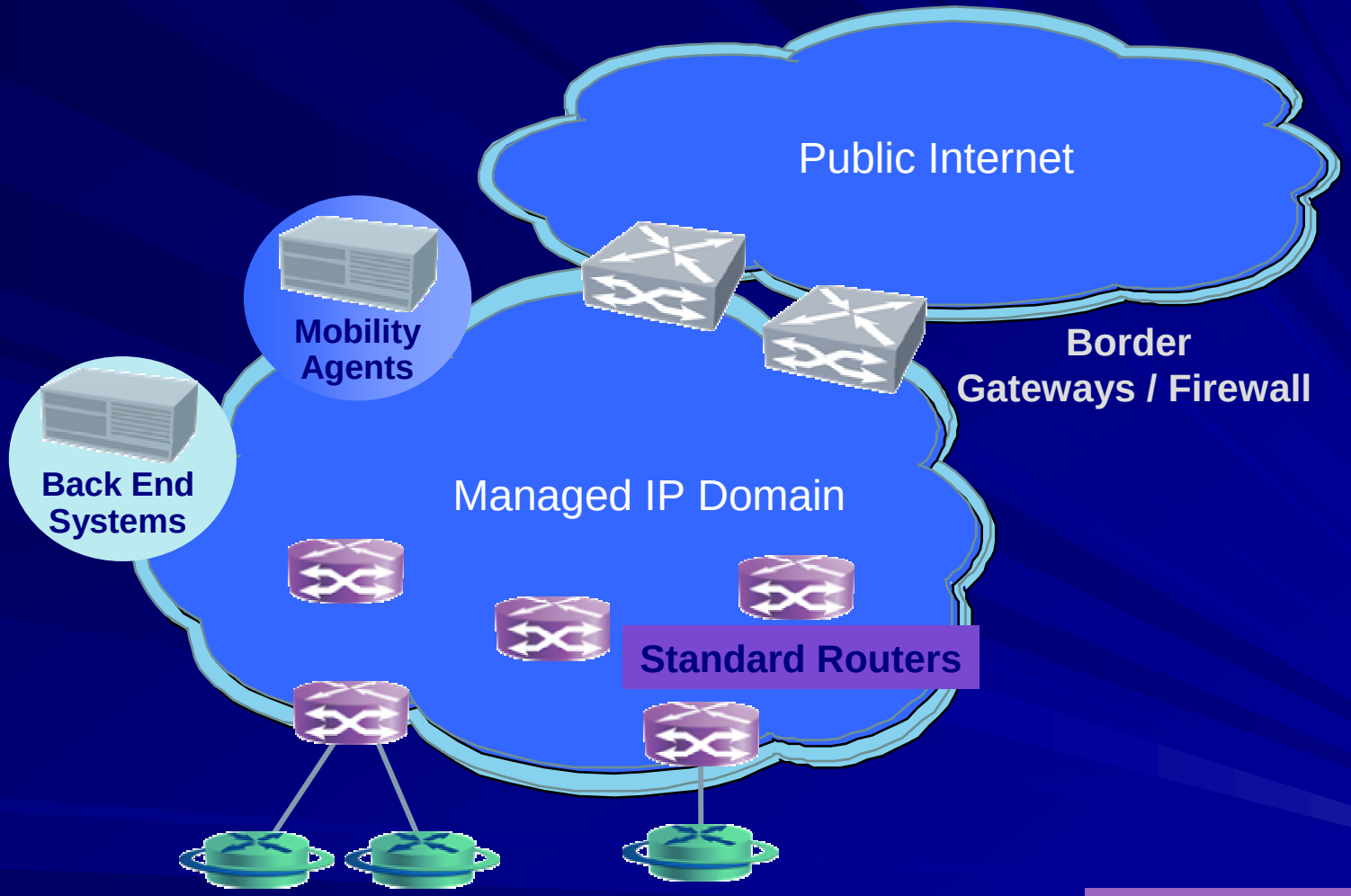
- **Reliable link**
  - Far fewer end-to-end retransmissions
- **Low delay**
  - Efficient transport layer (TCP/IP)
  - Interactive applications supported (VoIP)
- **Enhanced IP hand-off**
  - True make-before-break
  - Reliable seamless Mobile IP handoffs
- **Just another IP access link**
  - IP to the Basestation
  - Efficient IP Multicast
  - Optimal IP QoS control
  - Re-use IP Policy and management systems

