Trend of Digital Broadcasting in Japan and Research and Development in NHK STRL

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1. Introduction of NHK STRL

Leading organization
for future broadcasting world

NHK STRL

- NHK (Japan Broadcasting Cooperation)
  - Established in 1925
  - Non-profit public broadcasting organization
  - 2 AM radio, 1 FM radio, 2 terrestrial TV, 3 satellite TV
- NHK STRL (Science & Technical Research Labs.)
  - Established in 1930

    (5 years later science radio broadcasting started)
  - Research department of NHK
  - Major research themes
    - Advanced television systems, Wireless systems, Advanced broadcasting devices, Program production and future broadcasting related systems and devices.

3rd generation research complex

- Opened in April 2002
  - 14 stories high
    (office tower)
  - 6 stories high
    (experiment building)
- STRL area
  - B2 – 5th floors
- STRL employees ('05,March)
  - 282 personnel
    (260 research engineers)

- Researches based on "Middle and long term research vision(MLRV) of STRL" are conducted

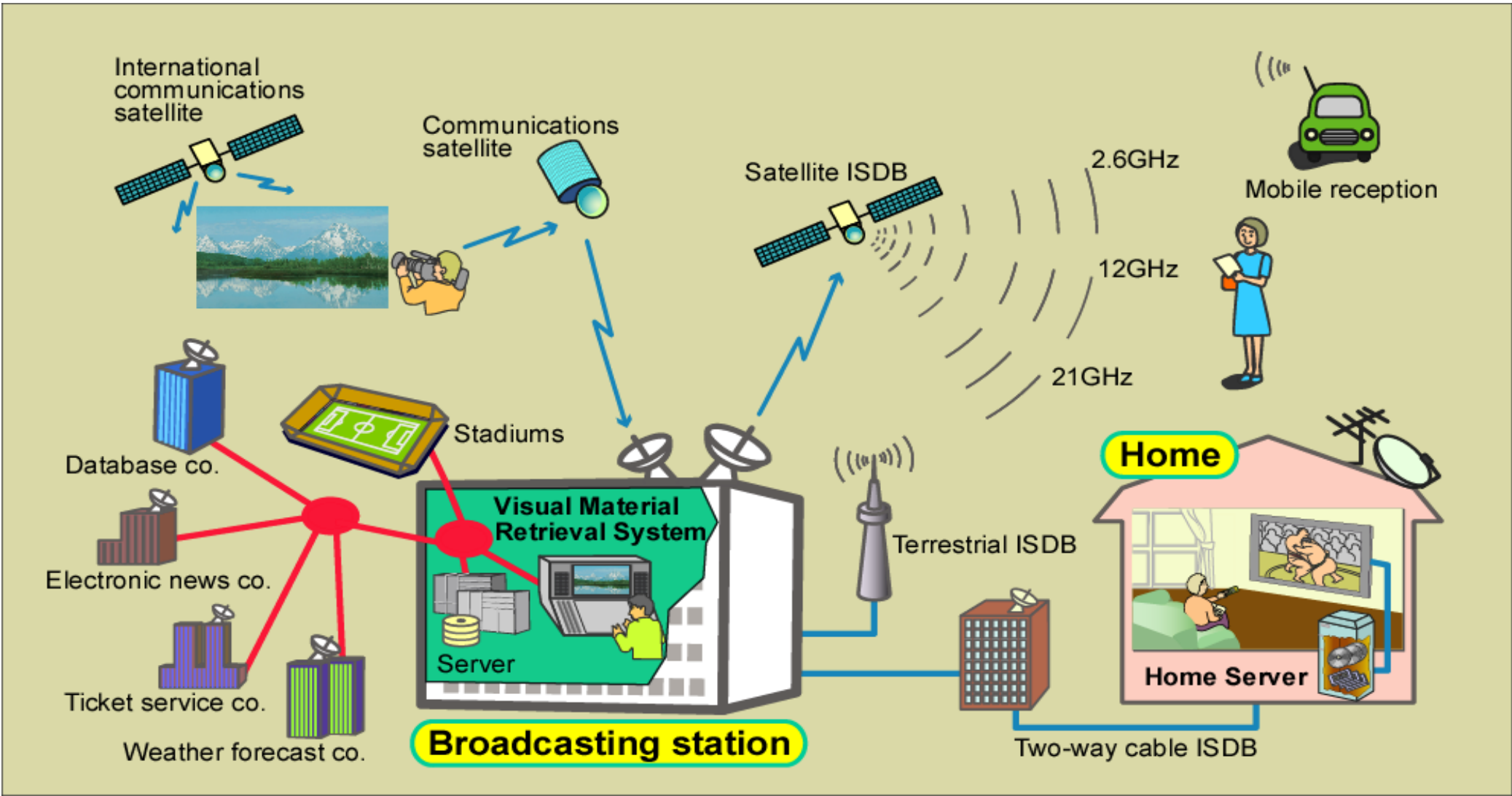
Organization of STRL (9 research labs.)

- Wireless systems
  - Terrestrial/satellite digital broadcasting, wireless LAN
- Networked broadcasting systems
  - Networked program production broadcasting systems and services
- Advanced television systems
  - Ultra high definition video (super hi-vision), 3D visual systems
- Acoustics and audio signal processing
  - High definition audio systems, acoustic signal analysis and coding
- Visual information technologies
  - Video compression and image expression
- Intelligent information processing
  - Metadata production and applications, image recognition, media processing
- Human science
  - Services for visual or hearing impaired, software agents, speech processing
- Advanced broadcasting devices
  - Ultrahigh-sensitivity imaging devices, ultrahigh-density recording
- Materials science
  - Materials for displays and recording devices

