Opportunities for Data Broadcasting in Digital TV

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DTV Broadcast Stream

• Based on **MPEG-2 transport stream**

• May contain multiple **virtual channels**:
  – Video channels, each with a video stream, one or more audio streams, and possibly one or more data streams.
  – Audio channels, each with one or more audio streams and possibly one or more data streams.
  – Data-only channels, each with one or more data streams.

• Data can be anything - files, directories, streams!!
MPEG-2 Transport Stream

- Consists of 188-byte transport packets; 4 byte header, 184 byte payload in each
- Conveys interleaved program elements and system streams -- audio, video, data, PSI, ...
- Packet id (PID) in packet header identifies the program element or system stream.
Transport Stream Encoding

System Tables
- System Info Generator
- Data Server

Data channel
- Data Server
- Audio Encoder
- Video Encoder

Data-enhanced Audio/Video channel
- Audio Encoder
- Video Encoder

Audio/Video channel

Multiplexer

MPEG-2 Transport Stream

PAT
PMT
Audio
Video
Data
Null
Sys.
Bandwidth for Datacasting

6 MHz DTV broadcast band

Provides 19.4 Mbits/sec digital bandwidth w/ 8VSB

HDTV: 15 - 18 Mbits/sec for one virtual channel
SDTV: 3 - 5 Mbits/sec for one virtual channel
Leaves 1.4 - 16.4 Mbits/sec for data
(1.4 Mbps ~ T1 line; 16.4 Mbps ~ 1/3 T3 line.)
Examples of Applications

- Interactive sports statistics
- Supplemental TV program information
- E-commerce music, software, etc.
- Interactive news, weather, traffic.
- Information kiosks
- Distance learning
- Interactive advertising
Application Classification

Three semi-independent axes:

- Tightly Bound to TV Program
- Business to Consumer
- Streaming Media

Unbound

• Interactive sports statistics
• TV program supplementary info
• E-commerce fulfillment
• Corporate communications
Data Distribution

Fat Digital Pipe: 20 Mbps

Digital Packets: Video, Audio, Data

Digitized Rich Media

Content Packages

Internet

Cable Headend

Content Delivery

Emergency Response Data

Education/Training packages

Schools, Libraries, etc

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Three Component Architecture

Network Feed

Program-
synchronous

iTV

Catalogs

Program-
Independent

Broadcast
Station/
Head-End/
Uplink

1

Receiver
Server

PC

Custom
Receiver

STB

DTV

2

3

DATA SPECIFIER
- Specify content
- Specify schedule
- Prioritize: guarantee/best effort
- Encrypt - customer access
- Generate catalogs

DATA SERVER
- Enforce Contract
- Allocate/control/optimize bandwidth
- Meter bandwidth usage
- Bill based on tiered rates
- Activate, deactivate new accounts

DATA RECEIVER
- Tune to channel, (view A/V)
- Present catalog, select data stream
- Extract data from stream
- Render / launch players
- Clean up local cache

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Applications - 1

• Broadcasting “Uncoupled” File Content
  – Carried in data-only virtual channels

• Schedule Parameters:
  – Carousel count, interval between transmissions,
  – Bitrate to be allocated,
  – Content-location,
  – Mime-types for files
Applications - 2

- Broadcasting Streaming Content
  - Media server provides IP packets to the data server.

- Schedule Parameters:
  - IP addresses for receiving packets,
  - Time periods when packets will arrive at Data Server,
  - Bitrate at which packets will arrive at Data Server.

- No carousel counts or transmission intervals.
Applications - 3

• Broadcasting Interactive Content
  – Tightly coupled to the program it enhances,

• Schedule Parameters:
  – Precise timing for sending triggers,
  – Complex schedules for inserting content,
  – Additional metadata like announcements.
Case Studies

• Enhanced TV
  – Television program experience enriched using HTML pages

• Distance learning
  – Delivery of training material to schools.
Enhanced TV

• Sending enhancements to set-top boxes and PC-based receivers:
  • Procedural applications - Java based.
  • Declarative applications - HTML pages with CSS etc.
  • Standards-based vs. Proprietary methods
    • Emerging standards - OCAP, ACAP, MHP.
  • Nationwide PBS trials held in 2001
System Architecture

PBS National

Uplink

AV

Mux

Data Server

Downlink

HTML Data

National level enhancements

WMVS
KRMA
NJN
KQED
WGBH

Local enhancements

HTML Data

Local Station

Data server

Home

PC-DTV Receiver

Zenith Set Top Box

Also:
WHYY
TPT
MPBC

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Sample Enhancements

Fact Mimics Fiction
The idea of using brain activity to control machines was dealt with fictionally in the 1982 Clint Eastwood thriller Firefox, based on a novel by Craig Thomas. In the film, NATO intelligence forces steal a Russian thought-controlled military aircraft during the cold war.

Photo courtesy Warner Brothers © 2001
Sample Enhancements (Contd.)

Life 360 looks at life as it's lived, from every possible angle. Life 360 is about the rich fabric of life and the interwoven connections that bind us all to one another.

Emmy Award-winner Michel Martin spent more than a decade reporting on politics at The Washington Post and The Wall Street Journal.
Sample Enhancements (Contd.)

Your mission:

Figure out how to use the map to find Dr. Marbles. Remember, you must use your arrow keys.

- Moth

You want to go to the arcade, but first you've got to find it! Find the arcade at (6,4) using your arrow keys.
Enhanced Content Delivery

Data components:
Carried as IP multicast data in MPEG2 transport packets:

• **Announcements:**
  Tells receiver where/how to find content & triggers
  (IETF standard for IP multicast services SAP, SDP)

• **Content:**
  HTML, graphics, etc that are to be rendered
  (HTML 4.0, PNG, JPG, CSS1, ECMAScript, DOM-T)

• **Triggers:**
  Tells receiver when to display specific graphics
  (URLs, Named vs Script, Automatic vs User-Invoked)
Technical Issues

• Tools for content development.

• Automated test environments.
  – For application developers
  – For middleware developers

• Delivery of interactive content and system information.

• Interoperability between receivers in early deployments.
Distance Learning

• Current trends in education & training
  – Increasing use of video and other multimedia content
  – Increasing stress on relevant, up-to-date materials
  – Distributed learning environments
  – Asynchronous learning (self-study) as well as classroom

• Challenges posed by these trends
  – Delivering large volumes of educational materials to many sites
  – Updating these materials frequently
  – Doing all this efficiently, reliability and economically
Internet Limitations

• For high quality streaming media delivery:
  – Hopeless with low bitrate Internet connection
  – Shaky even with pretty good Internet connection

• For high volume file delivery
  – Poor for education/training centers with limited Internet access
    • Rural areas
    • Many homes (self-study)
    • Military units in the field (including ships at sea)
    • Developing countries, etc.
  – Poor for pushing out updates to large numbers of sites
Datacasting Strengths

- Delivering high quality media streams
- Delivering large files (e.g., high quality, multimedia content)
- Updating content frequently
- Delivering content to many sites simultaneously
- Delivering to sites with poor Internet connections
Asynchronous Distance Learning

Videos and other education/training materials

files

“push” and/or “pull” delivery

Data Server

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Summary

• Data broadcasting in DTV enables different kinds of applications.
  – Provides new revenue opportunities.

• Applicable in different delivery mechanisms.
  – Delivery to hand-held devices is an emerging trend (DVB-H).

• Appropriate architecture is crucial.
  – Many technical challenges: loss of packets, bandwidth management, encryption, targeting.