Better User Experience

flash-OFDM™ Access Router

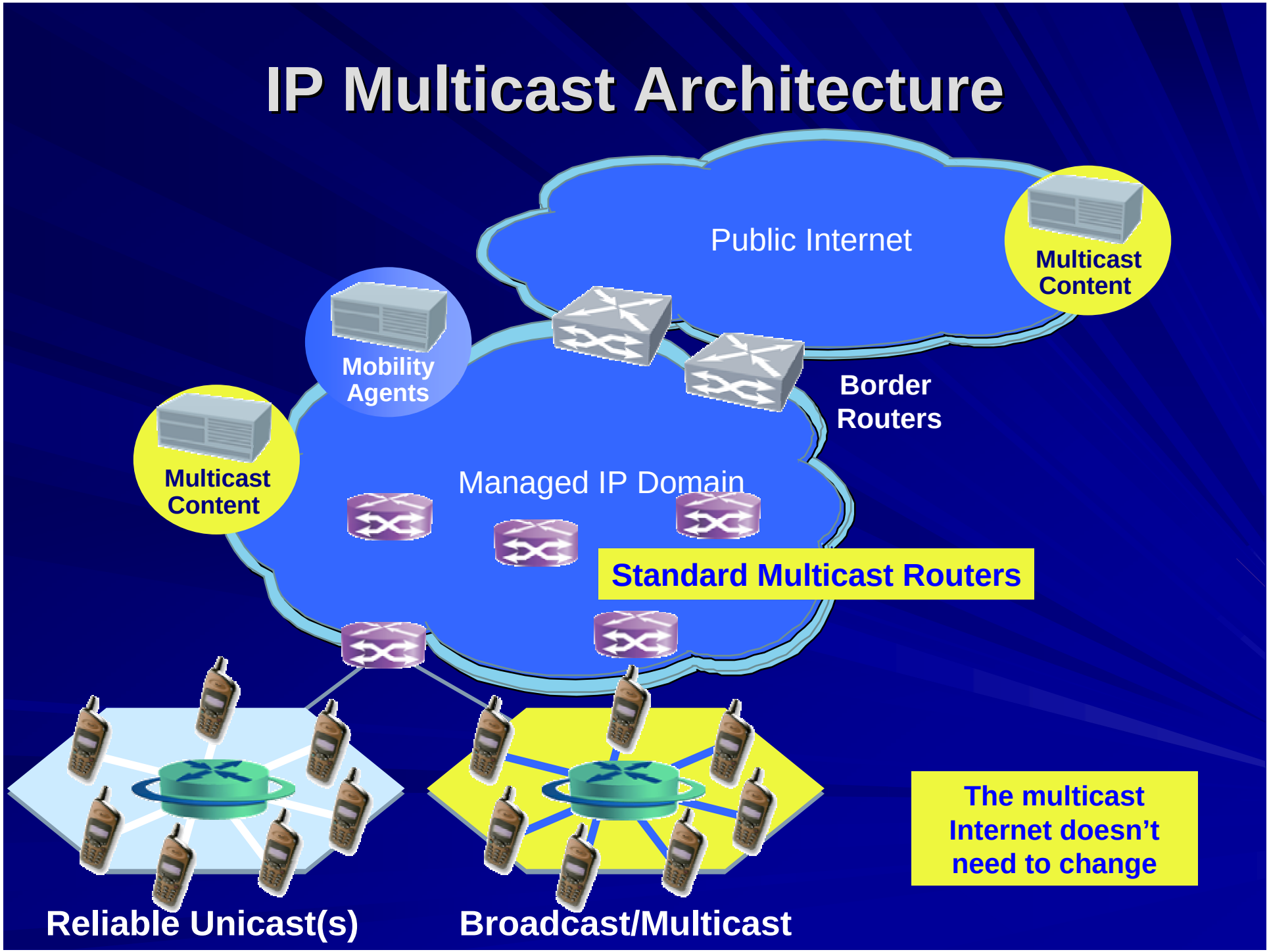
- **Combined Router and Base Station Functionality**
  - **Extends Wired Internet Experience to Mobile User**
  - **Adapts Wireless to the Internet and not vice-versa**
  - **IP unicast and multicast routing with hand-off**
  - **Enables Ideal TCP behavior over wireless**
  - **Enables IP-based cellular multimedia services**
  - **Maximizes Revenue/Hertz, not just bits/Hertz**

