Next Generation Wireless Networks:
Bringing Mass Appeal to 4G+

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Mobility + Wireless = Technology Innovation

2007-2010 may be to Ubiquitous Multimedia what 1993-1996 was to the Internet

- **2007: the beginning of the main phase of the next revolution:**
  - Ubiquitous Multimedia through converged networks

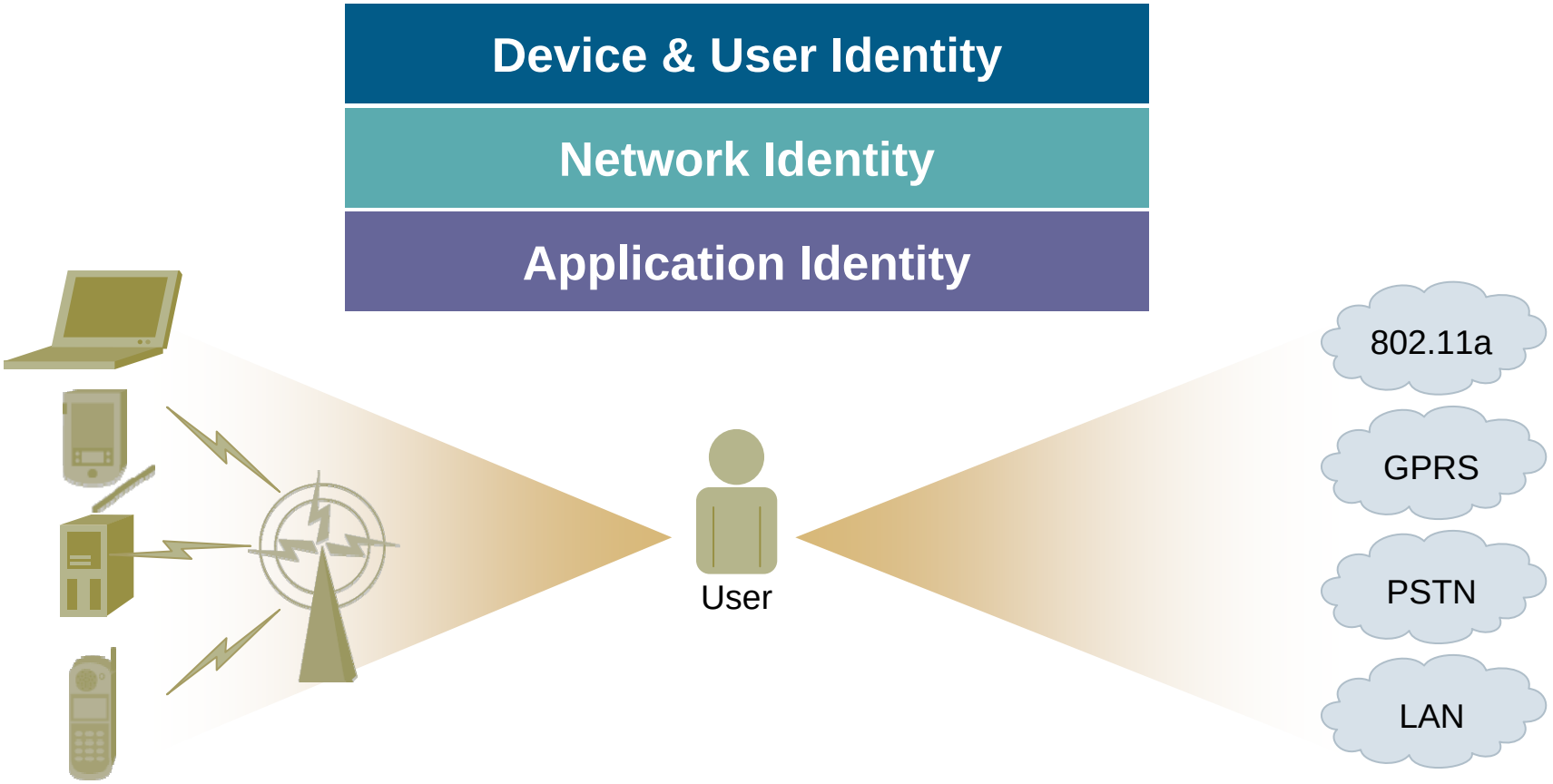
- **2010 and beyond: The Global Medianet**
  - Instantaneous, ubiquitous multimedia communications
  - High-speed connectivity is omnipresent
  - Focus on services and applications

The Silent Revolution

- Unification of two separate worlds:
  - Data applications (Internet)
  - Telecommunications

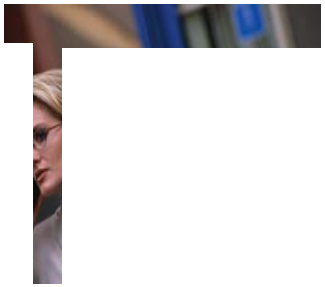
- The key tactical ingredients of the new revolution:
  - *Wireless* broadband is coming of age
  - *Mobility*
  - *Convergence*
  - *Device* evolution (embedded systems)
- The strategic ingredient of the new revolution:
  - *Embedded Intelligence:* Intelligent access networks

What is Convergence?



Multiple Devices	One User	A "Single" Global Access Network

The Global Medianet



“One” global, transparent network,

same rich multimedia services

any time, anywhere





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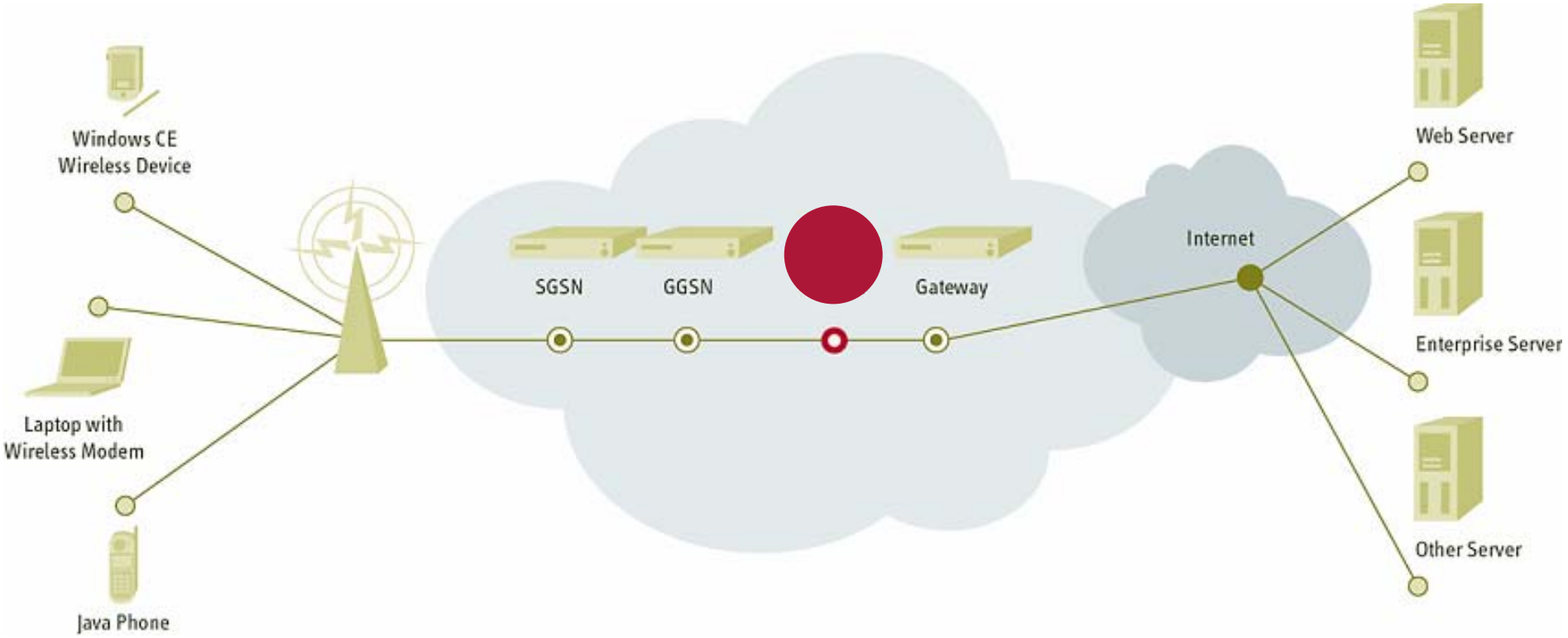
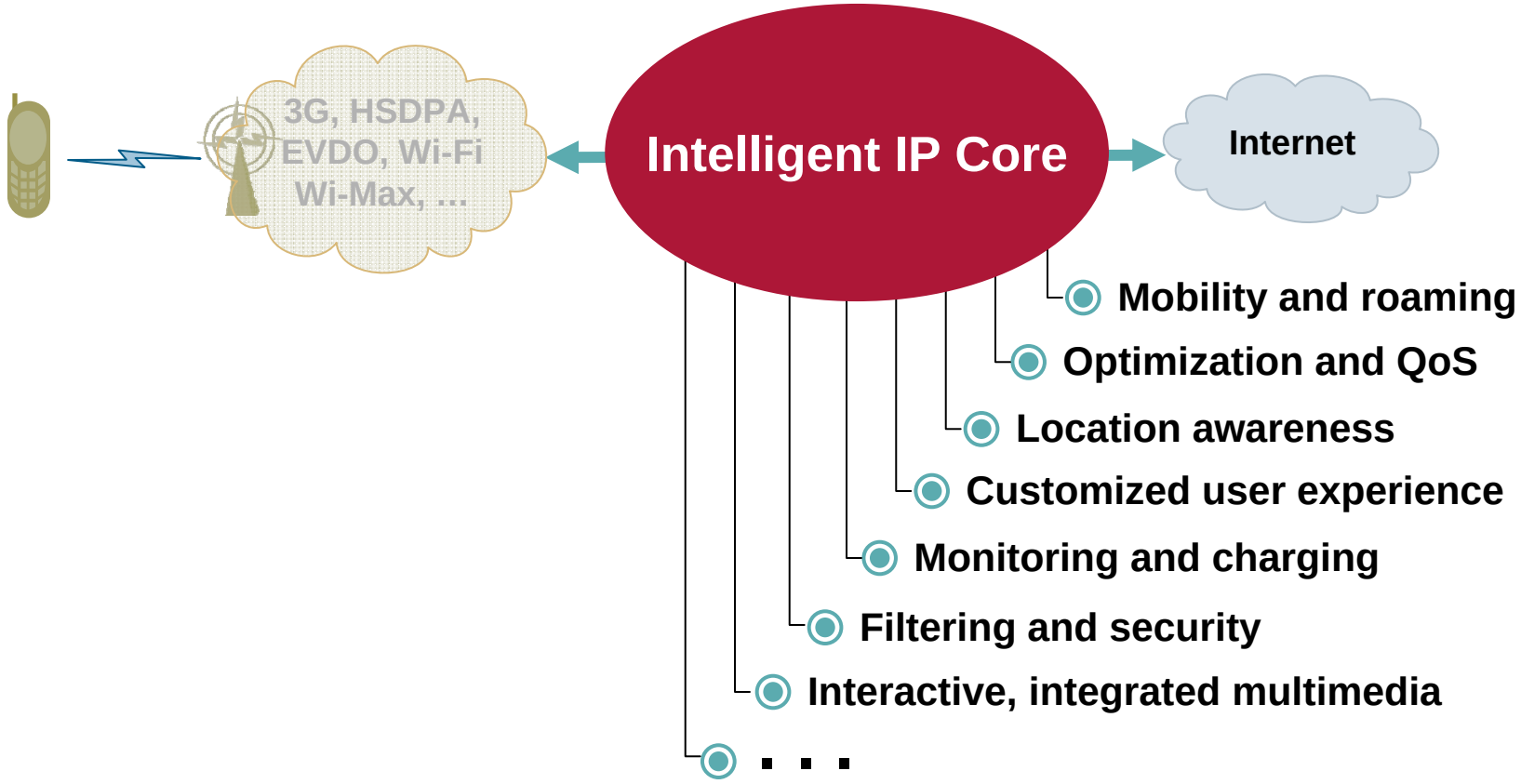
Overview of Wireless Network Architecture