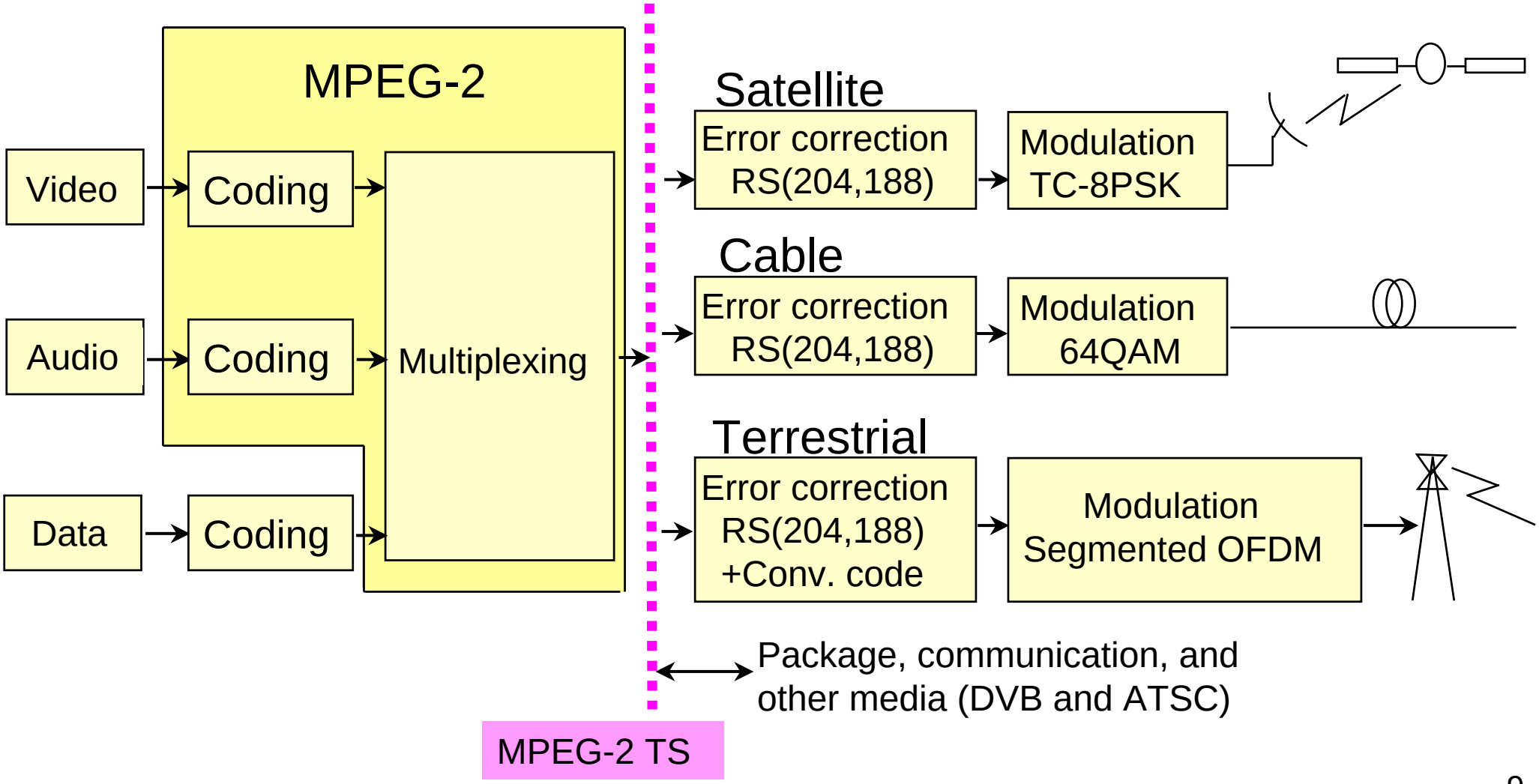
2. Digital broadcasting in Japan

Broadcasting systems in the digital era

ISDB (Integrated Services Digital Broadcasting)



ISDB family

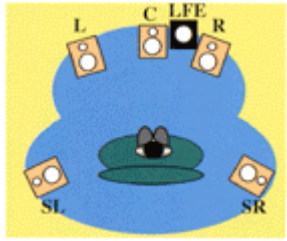

MPEG-2
Video
Coding
Audio
Coding
Data
Coding
Multiplexing
Satellite
Error correction
RS(204,188)
Modulation
TC-8PSK
Cable
Error correction
RS(204,188)
Modulation
64QAM
Terrestrial
Error correction
RS(204,188)
+Conv. code
Modulation
Segmented OFDM
Package, communication, and
other media (DVB and ATSC)
MPEG-2 TS

Transmission parameters for ISDB family

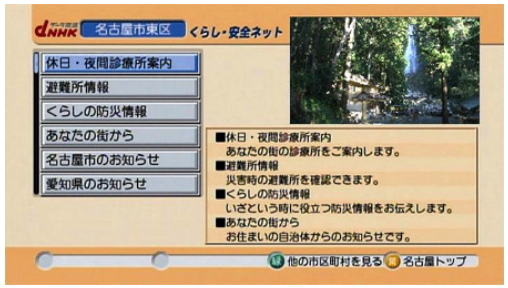
System		ISDB-S	ISDB-C	ISDB-T
Video coding		MPEG-2 Video (ISO/IEC 13818-2)		
Audio coding		MPEG-2 AAC (ISO/IEC 13818-7)		
Data broadcasting		BML (XHTML), ECMAScript		
Multiplex		MPEG-2 Systems (ISO/IEC 13818-1)		
Conditional access		Multi 2		
Error correction	Outer	(204,188) Reed-Solomon code		
	Inner	2/3Trellis Code / Conv.code(1/2-7/8)	-	Conv.code(1/2-7/8)
Modulation		TC-8PSK, QPSK, BPSK	64QAM	Segmented OFDM (DQPSK,QPSK, 16QAM,64QAM)
Information bit rate		52.17 Mbit/s (Max)	28.6 Mbit/s	3.7 – 23.2 Mbit/s
Channel bandwidth		34.5 MHz (12GHz)	6 MHz (Cable)	6 MHz (VHF/UHF)

Digital broadcasting services in Japan

- High picture quality / sound quality
  - HDTV and 5.1 surround stereo system



- Multi-programs broadcasting
- High performance
  - Electronic Program Guide (EPG)
  - Data broadcasting (program related data services, interactive data services)

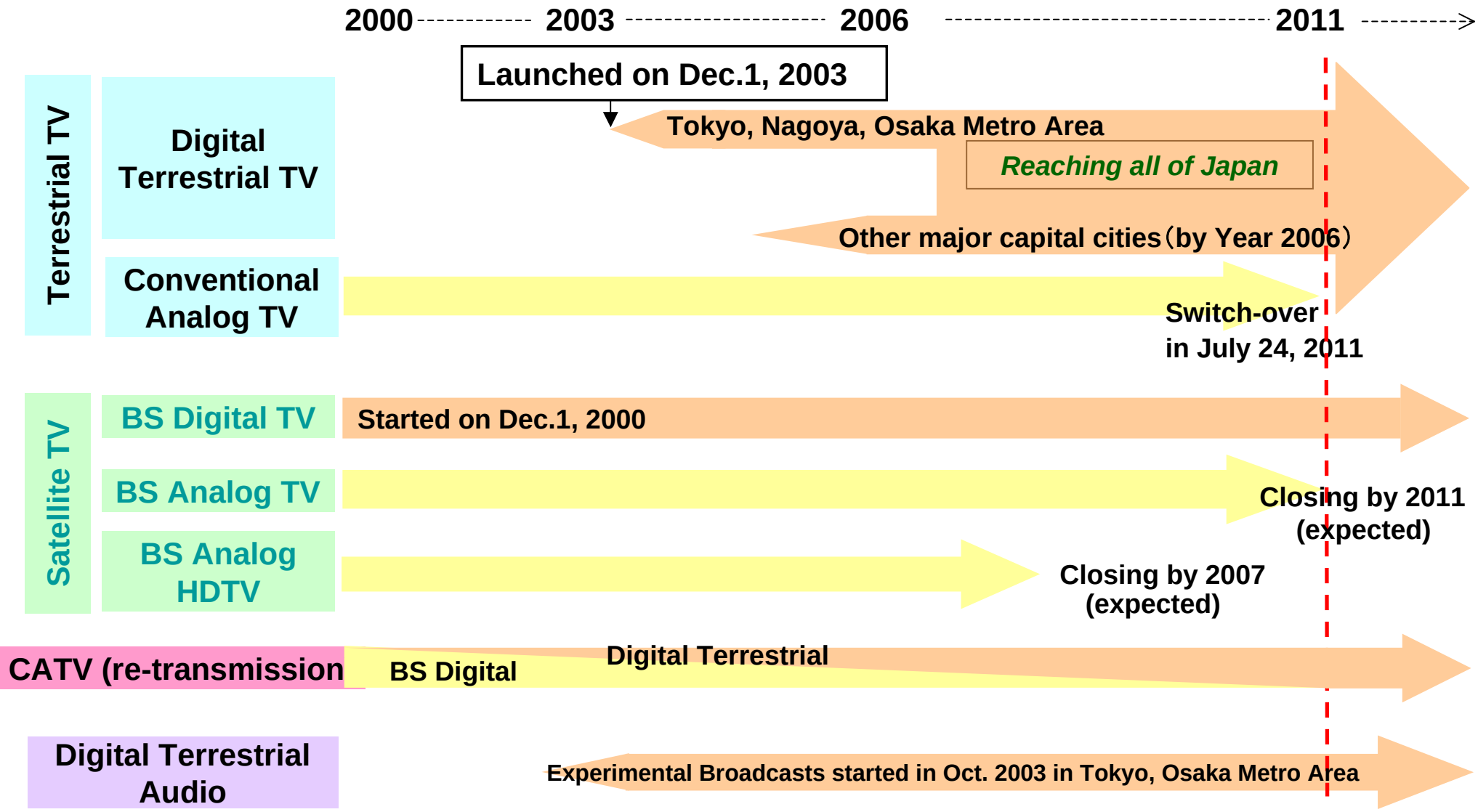


- Digital terrestrial TV broadcasting

  Along with digital satellite broadcasting services,
  - Services for mobile reception terminals (1 segment broadcasts)
  - Regional broadcasts
  - NHK Data Online