High Level Architecture

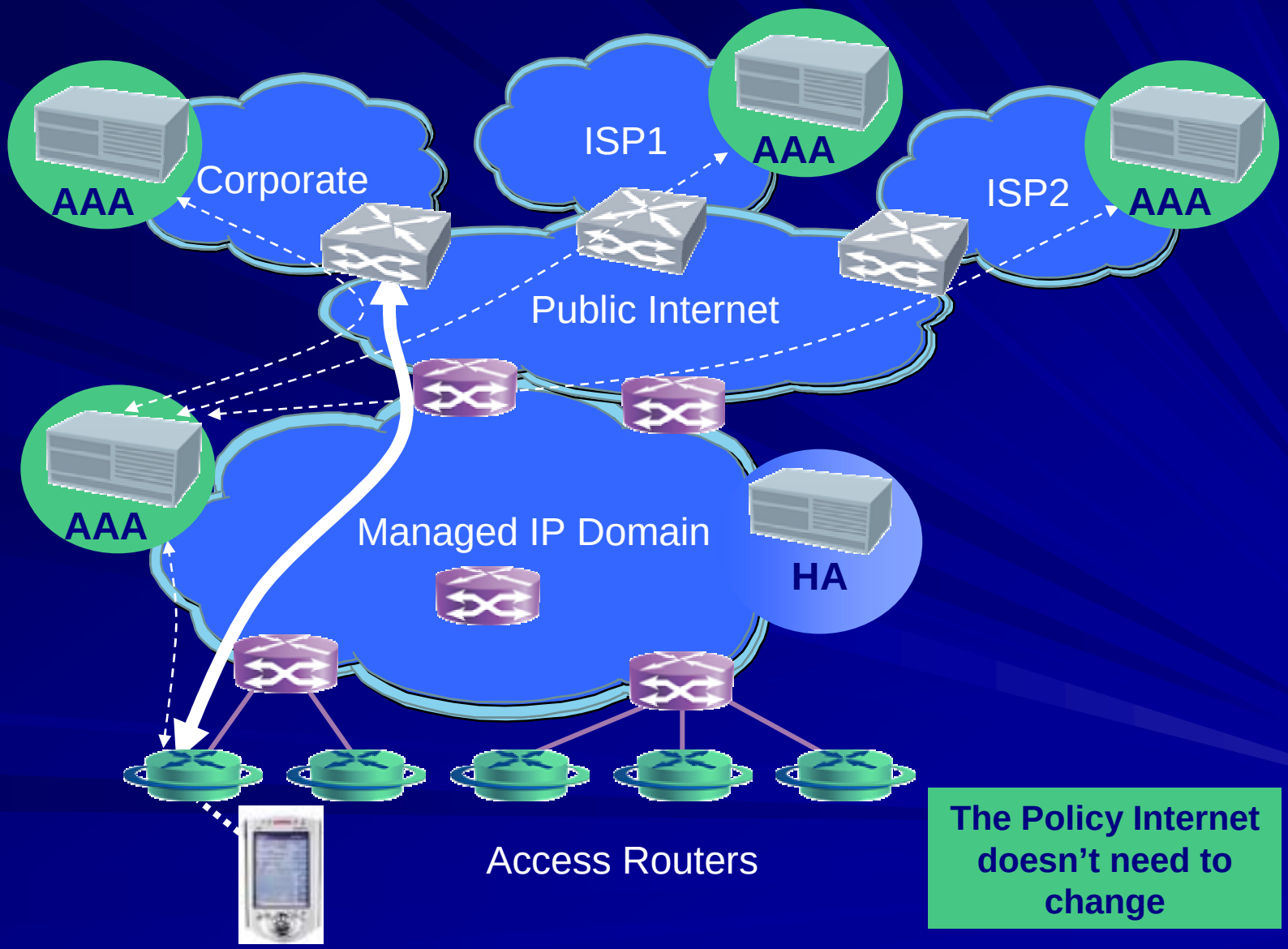


The Unicast Internet doesn't need to change

IP Multicast Architecture



Roaming/Mobility Models



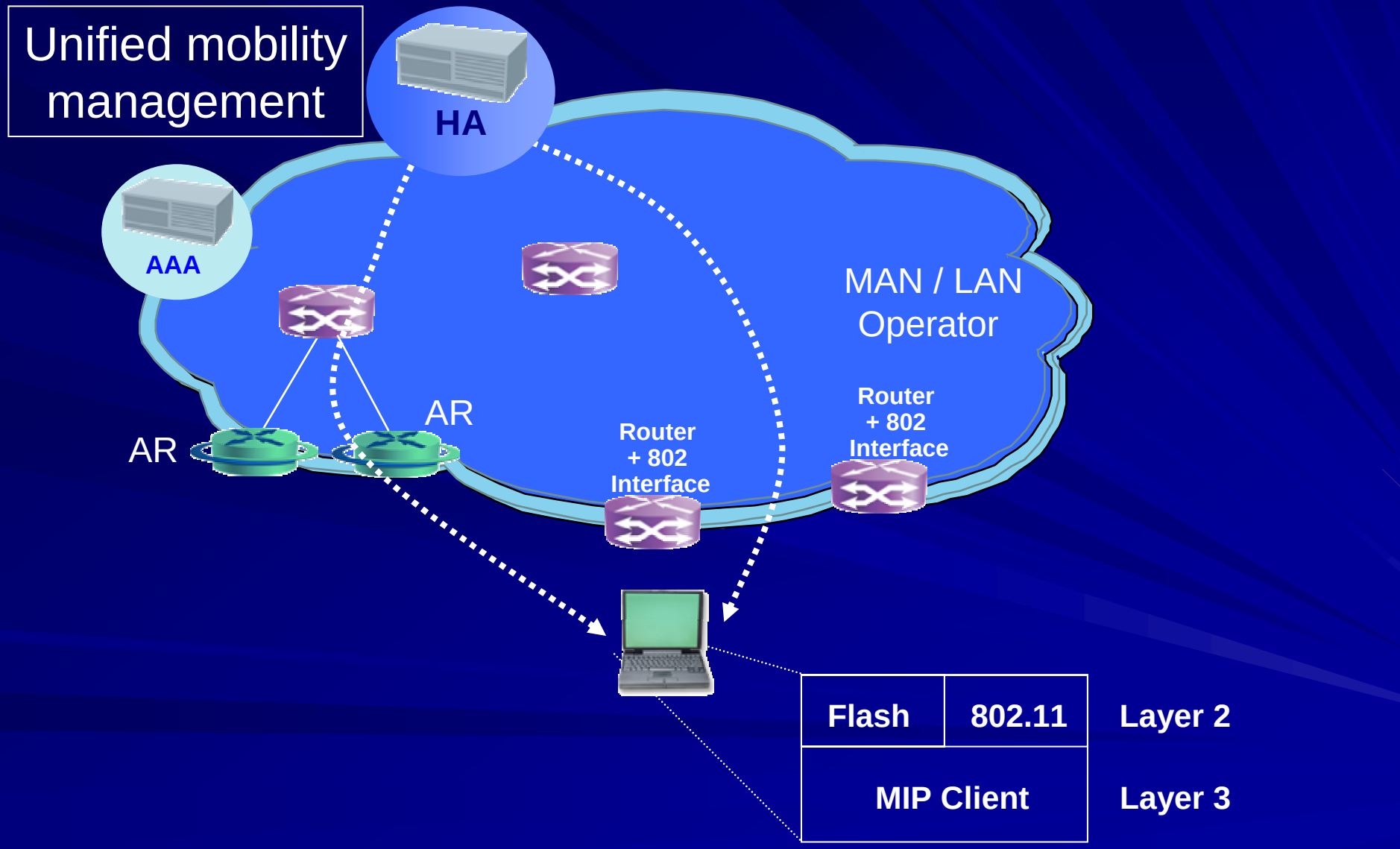
The Policy Internet doesn't need to change

IP Handoff Features