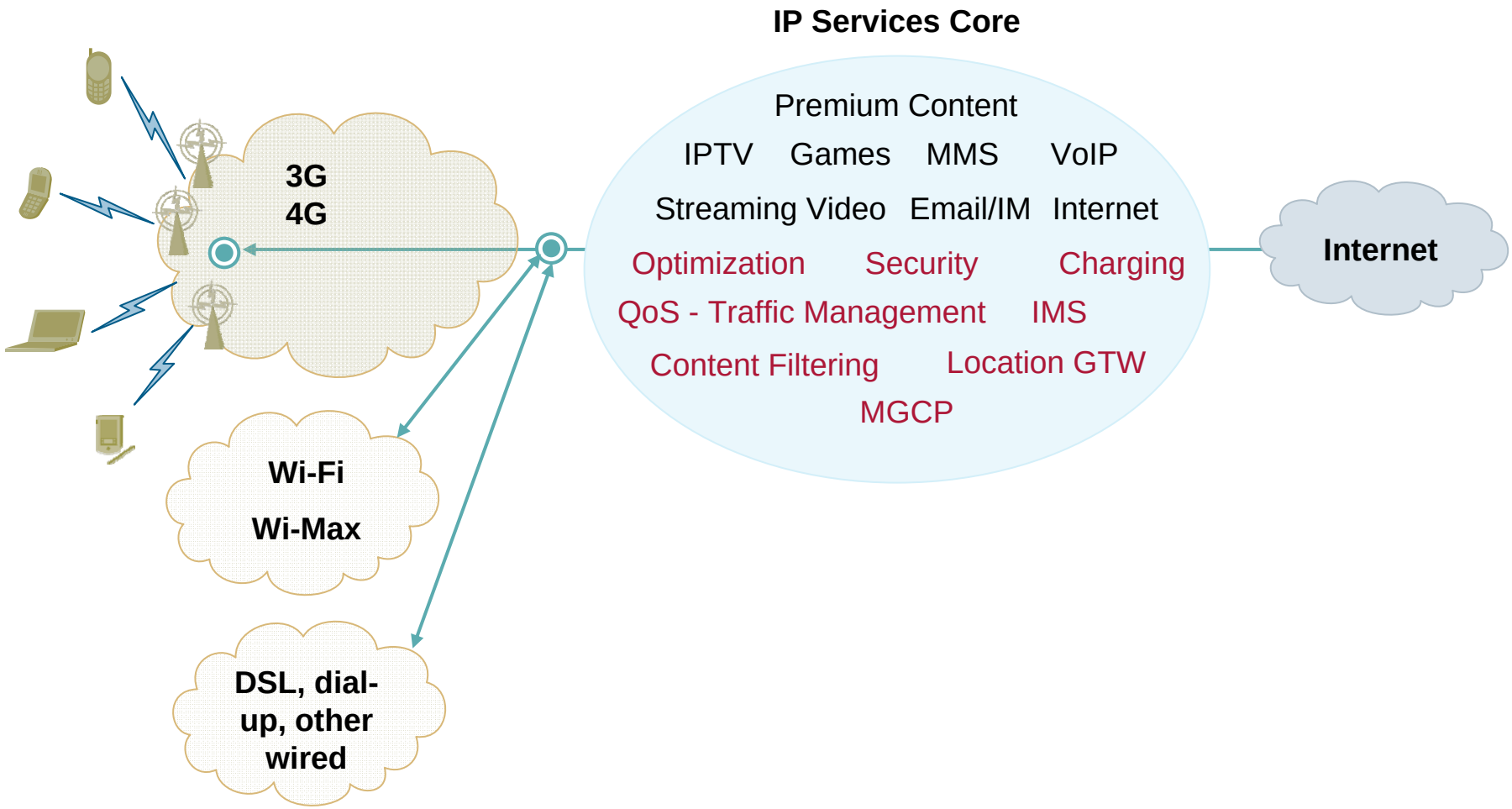


Smart, Next-Generation Networks: Focus on service

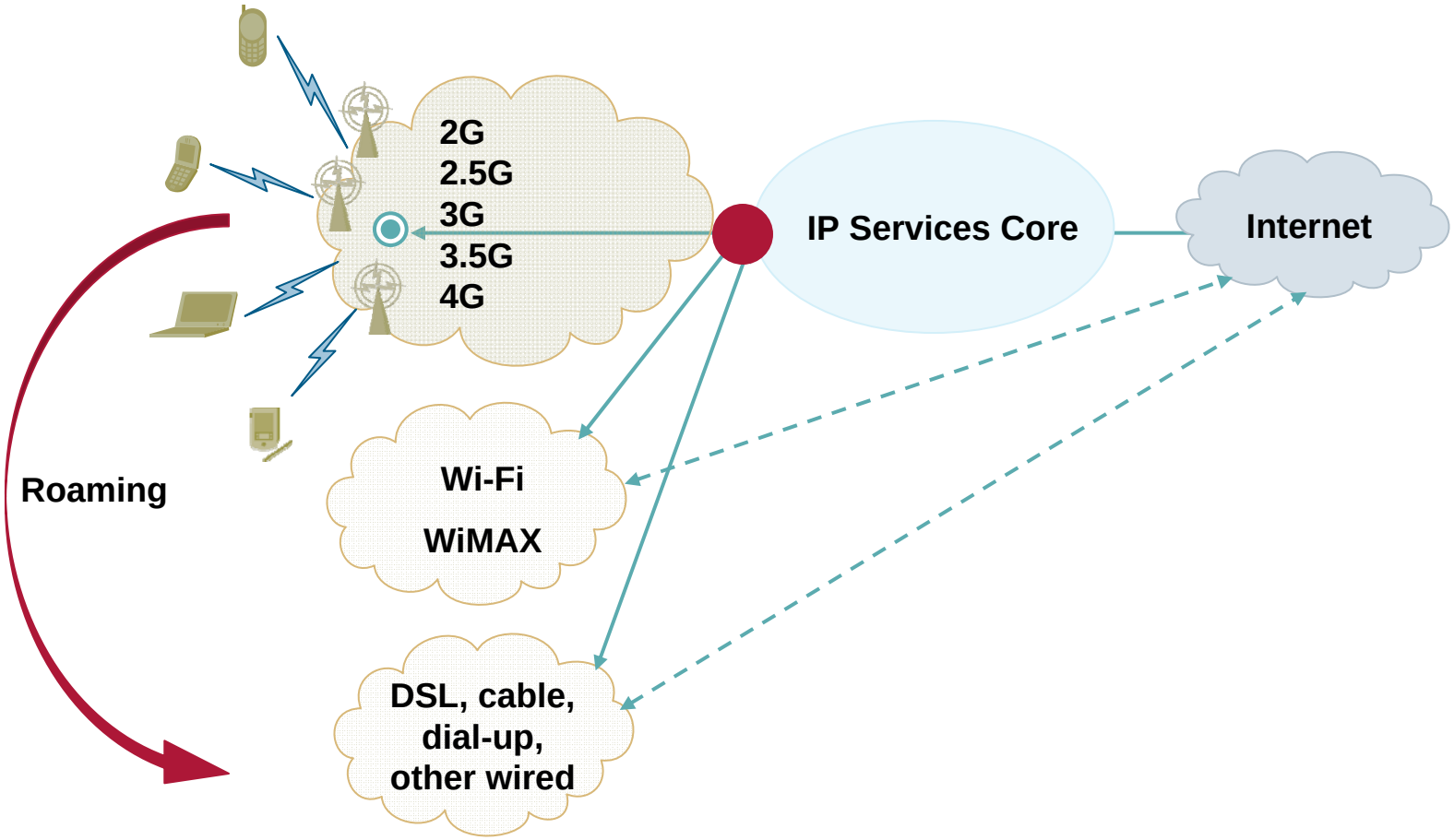
From simple connectivity to networks that sense, locate, react, customize, filter, charge, unify, simplify: *Toward a global service network*



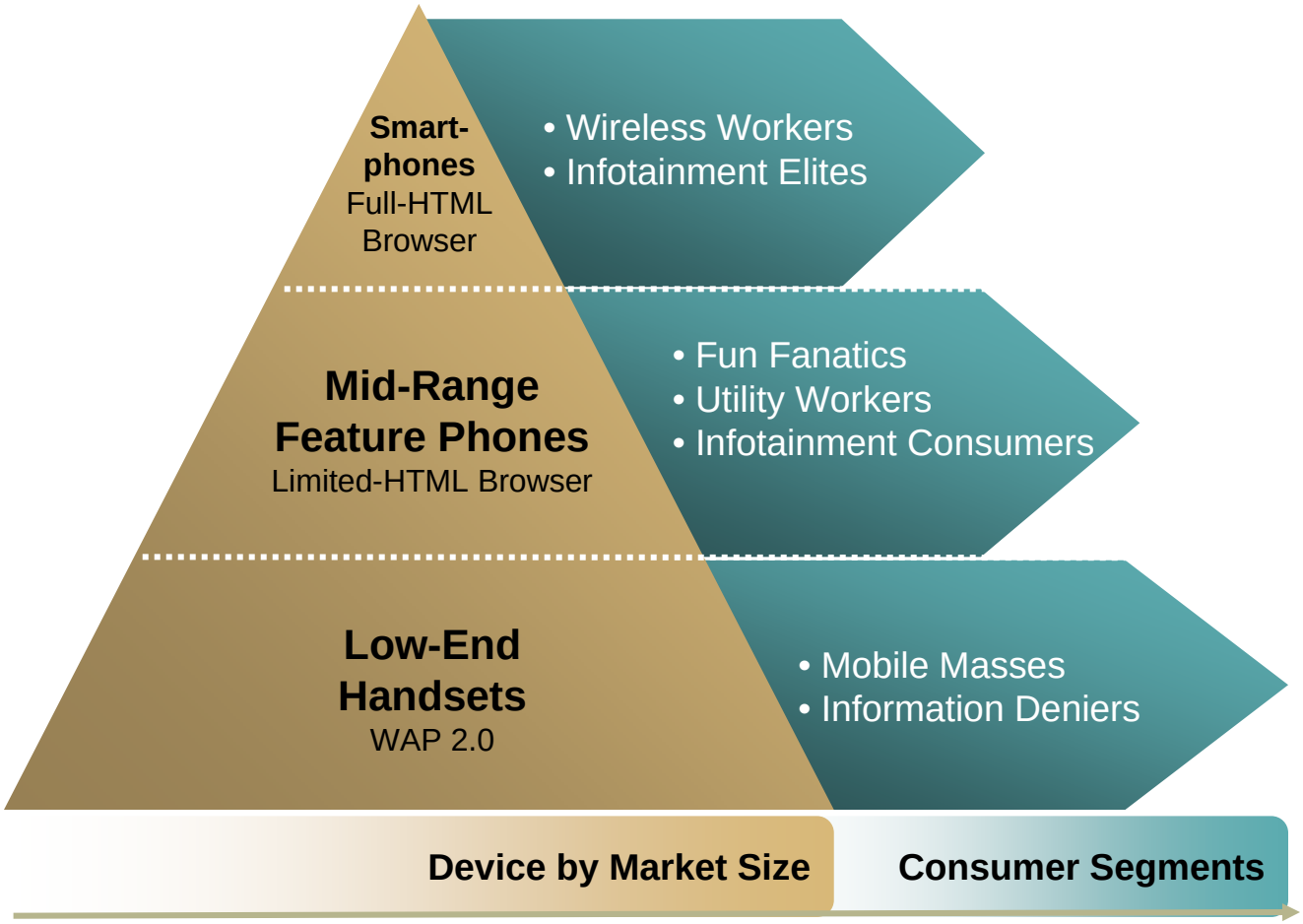
Intelligent IP Content Delivery



Optimization as a network requirement



Many limitations: Wide range of mobile devices



Users Get:

Limited Access to the Internet

- Low end browsers – cannot support most websites
- Limited open access – majority of accessible content is on the 'mobile Internet'
- Limited video or multimedia support

Users Get:

Slow, Cumbersome Experience

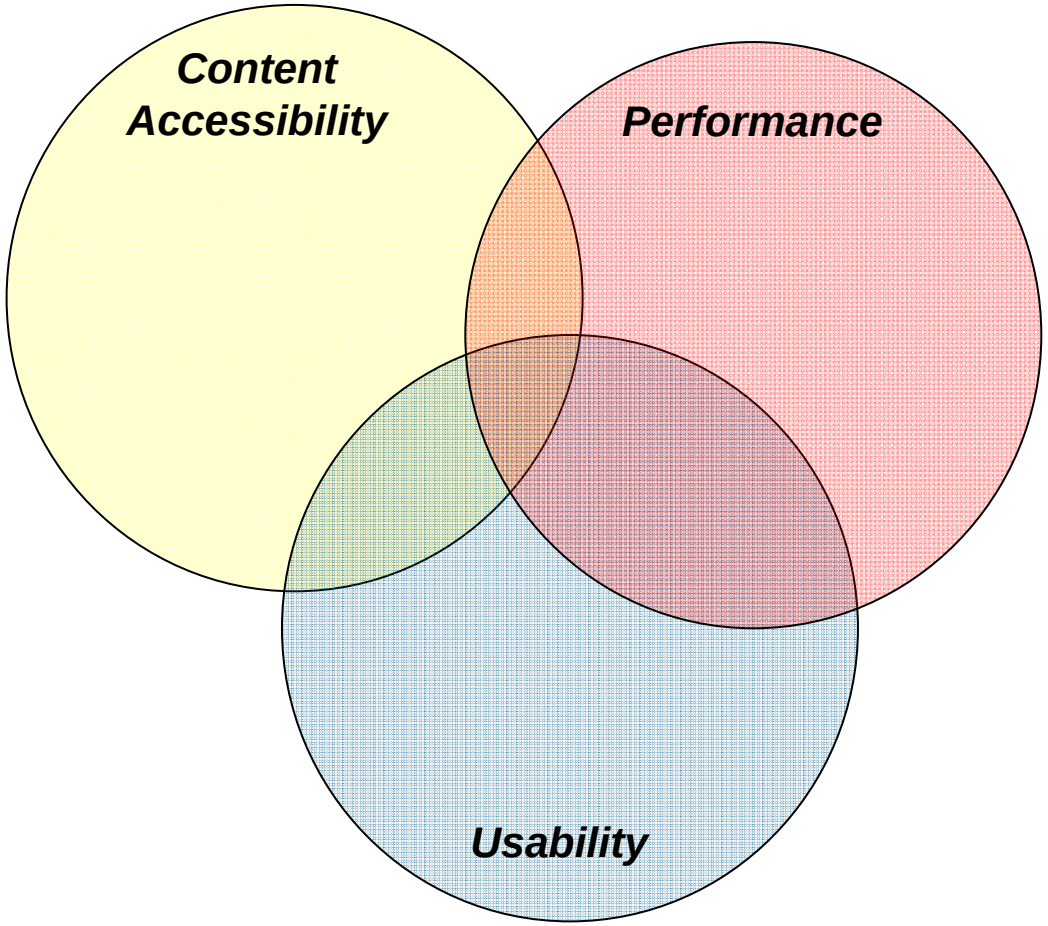
- ‘Dial-up like’ network speeds
- Series of links/directories on many mobile sites – difficult to navigate, extra loading time
- Non-qwerty keyboard handsets slow down browsing