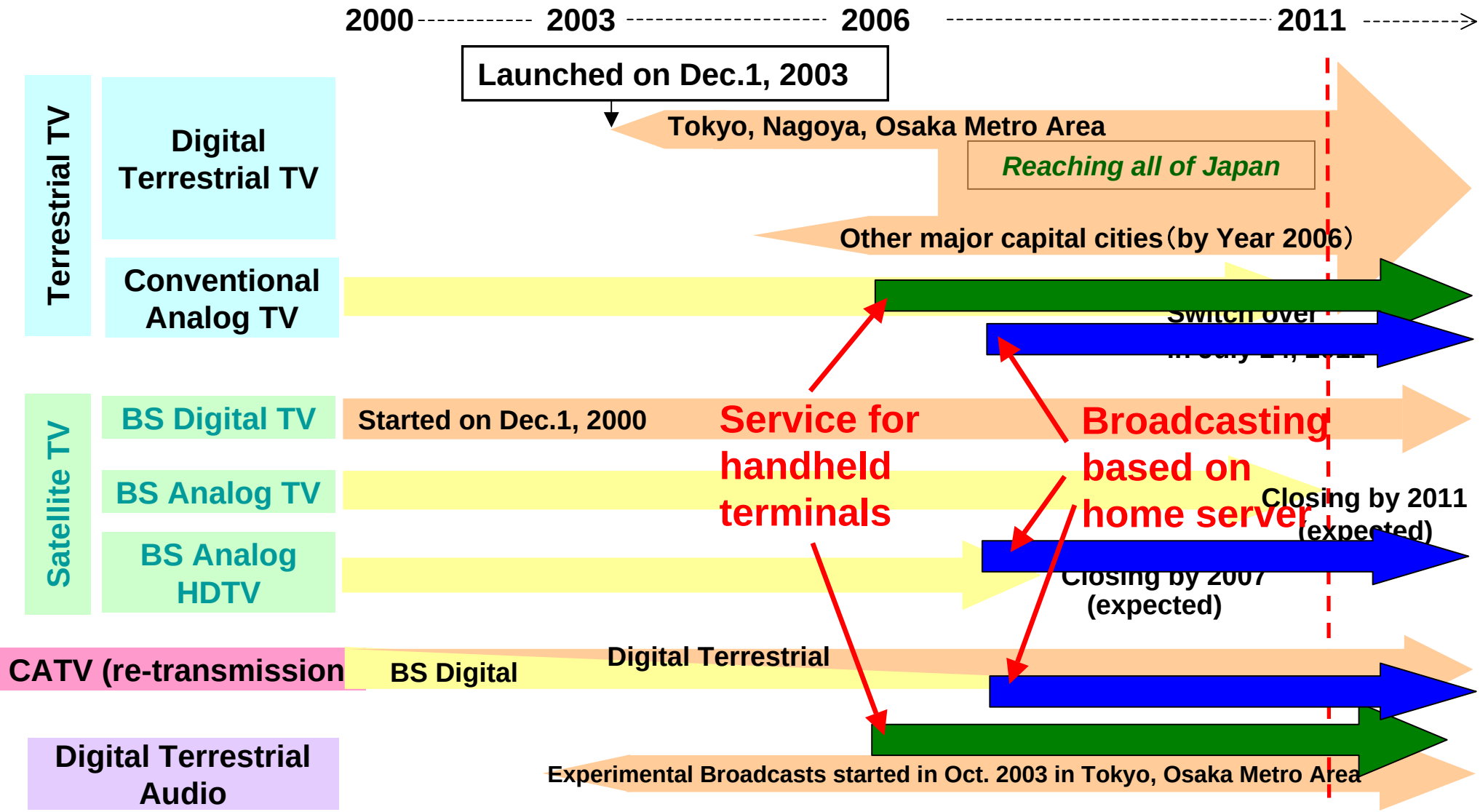
    New service using the Internet connection of digital broadcasting receivers

Schedule of digitalization of broadcasting media in Japan



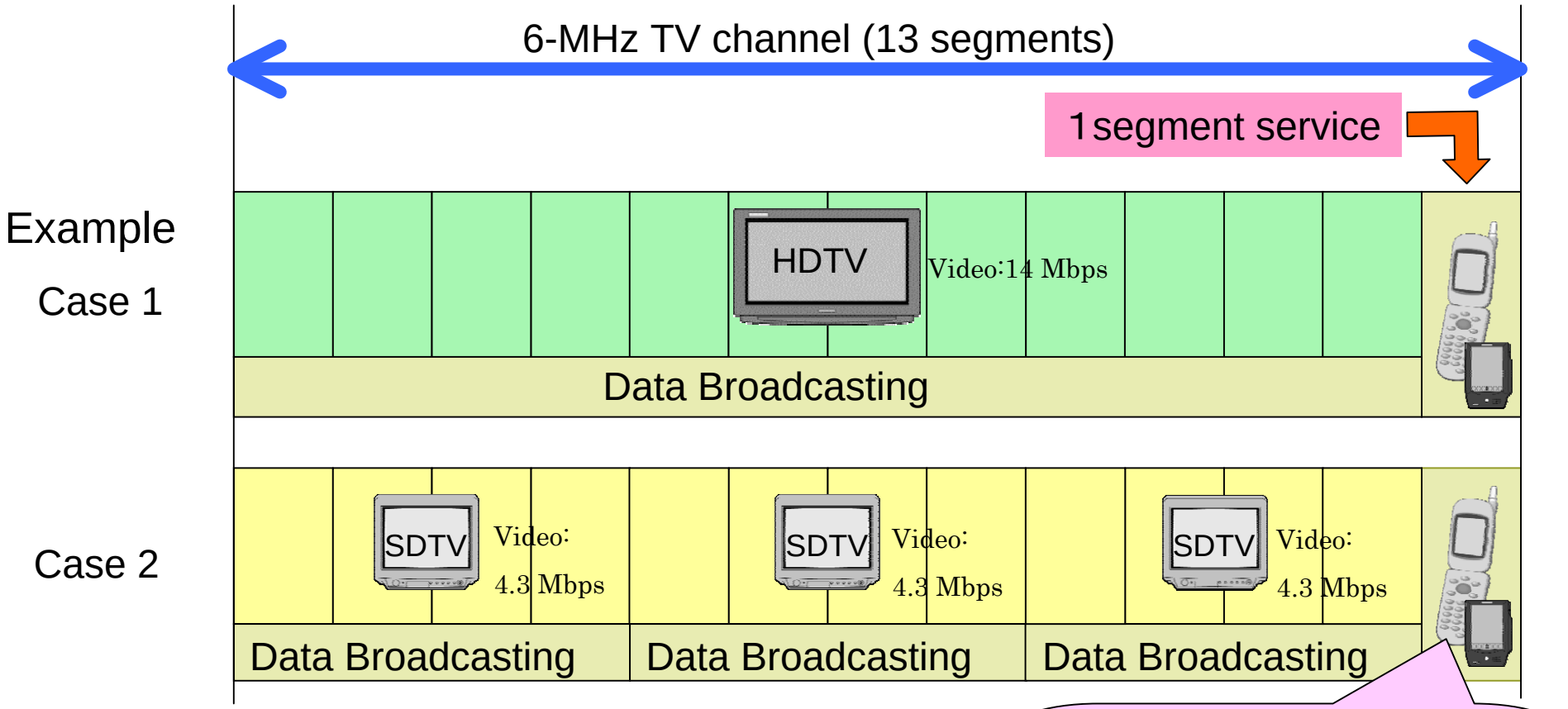
3. New services for digital broadcasting

New services are coming !