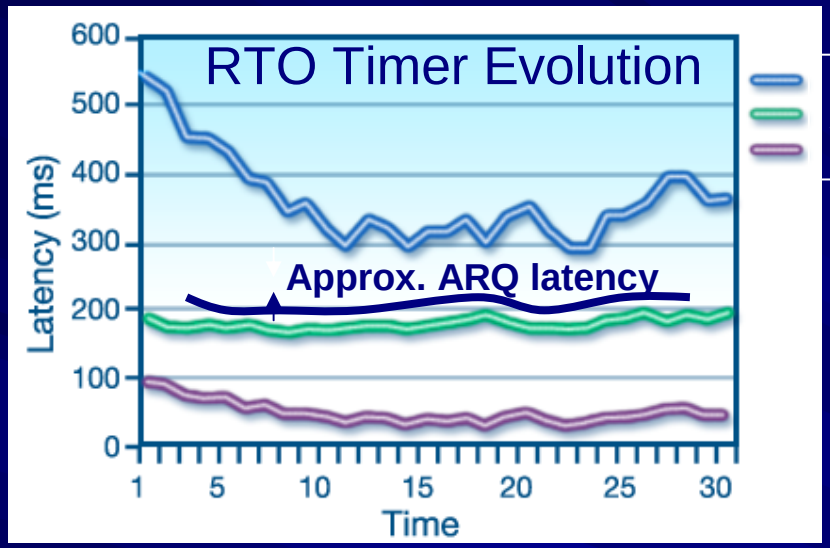
- Interoperable
  - Home Agent (HA) uses vanilla Mobile IP
  - Foreign Agent (FA) uses vanilla Mobile IP + hand-off extensions
  - facilitates inter-technology hand-offs
- Seamless to the user
  - Minimum packet loss and latency
- Robust
  - Proactive and reactive flavors