High cost of access to the same content they get for free on their PCs

Intelligent IP Core Networks

- Can address most, if not all, client, server and bearer layer limitations:
  - Optimization
  - Content adaptation
  - Security
  - Video optimization (transcoding & transrating)
  - Multimedia adaptation
  - Location based services
  - Traffic monitoring and flow throttling
  - QoE

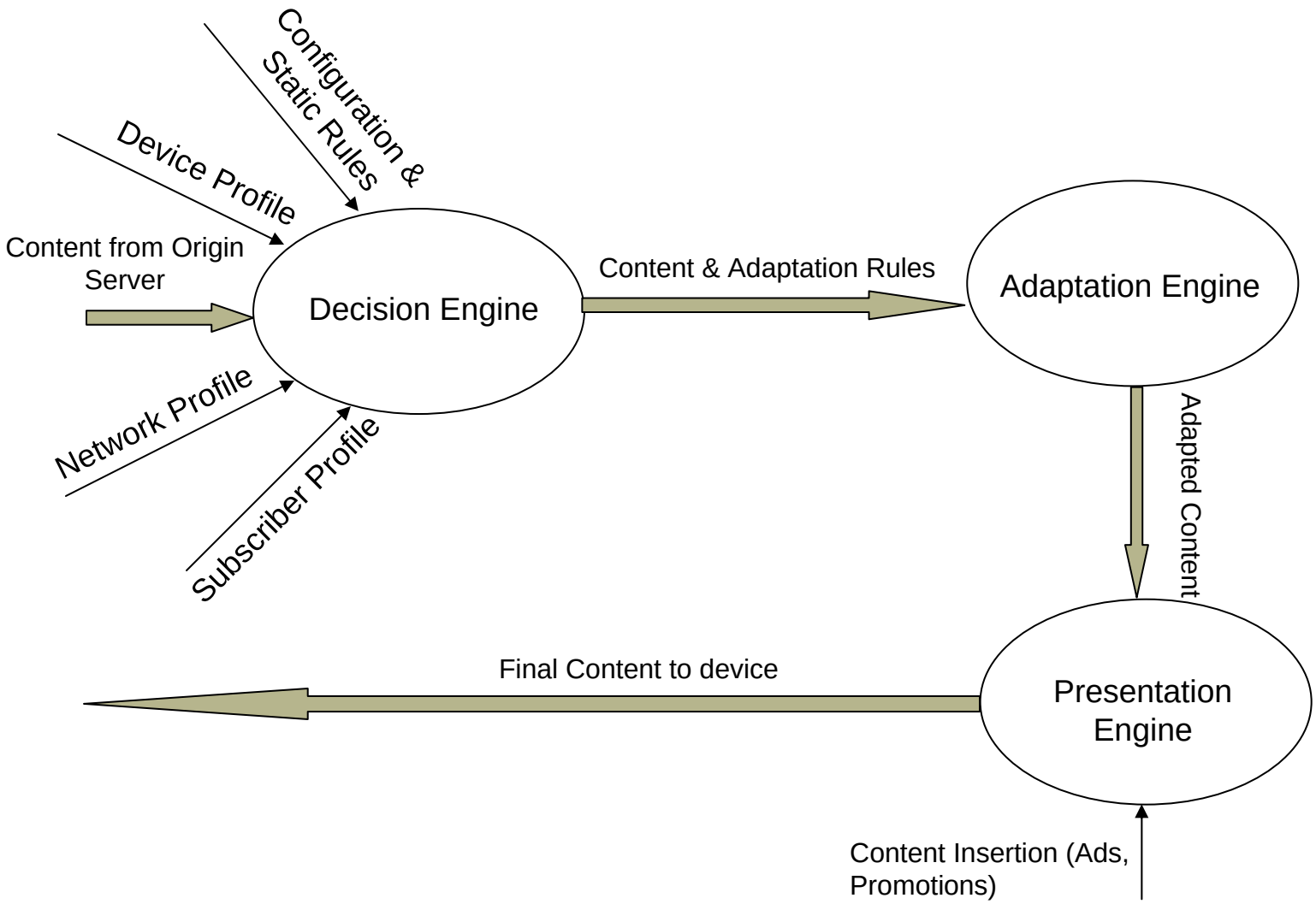
Intelligent Content Adaptation: Open Internet for all devices



Examples

Content Transparent	• Device Database Aware • Data Streamlining • Image Resizing, Compression • Dynamic Multipart Packaging • Content Tagging (Caching Enhancement) • Enhanced Browser Rendering (e.g. Fit-to-screen)
Content Modifying	• Handling frames • Content translation • Server side rendering execution (e.g. Javascript) • Page splitting • Ad Insertion

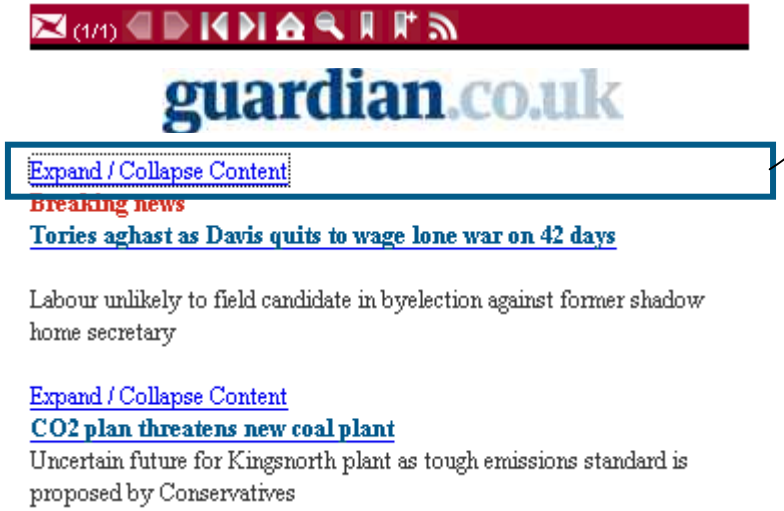
Content Adaptation Architecture



Example: Content Folding

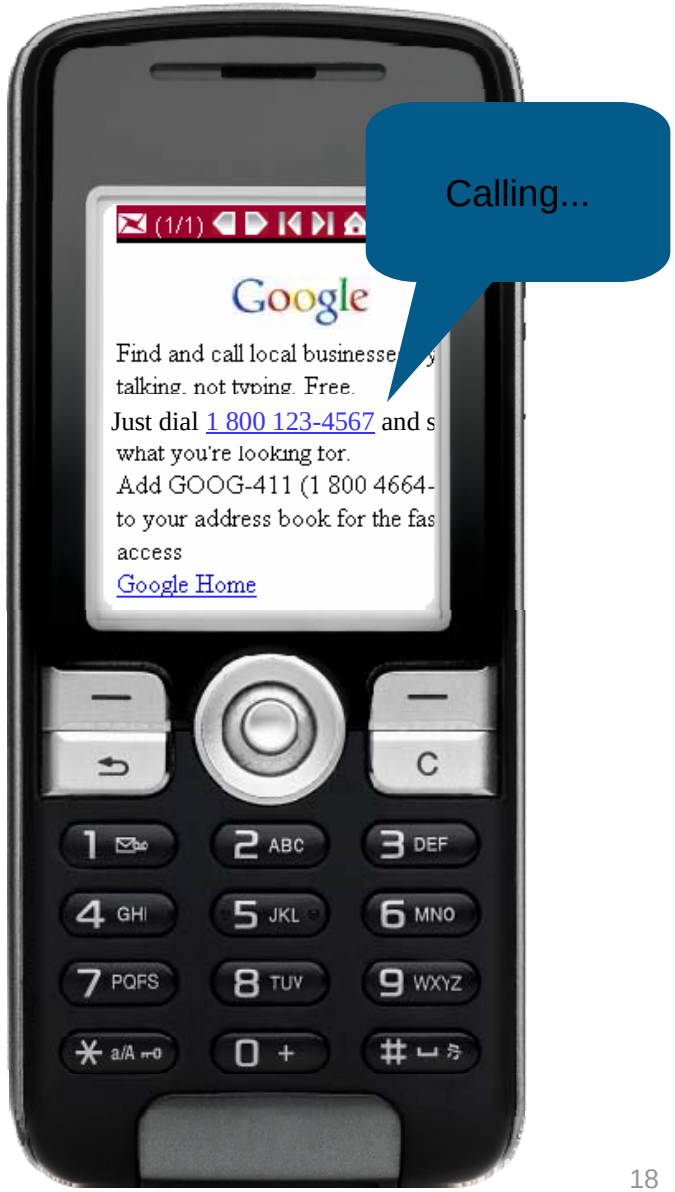
Menu links are folded into a drop down menu

