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?

- **Device & User Identity**
- **Network Identity**
- **Application Identity**

Multiple Devices  | One User  | A “Single” Global Access Network

802.11a  | GPRS  | PSTN  | LAN
The Global Medianet

“One” global, transparent network,
same rich multimedia services
any time, anywhere
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

IP Services Core
- Premium Content
- IPTV
- Games
- MMS
- VoIP
- Streaming Video
- Email/IM
- Internet
- Optimization
- Security
- Charging
- QoS - Traffic Management
- IMS
- Content Filtering
- Location GTW
- MGCP

3G
4G
Wi-Fi
Wi-Max
DSL, dial-up, other wired

Internet
Optimization as a network requirement

- 2G
- 2.5G
- 3G
- 3.5G
- 4G
- IP Services Core
- Wi-Fi
- WiMAX
- DSL, cable, dial-up, other wired
- Roaming
- Internet
Many limitations: Wide range of mobile devices

- **Smartphones**
  - Full-HTML Browser
  - Wireless Workers
  - Infotainment Elites

- **Mid-Range Feature Phones**
  - Limited-HTML Browser
  - Fun Fanatics
  - Utility Workers
  - Infotainment Consumers

- **Low-End Handsets**
  - WAP 2.0
  - Mobile Masses
  - Information Deniers
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

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

Decision Engine

Adaptation Engine

Presentation Engine

Content from Origin Server

Device Profile

Network Profile

Subscriber Profile

Configuration & Static Rules

Content & Adaptation Rules

Final Content to device

Adapted Content

Content Insertion (Ads, Promotions)
Example: Content Folding

Menu links are folded into a drop down menu

User clicks the menu to expand the content

Labour unlikely to field candidate in byelection against former shadow home secretary

CO2 plan threatens new coal plant
Uncertain future for Kingsnorth plant as tough emissions standard is proposed by Conservatives
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

Frame Composition – Dynamic Bit/Frame-rate
Application QoS Optimization

Media Gateway and Codec Optimization

Intelligent Caching

Channel Monitoring (Players/prot) – Traffic Shaping – QoS
RTSP & RTP/RTCP Optimization

Deep Packet Inspection – Packet Classification

Media Proxy
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)

When user clicks URL, redirected to RTSP://....unique_token
HTML Page with embedded links (e.g., HTTP://....filename.wmv)

Multimedia Transcoding

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

- Embedded player is replaced with
  - Configurable icon, or
  - Still image of first video frame, or
  - Animated GIF of first few seconds

- Embedded links replaced with (e.g., RTSP://....unique_token)

- HTML Page with embedded code (e.g., EMBED SRC= “application.swf”)

- Mapping between token and URL

- Multimedia Transcoding

- Content Adaptation
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

- Packet generation
- Network delay
- Buffer
- Packet arrival
- Time
- Sequence number

Diagram showing the relationship between packet generation, network delay, buffer, packet arrival, time, and sequence number.
The Mobile Internet Gateway (MIG) Architecture

- Security
- Traffic Shaping
- Charging
- Other...

Device Optim. | Content Adaptation | Media Optimization | Content Filtering | Next Gen WAP | Ad Insertion | ISN

Optimization

- Management & Reporting
- Integration APIs
- Load Balancing & Chaining
- Signaling APIs
- Low level Stats Generation
- Deep Packet Inspection
- Flow Categorization
- Flow Switching
- Tunneling
- QoS
- Policy Enforcement Point

IBM BladeCenter | HP e-series Platforms | Sun Blade Servers | ATCA Platform
Next Generation Network Elements (NGNE): The big challenge

- Virus detection
- Spam detection
- Content Filtering
- Content transcoding
- Network traffic monitoring
- Flow-level traffic management
- Policy enforcement
- Other
- Socket layer
- Packet Inspection – Service Tagging – Service Selection
- Tunneling – Policy Routing – Traffic Aggregation & Management
NGNE Performance Limitations

Basic requirements

- 10Gbps real-time switching and application level servicing
- $1 \leq k \leq 16$, and $1 \leq m \leq 32$
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