Mobile IP Handoff

Inter-Technology Handoff



flash-OFDM™ TCP Advantage



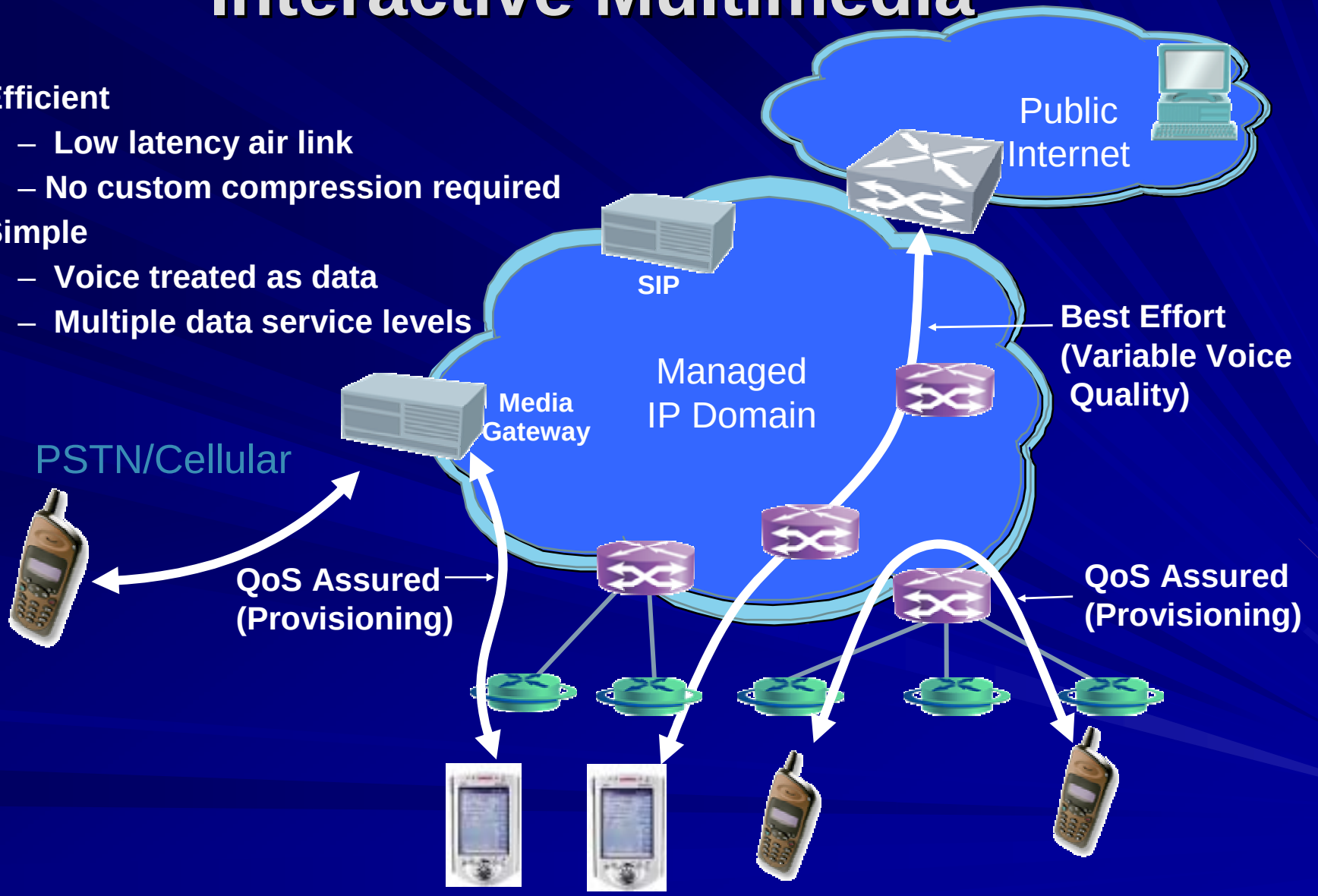
- Reliable link
- Adaptive TCP bandwidth discovery as per wired Internet

TCP BACK-OFF FAR LESS LIKELY

- **flash-OFDM™ ARQ latency below TCP Retransmission Time-Out (RTO)**
- **No need for wireless-specific modification**
- **Round Trip Times short**
  - **Interactivity and short-lived TCP transactions (web "mice") for a large user set**
- **TCP over 2.5/3G similar to TCP over Geo-synchronous satellites**
  - "Long delays cause TCP to react slowly"
  - "Transient congestions may take 10's of seconds to be resolved"
  - *TCP Options for Satellite Paths (RFC 2488) from Cisco IPJ, vol.3, no.2., Sept.2000*
  - *"TCP Over 2.5G and 3G Wireless Networks," Draft-ietf-pilc-2.5g3g-00.txt, Feb.2001*

Interactive Multimedia

- **Efficient**
  - **Low latency air link**
  - **No custom compression required**
- **Simple**
  - **Voice treated as data**
  - **Multiple data service levels**