User clicks the menu to expand the content

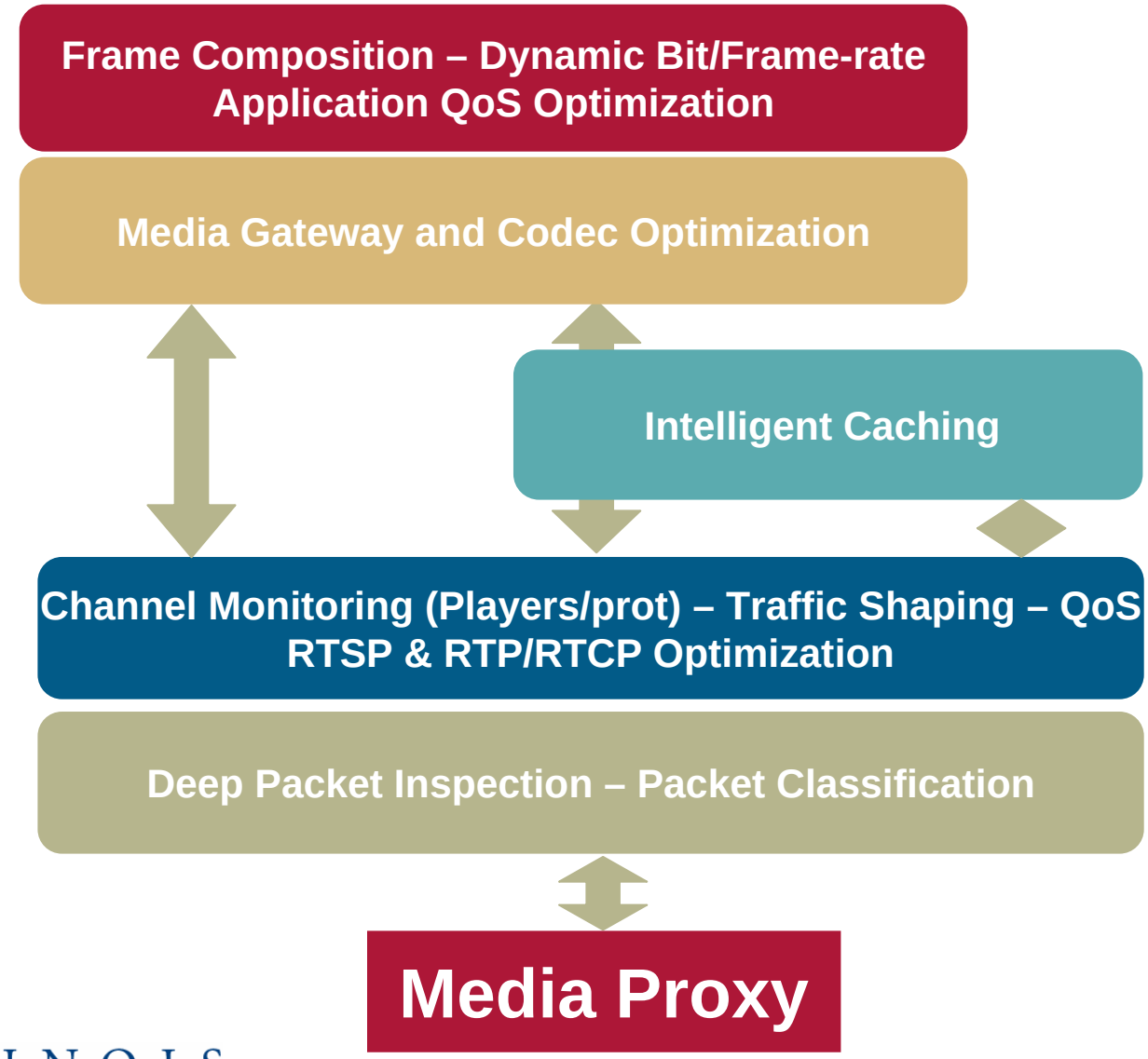


Example: Click-to-Call Control

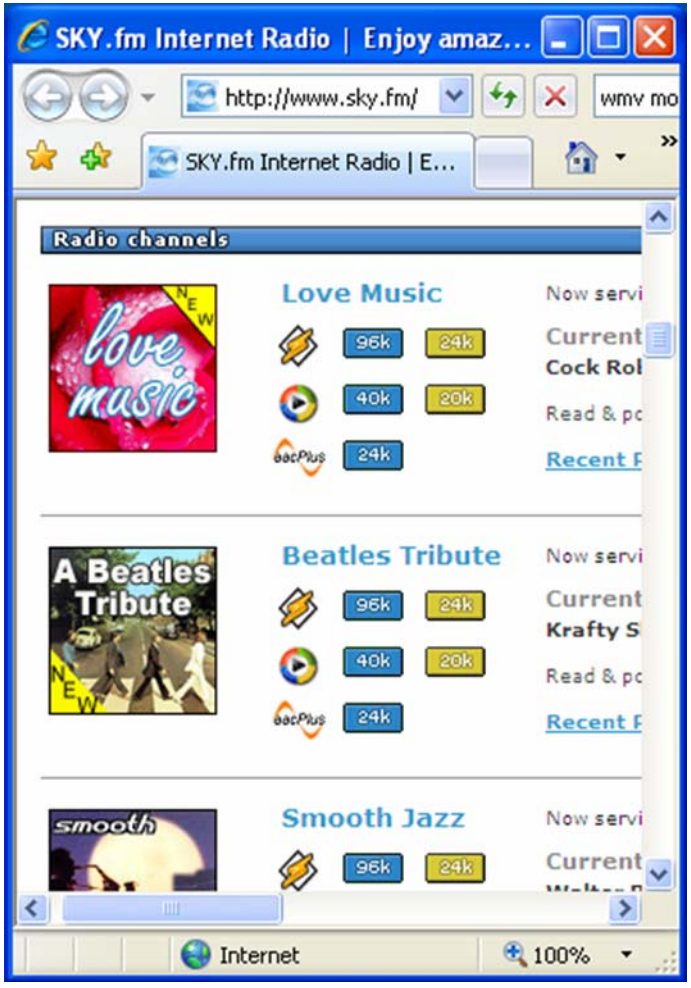
- **Automatically replace phone numbers with hyperlinks**
- **Users can place a call directly by clicking on the link**
- **Click-to-Call links use native phone functionality**
- **If phone does not support any click-to-talk format, no conversion is performed**
- **Similar adaptation for Click-to-Email**