Digital terrestrial broadcasting for handheld receivers

Segmented OFDM and services in ISDB-T



Transmission Data Rate: 310 kbps
Modulation: QPSK (1/2)
- Low Bit Rate Video: AVC/H.264
- Data Broadcasting

Handheld terminals for ISDB-T (prototypes)

Service will start in next spring

Handheld terminals

- Get information related to a program with low-bit-rate video from data broadcasting or Internet

Low-bit-rate video from broadcasting channel

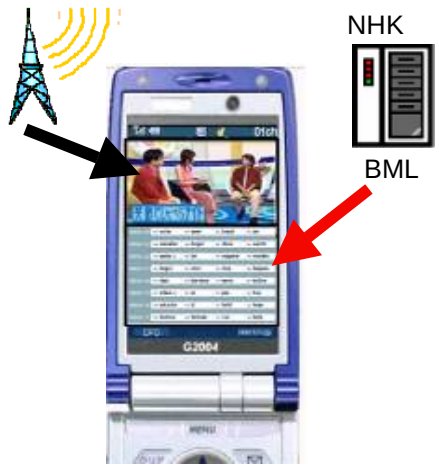
- Video:AVC/H.264 (about 128 kbps)
- Audio: AAC-SBR (about 48 kbps)
- Data Broadcasting
- Closed caption
- Wake up function in case of emergency

Information from broadcasting and communication channel

Service model of 1-segment service for handheld communication terminals

- Various types of services can be realized using functionalities combining 1-segment service reception and mobile communication

Linkage from broadcasting to communication

Broadcasting program view	Data broadcasting view	Handheld data online	Link to web sites
			
To receive and view broadcasting program with mobile terminal	To receive data broadcasting on the air (due to low bit rate, content is limited.)	-TV program is on the air -Data is received via the Internet (without limit of bandwidth)	Full screen display of internet content (TV program does not appear on the screen)

Network-Linked Service for handheld reception(1)

- Get the information related to a program with low-bit-rate video from data broadcasting

Low-bit-rate video from broadcasting channel

Choose summary from the display ⇨ Data broadcasting provides summary of the program.

Network-Linked Service for handheld reception(2)

- Rich information will be available through Internet

Choose “On-Line” from the display → Connect to Internet → Select “Cast” → Display the profile of the cast

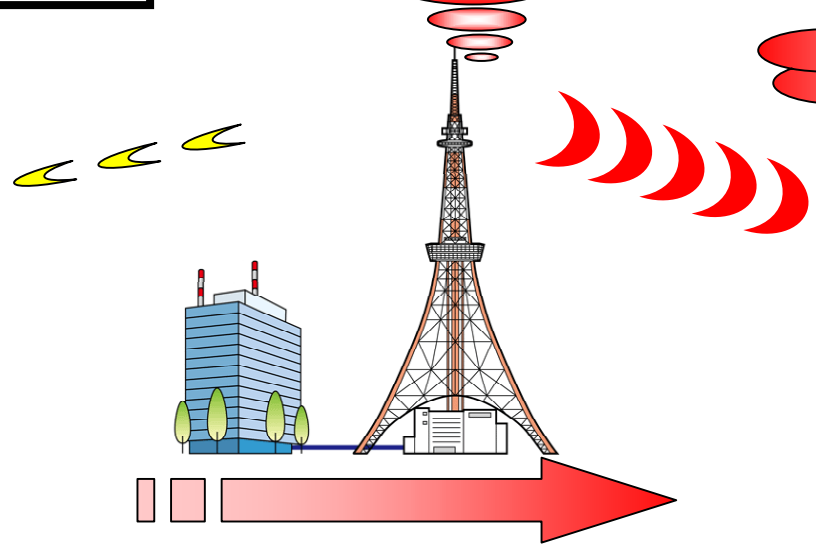
Waking up a handheld receiver with an emergency warning

Receive only Emergency Warning Signal (EWS)

Tsunami warning issued

Wake up handheld receiver

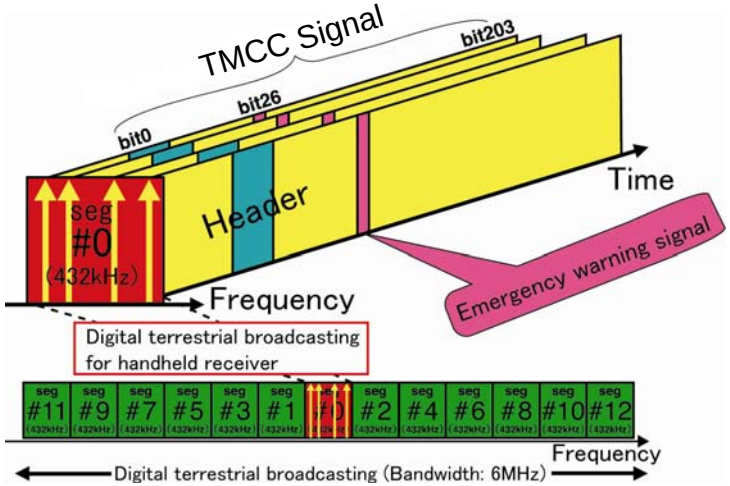
Emergency warning broadcast



Power Consumption: under 3nW (desired)

The system does not employ FFT, but instead stays on stand-by for the EMS frequency component.

Explanation



Low power consumption Stand-by mode

Active mode to receive emergency warning broadcast

Improved AVC/H .264 video encoder

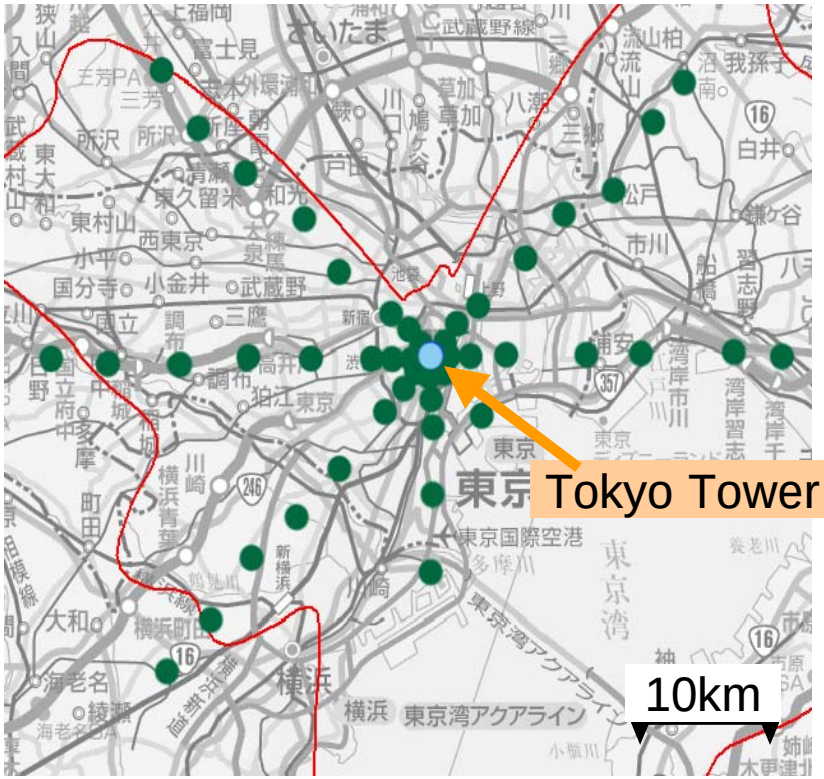
Conventional image
using AVC/H.264 scheme