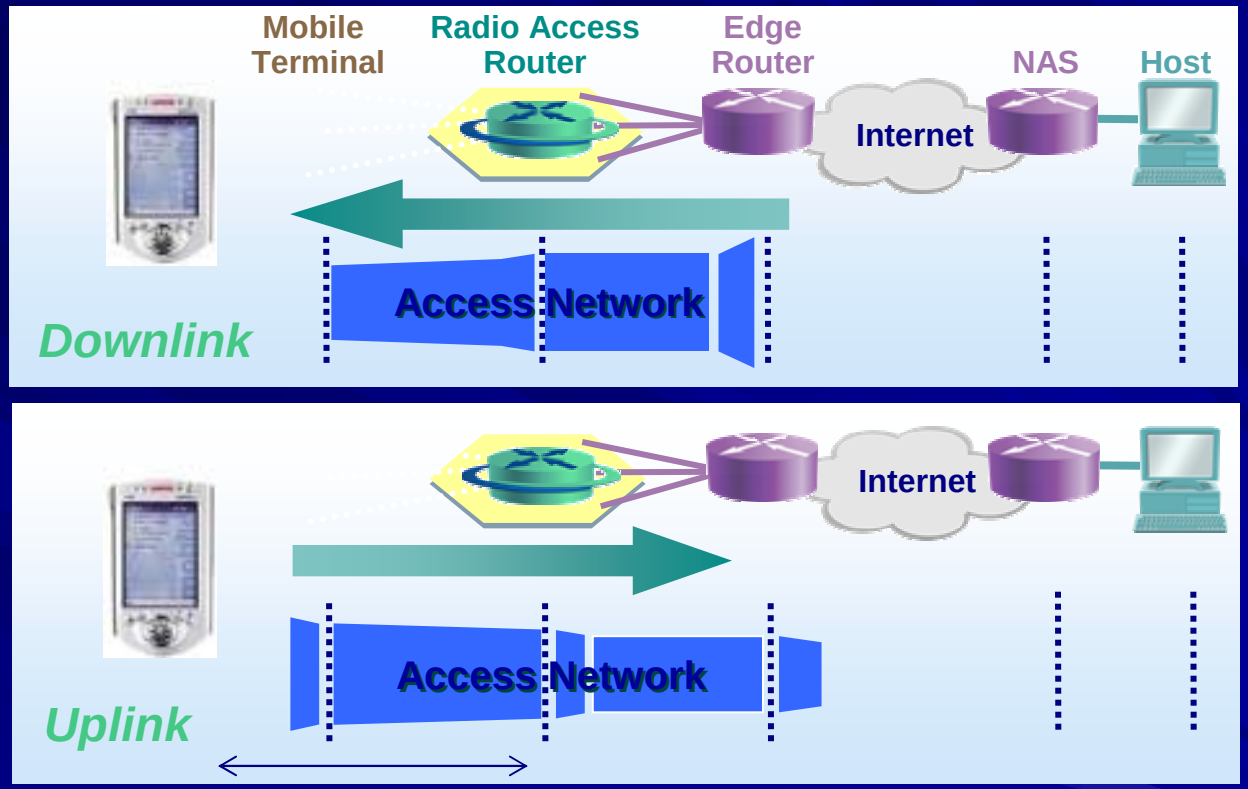
Maximizing Revenue/Hertz

Focus on Access Network and Not Just Air Link

Maximized Mobile role in IP Resource Management

Mobile Servers supported (e.g. 100 kbps cameras)