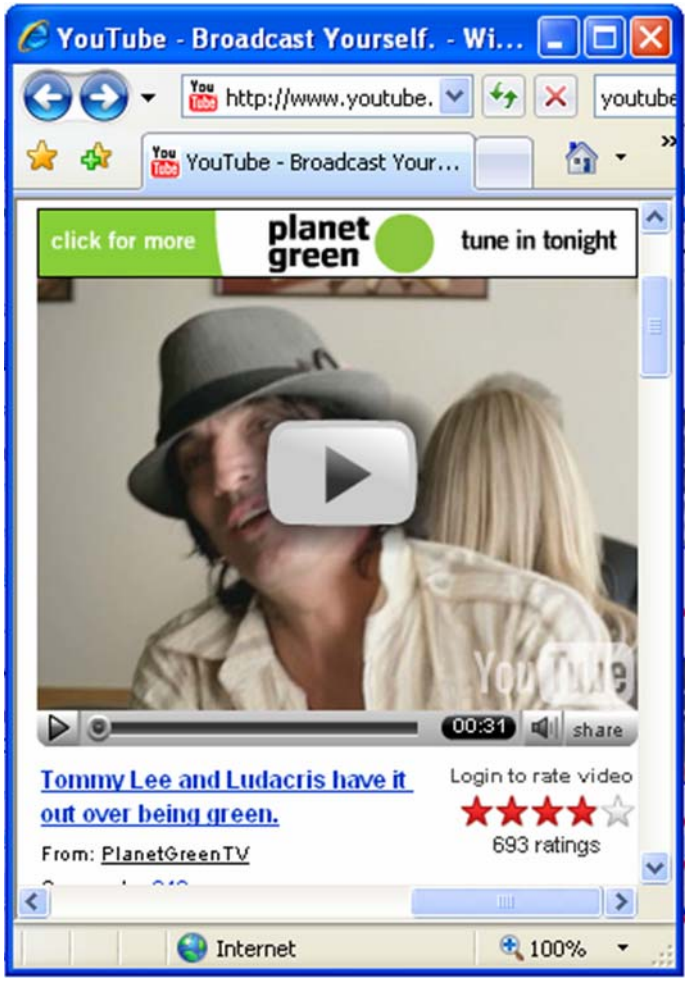


Multimedia Optimization – Functional Architecture



Downloadable Media vs. Embedded Media





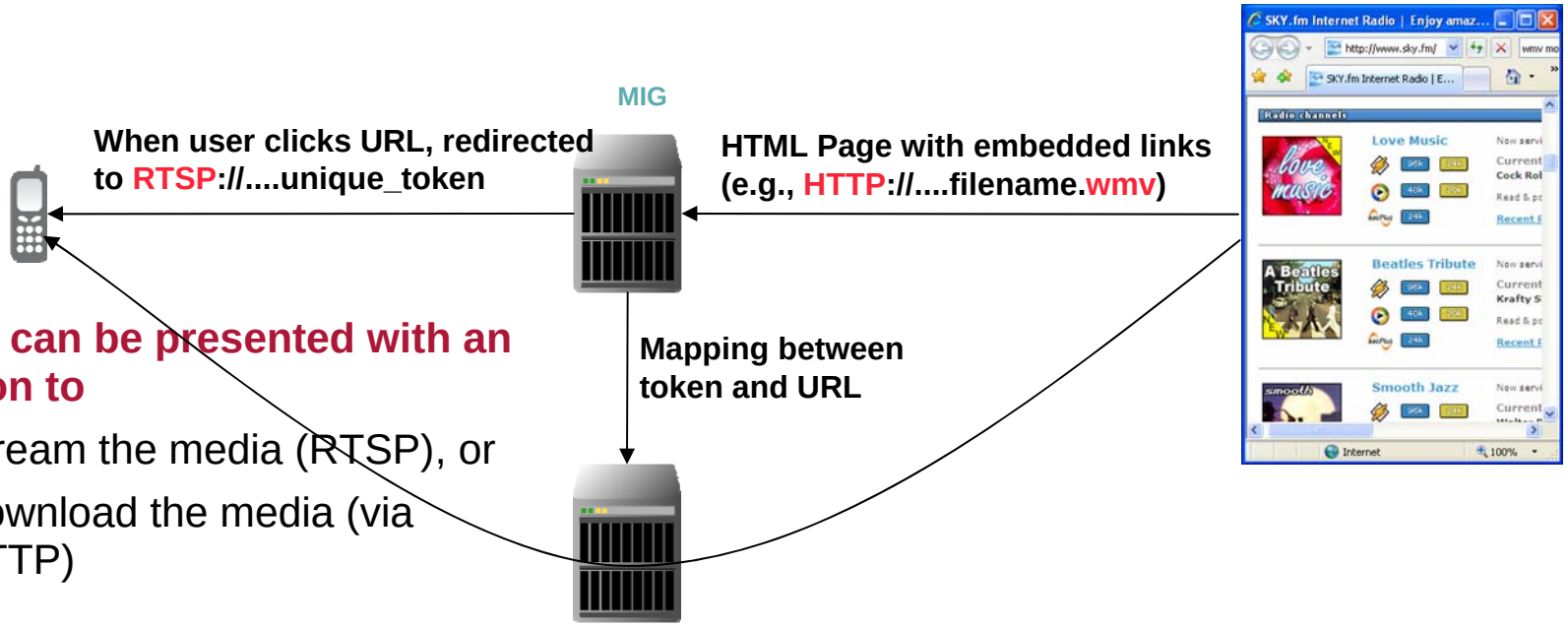
Optimizing Downloadable Media

Progressive Download to Streaming Conversion

Adjust bandwidth to network and phone capabilities

Ensure codec compatibility

RTSP more appropriate for dynamic wireless environment

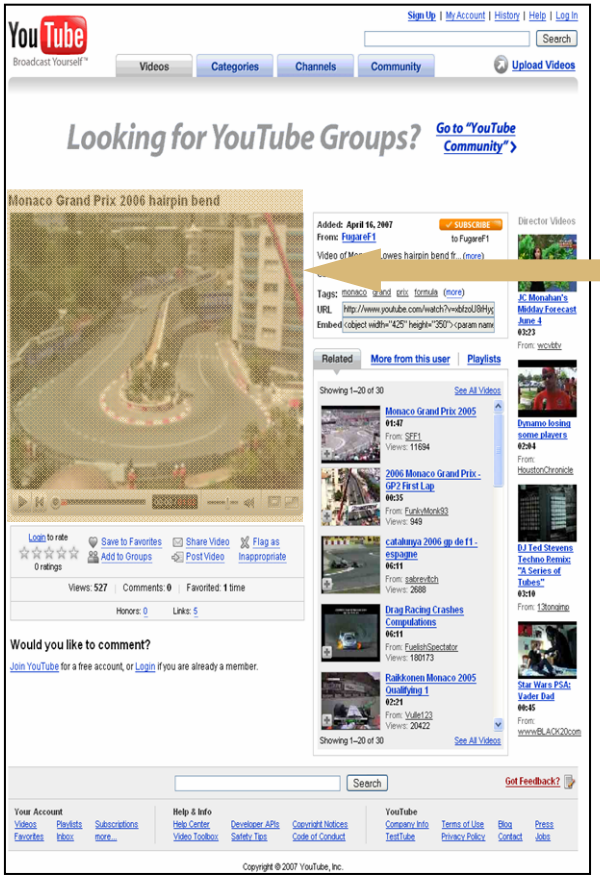


User can be presented with an option to

- Stream the media (RTSP), or
- Download the media (via HTTP)

Download or Stream?

Dynamic Discovery for Embedded Media



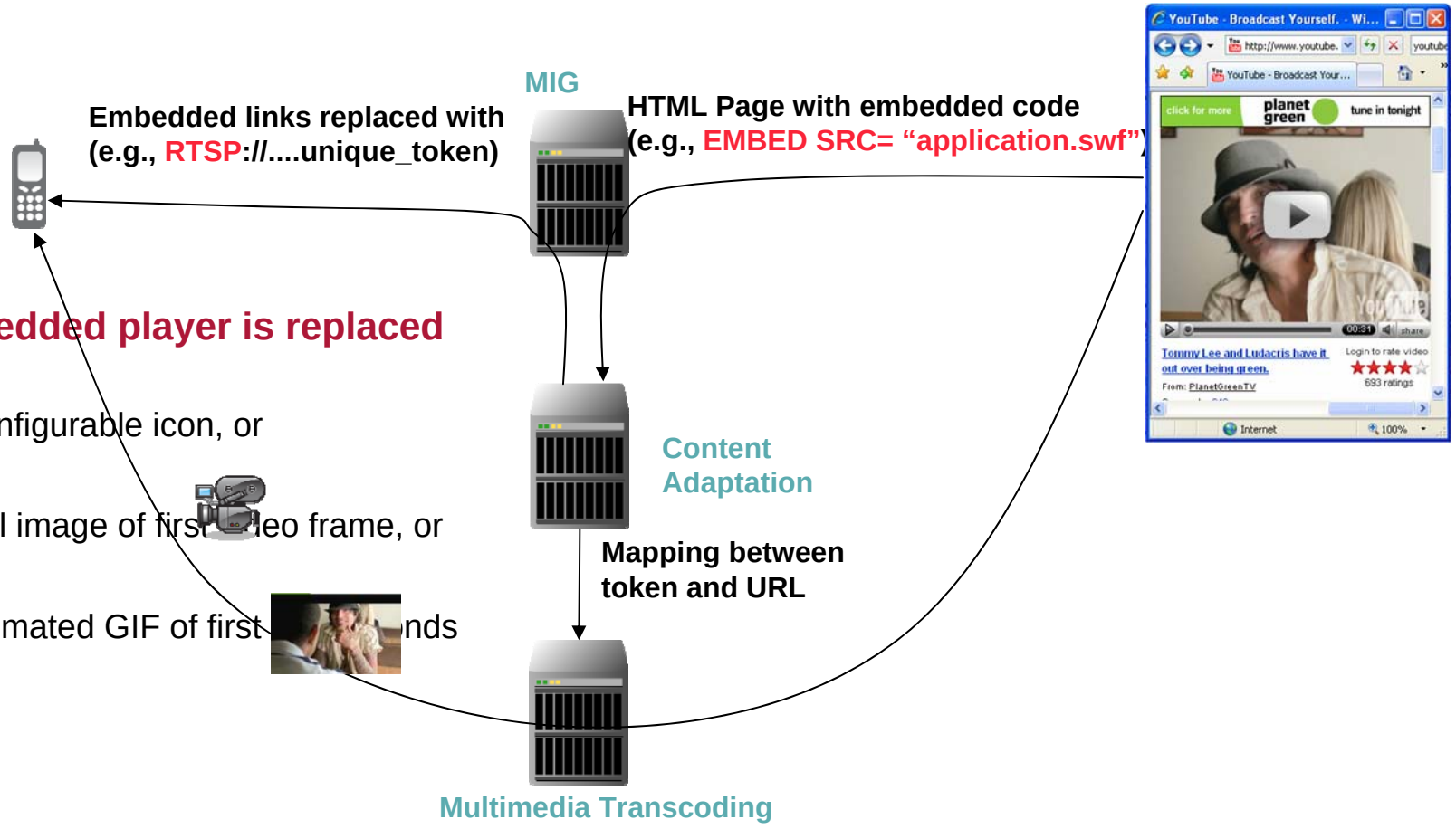
Dynamic Media Discovery of Flash, Windows (WMV, WMA), MPEG-2, MPEG-4, MP3

Original YouTube video encoded in Flash (450x370) and downloaded via HTTP at 300 kbps