Image processed with picture quality
enhancement technology

Explanation

Transmission test for handheld reception

Measurement sites

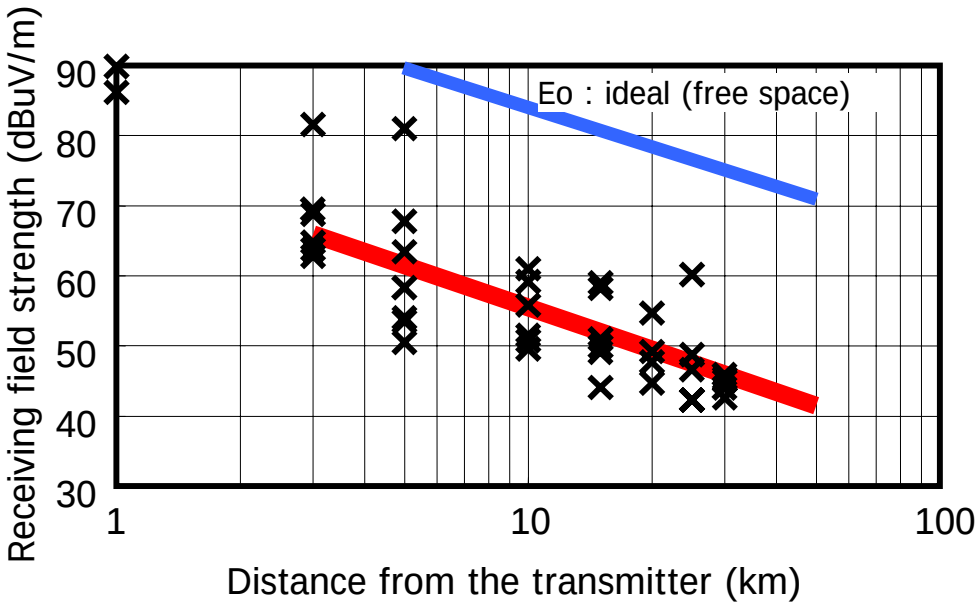


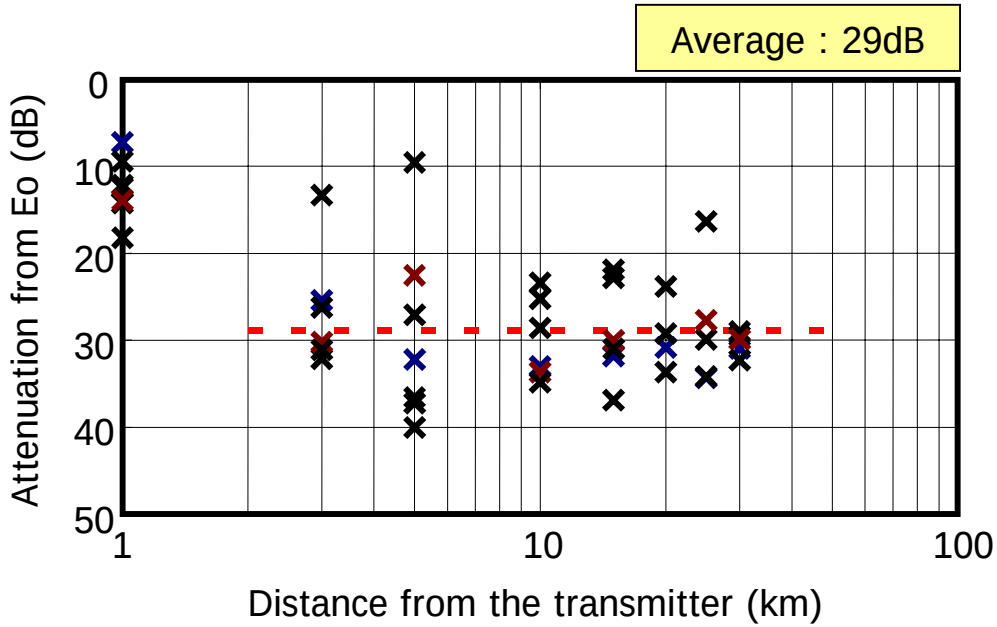
- 7 directions (spokewise)
- 1,3,5,10,15,20,25,30 km