'Impedance Matched' Access Components

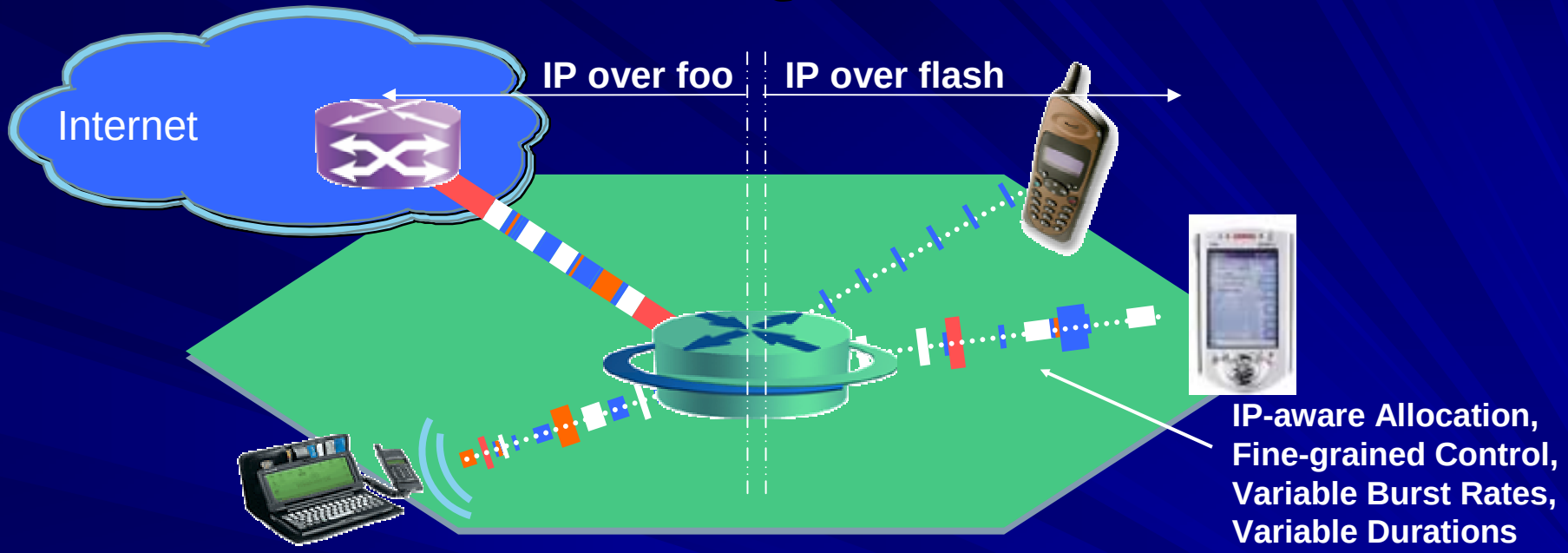


flash-OFDM IP QoS

IETF IP QoS Standards

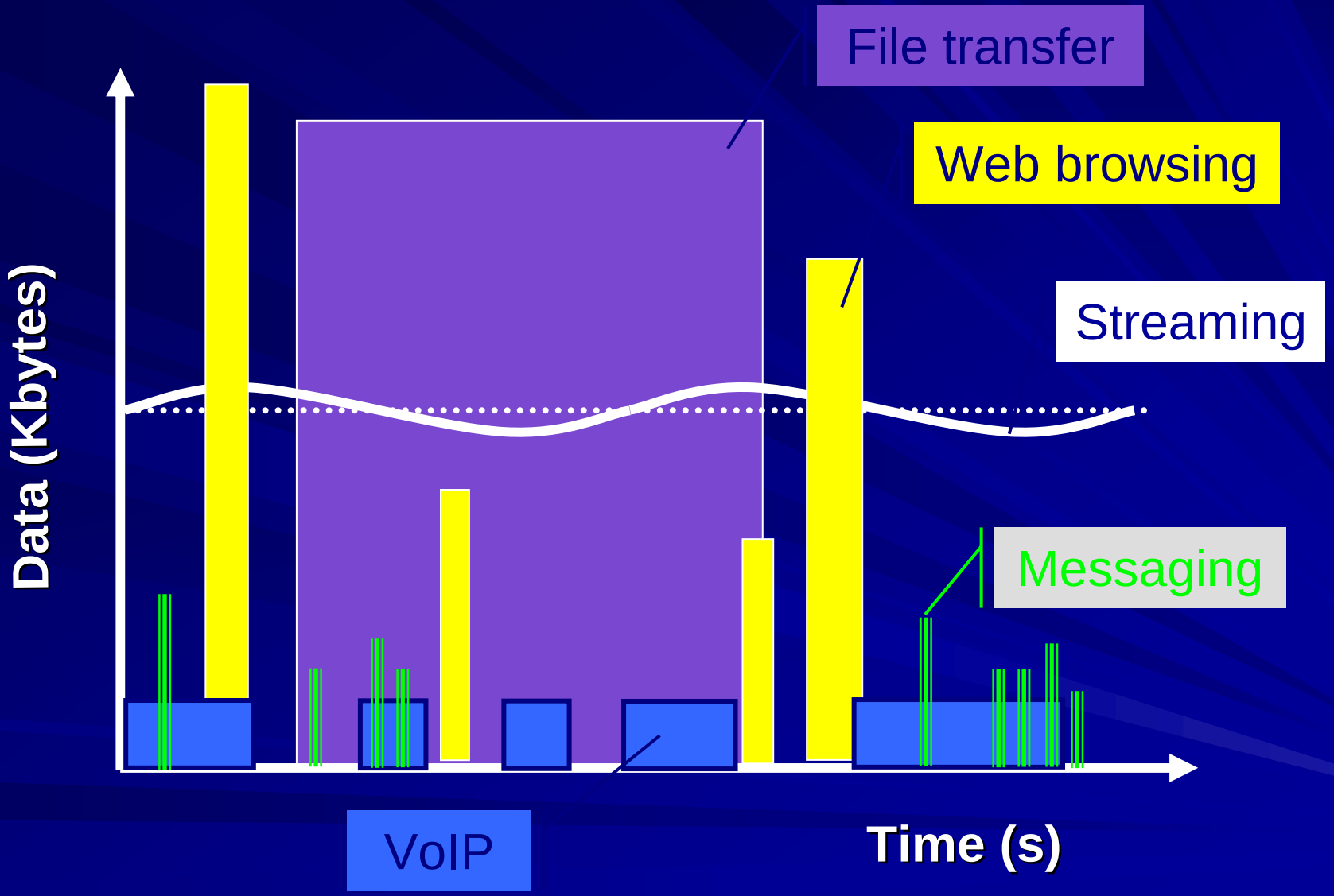
- **IETF standard 'tools' utilized at / between pinch points (Diff-serv, RSVP, etc.)**
- **Joint MAC / IP Layer optimization over air link**
- **Rich flexible QoS toolkit (unicast + multicast)**

Enablers for IP QoS 'Over the Air'