New video format is QCIF (176x144) and 3GPP/MPEG4 downloaded via RTSP/RTP at 120 kbps

Bring Multimedia to Your Mobile Phone

With Discovery of Embedded Media



Media Optimization

Re-sizing

- To fit the screen use

Codec selection

- Codec supported by the device
- Most efficient codec

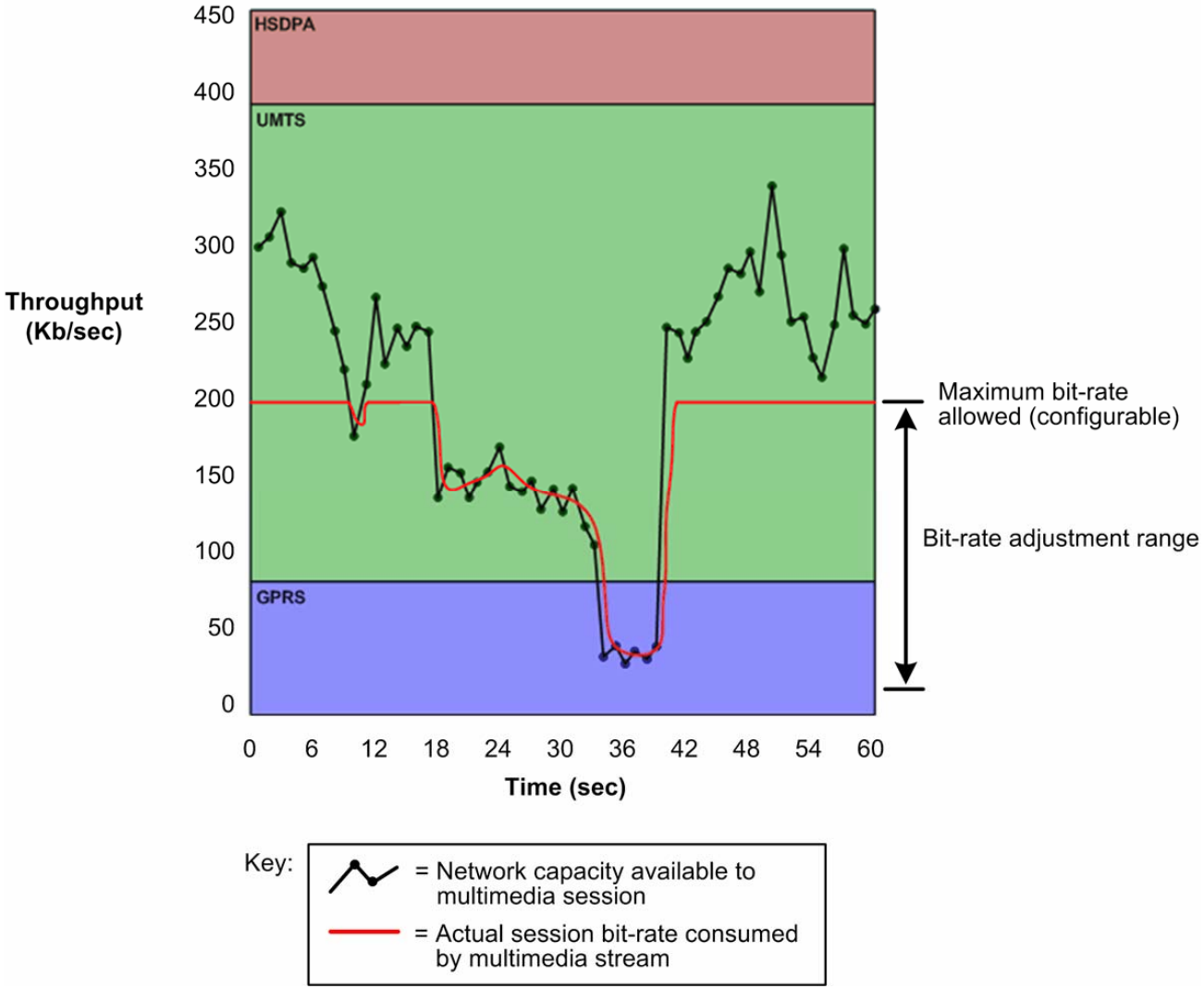
Bit rate reduction

- Lossy compression / Frame reduction
- Based on device capabilities, RTSP feedback, and operator settings

Dynamic bandwidth shaping

- Recursive feedback control models

Dynamic Bandwidth Shaping

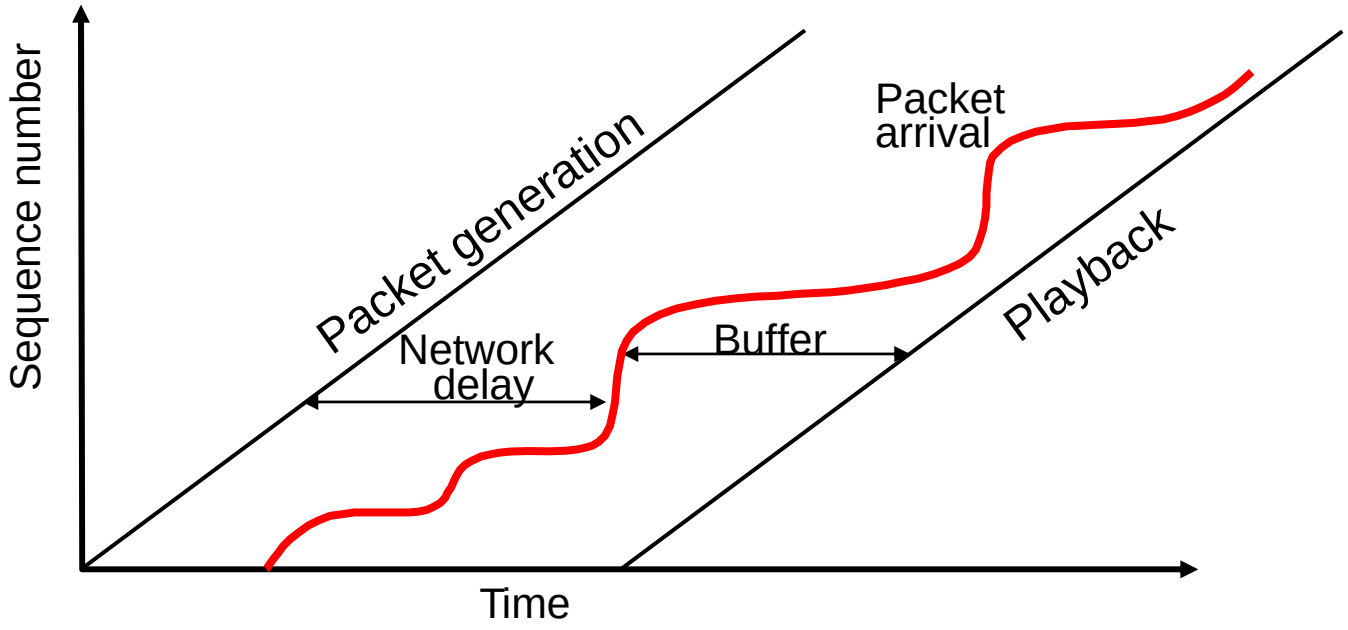


Media function constantly monitors the network connection with the client and shapes the multimedia stream to adapt to current network conditions.