Receiving scenery

Receiving antenna height : 1.5m
Receiving antenna : Cross dipole antenna

Distribution of measured field strength



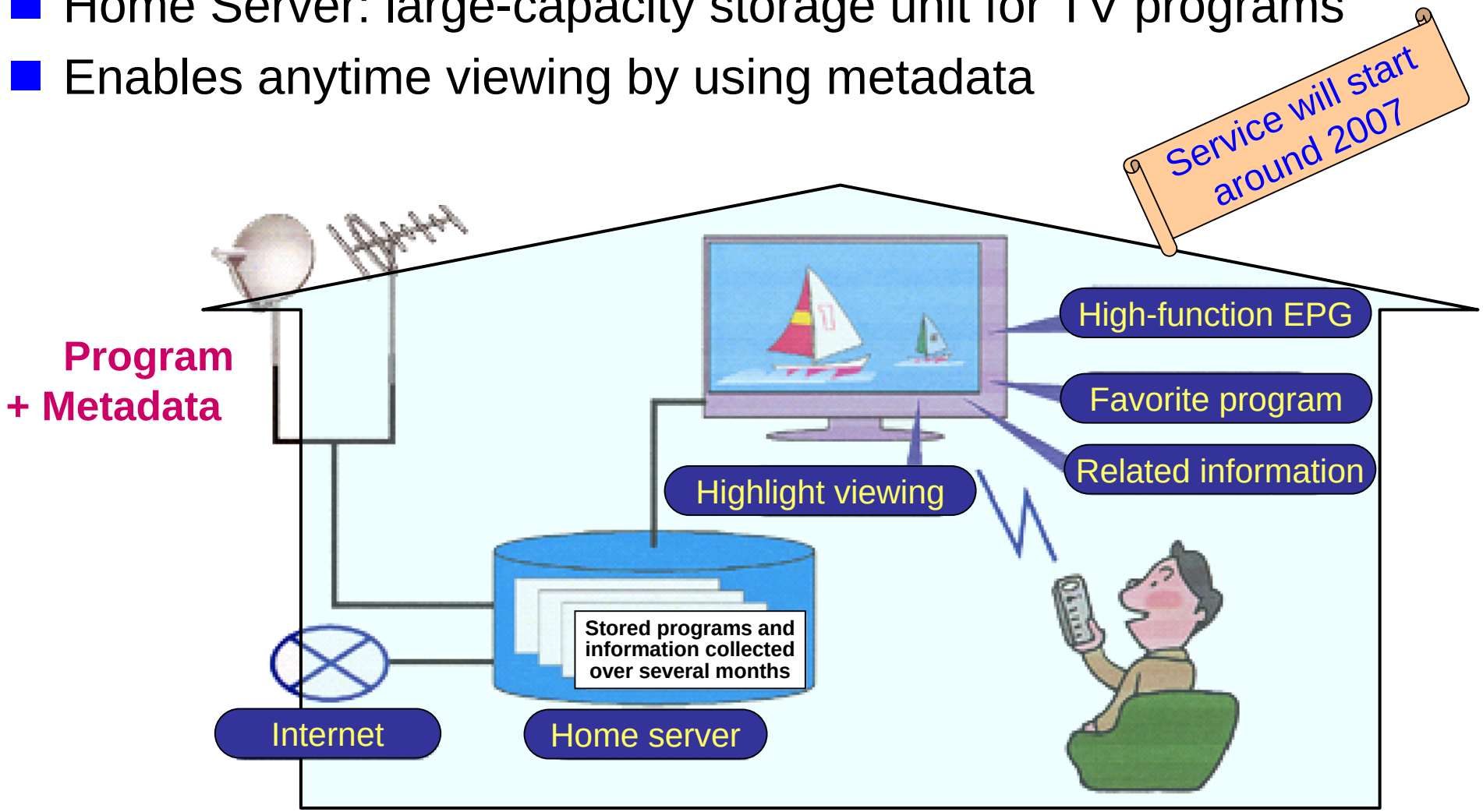


Average attenuation from Eo (free space electric field strength) = 29dB

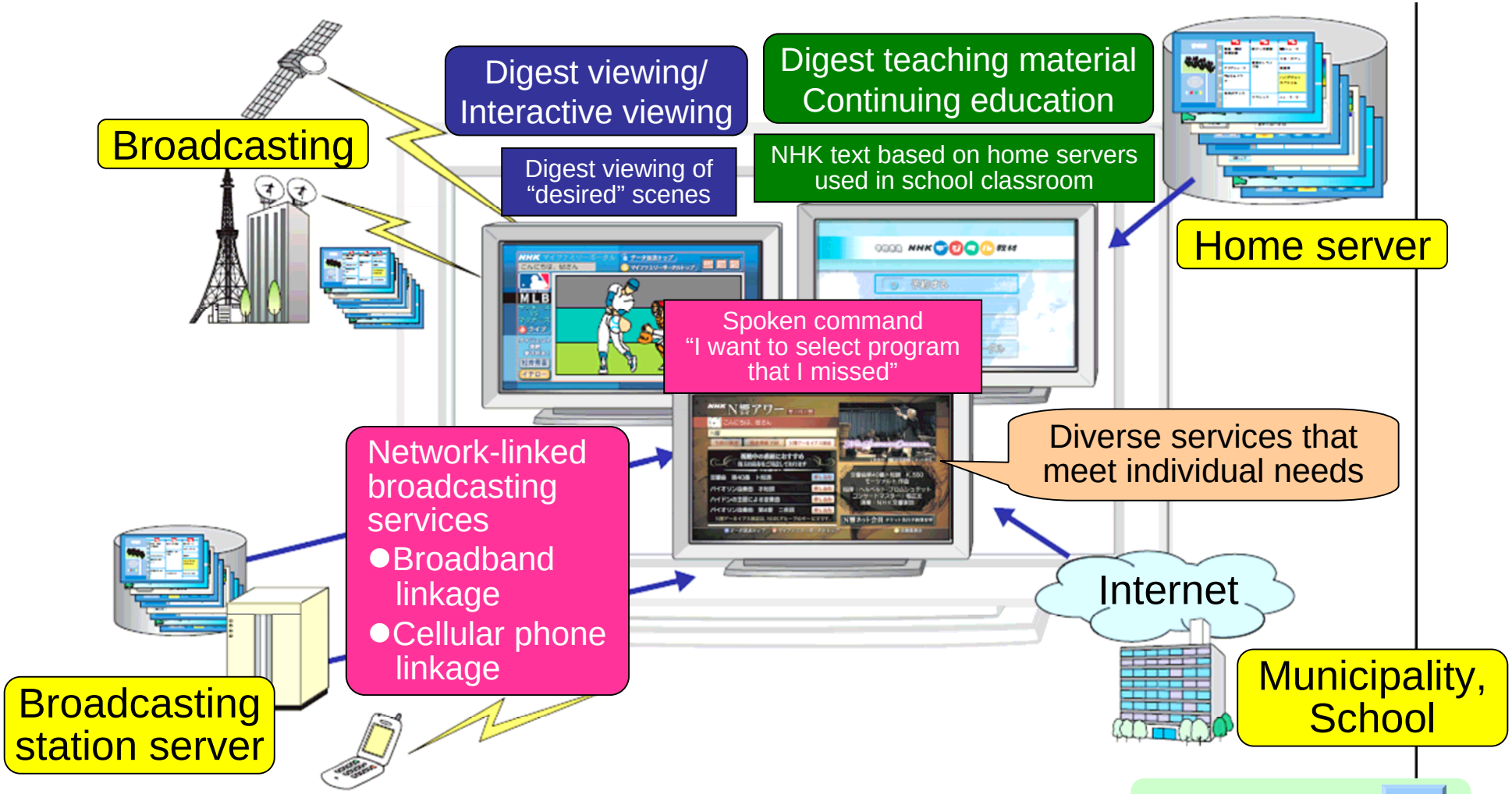
Broadcasting based on Home Servers

Broadcasting based on home servers

- Home Server: large-capacity storage unit for TV programs
- Enables anytime viewing by using metadata



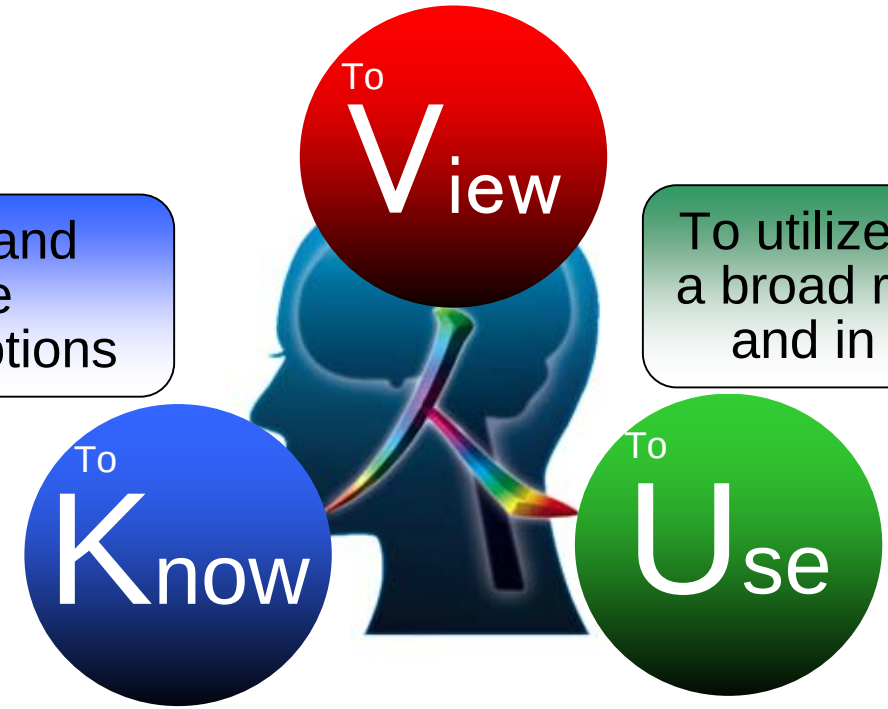
Service example for broadcasting based on home servers and Internet



4. NHK STRL Vision "NEXT"

NHK STRL Vision “NEXT”

To view a faraway scene as if it were nearby in real time



To enable sender and viewers to share information and emotions

To utilize information media for a broad range of daily activities and in times of emergency

“Human-oriented” system

R&D Framework

Explanation

Broadcasting technology that learns from human possibilities

To View — Ultimate broadcasting system conveying a strong sensation of reality

To Know — Advanced content production and agile news-reporting systems

To Use — Ubiquitous and universal services

System technology

- Audio-video technology conveying a heightened sensation of reality
- Content production technology that incorporates the knowledge of production experts
- Network technology; Security technology
- Highly functional wireless transmission technology
- Flexible system construction technology

<Approaches>

Human science

- Image/speech recognition, language processing
- Analysis and application for knowledge and sensibility
- Psychology; Physiology

Fundamental device technology

- Ultrahigh-resolution video devices, Ultra large-capacity recording devices
- Devices with new functions
- Nanophotonics materials

5. Typical research and development in NHK STRL

Typical research and development

- View
  - Super Hi-Vision
  - Integral 3-D television
  - Electro-holography
- Know
  - Metadata production system
  - Advanced program production system using wired and wireless IP networks
  - Advanced imaging devices
  - Ultrahigh-speed high-sensitivity camera
  - Ultrahigh-sensitivity HDTV new-super-HARP handheld camera
- Use
  - Flexible displays
  - TV agent system

Research on Ultimate System with Heightened Sensation of Reality

Super Hi-Vision

(Ultra-high-definition, Wide-screen System with 4000 Scanning Lines)