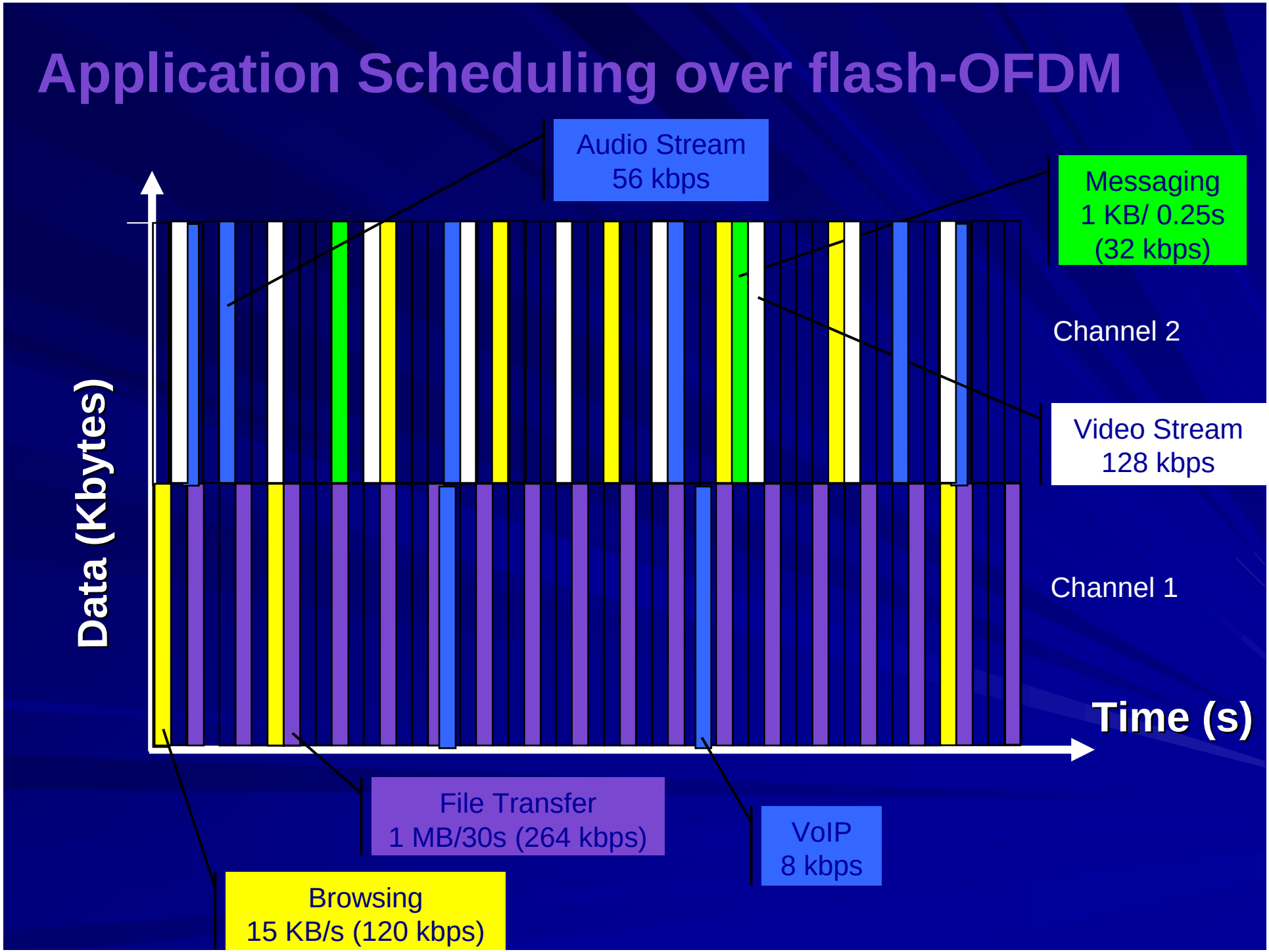


- **One wired backhaul, multiple 'wire-like' links**
  - Reliable, low latency air links with **minimal** mac layer QoS features
  - Operator-defined and customized IP QoS services
  - Fully integrated with AAA and user profiles
- **Link layer Unicast / Broadcast / Multicast**
  - Mobile can **simultaneously** receive unicast and multicast
- **Fully-scheduled, flash-OFDM air resource**
  - **Downlink:** IP aware scheduler in Access Router
  - **Uplink:** add generic, lightweight assignment requests

Applications and Data Flow



Application Scheduling over flash-OFDM



Flash-OFDM IP Advantage

- **Reliable link**
  - Far fewer end-to-end retransmissions
- **Low delay**
  - Efficient transport layer (TCP/IP)
  - Interactive applications supported (VoIP)
- **Enhanced IP hand-off**
  - True make-before-break
  - Reliable seamless Mobile IP handoffs
- **Just another IP access link**
  - IP to the Basestation
  - Efficient IP Multicast
  - Optimal IP QoS control
  - Re-use IP Policy and management systems

Better User Experience

“Every Bit Wireless”