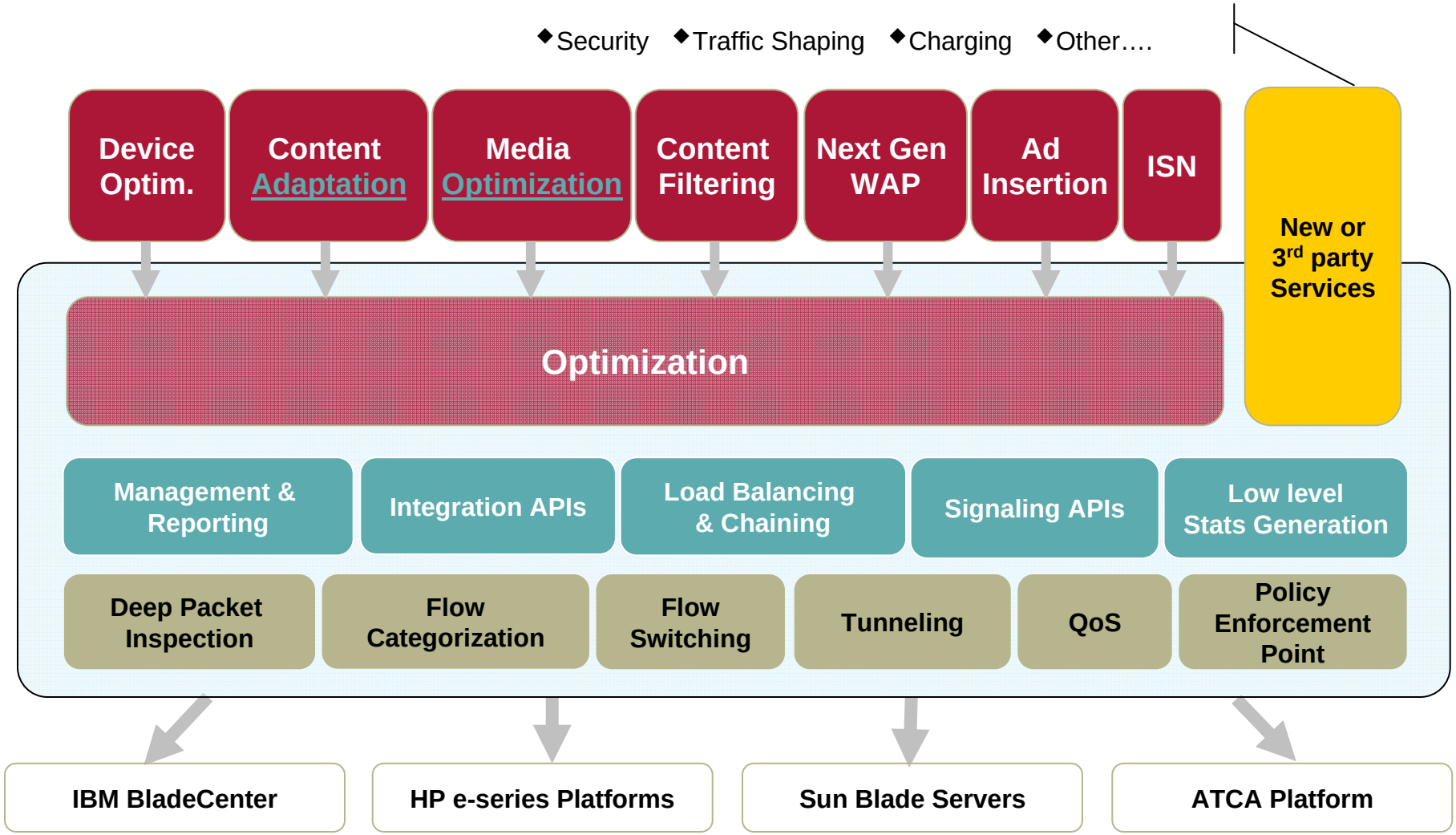
Ensures uninterrupted streams at optimal rates.

Real-Time Constraints for Communication Apps

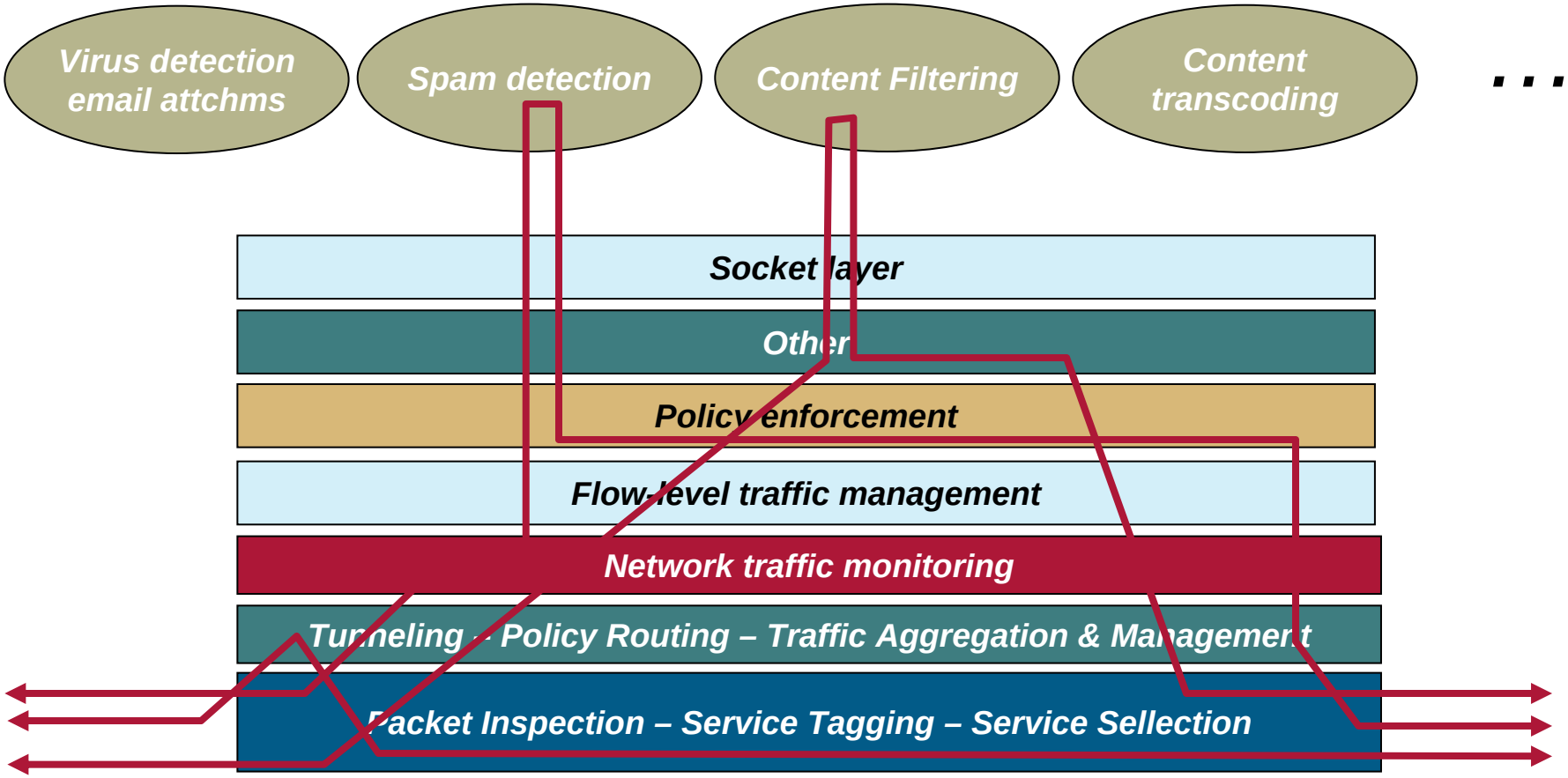
Playback Buffer



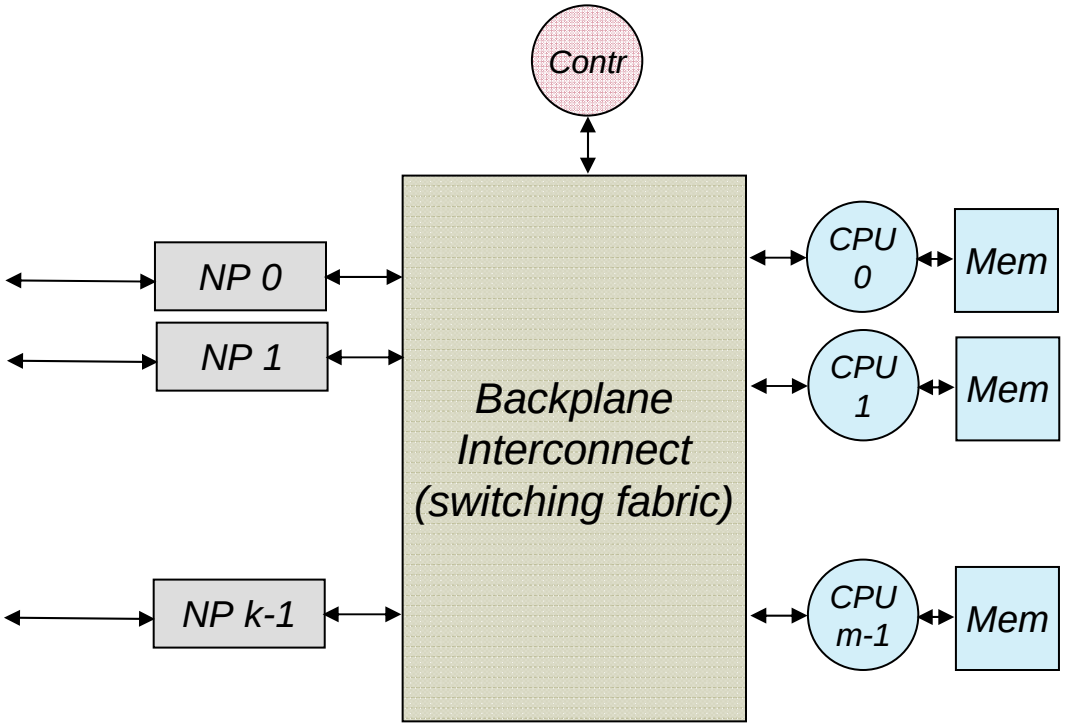
The Mobile Internet Gateway (MIG) Architecture



Next Generation Network Elements (NGNE): The big challenge



NGNE Performance Limitations



Basic requirements

- *10Gbps real-time switching and application level servicing*
- *1<= k <= 16, and 1<= m <= 32*

Rich, high impact research problems

Traffic Engineering

- Deep packet inspection
- Flow classification (stateful?)
- QoS and QoE (policy enforcement, user centric QoS)

Dynamic Media Optimization

- Media discovery
- Video optimization

Convergence

- Mobility support
- Transparent adaptation

Next Generation Network Elements

- New massively scalable architectures