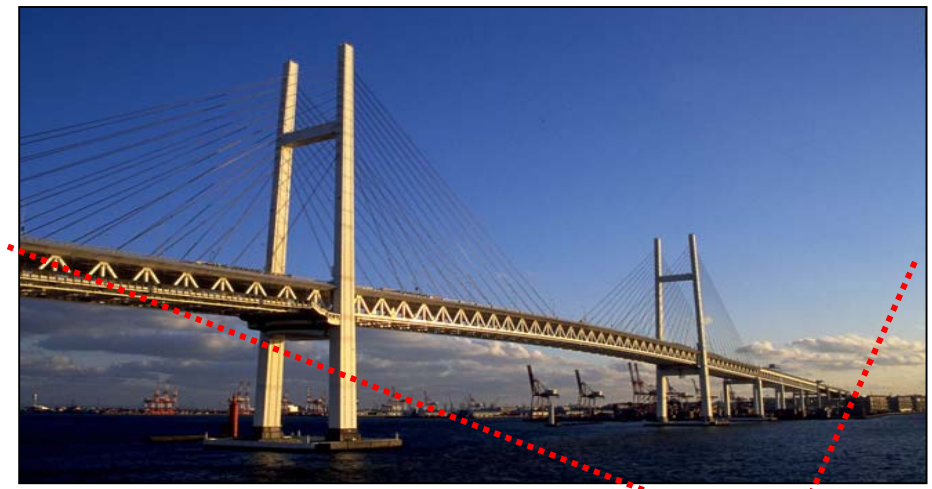
Future TV System with Greater Sensation of Reality

Effects

- Strong sensation of reality (as if you are there)
- More exciting live TV programs

Our objectives

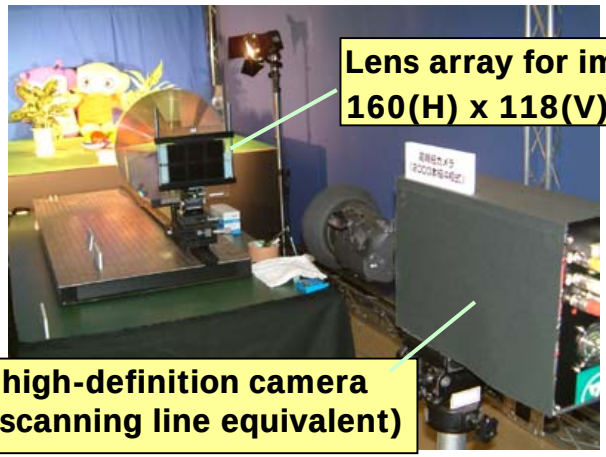
- Examine physical and psychological effects
- Enhance the reality sensation for future TV systems



Explanation

Integral 3-D television

- Natural and realistic autostereoscopic images can be viewed from any viewpoint.
  - Requires no special viewing glasses
  - Different aspects of the object can be seen depending on the viewing position
  - 3-D effects viewable at any viewing angle
- STRL's prototype can shoot and display 3-D images in real-time.



Imaging system

Viewing a little higher

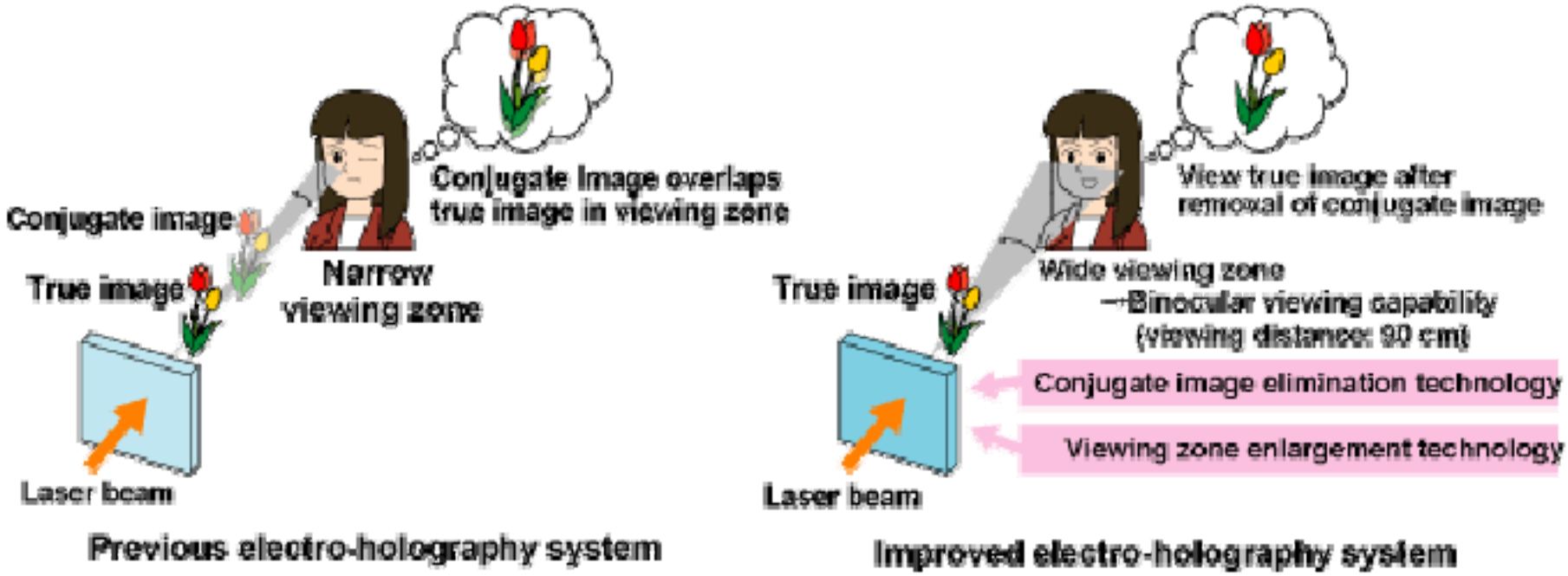
Viewing a little lower

Vertical parallax

Explanation

Electro-holography

- Technology to record and reproduce optical information with the use of optical interference ---> reproduce ideal autostereoscopic images
- Applied to a three-dimensional television system
- Many issues to be overcome ---> low quality and narrow viewing zone



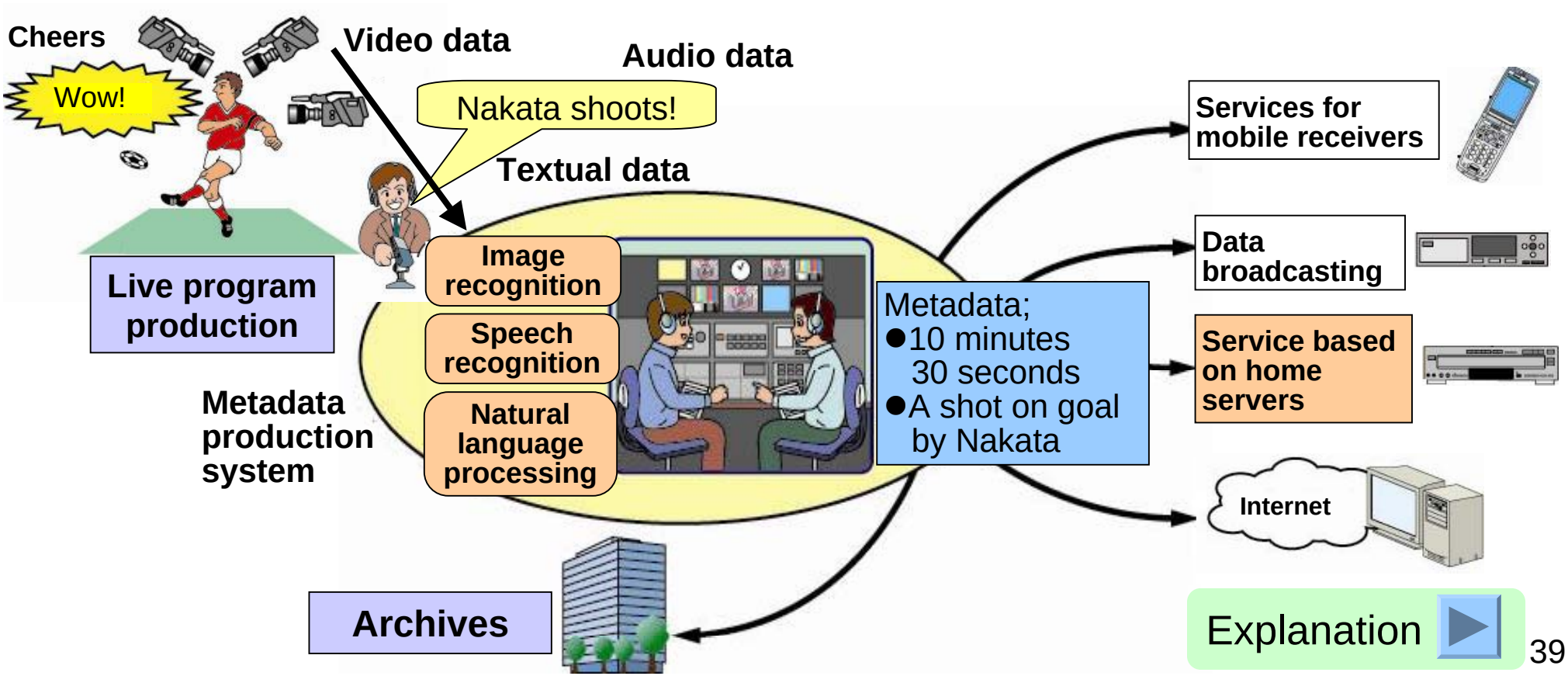
Common electro-holography system

Explanation

Research on Advanced Content Production and Mobile News-reporting Systems

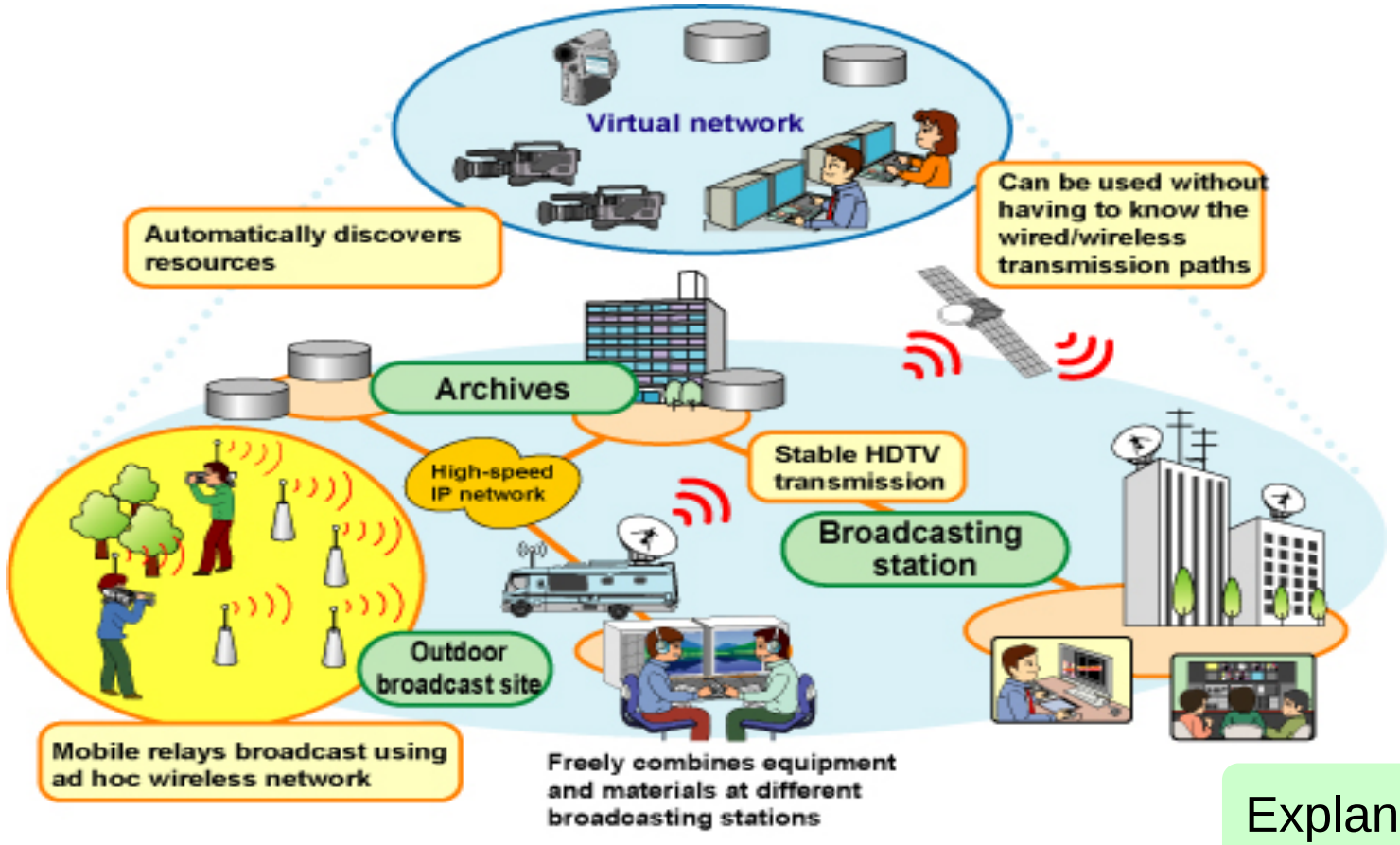
Metadata production system

- Program script and shooting plan can be used for metadata production for drama and documentary program.
- Metadata can be efficiently produced for sports programs by combining image recognition, speech recognition, natural language processing, etc.



Advanced program production system using wired and wireless IP networks

- Program production system using broadcasting equipment and contents not only within a broadcasting station but also other stations or archive facilities via broadband networks.

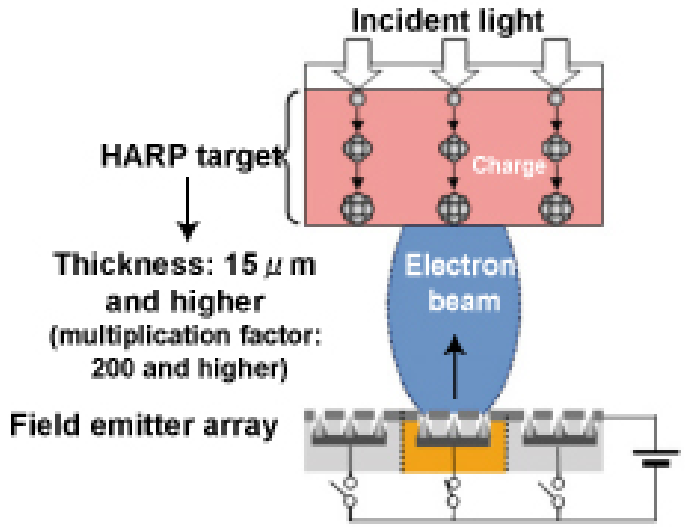


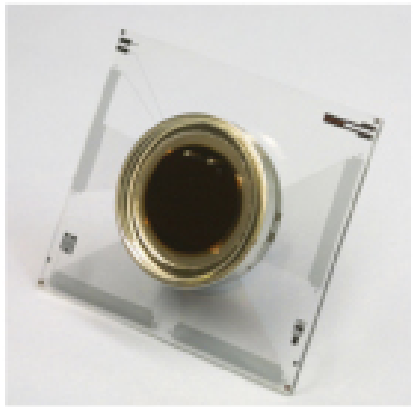
Explanation

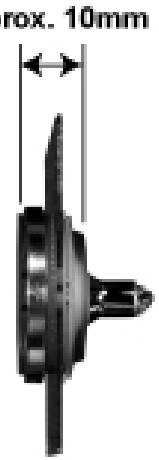
Program production system using wired/wireless network

Advanced imaging devices

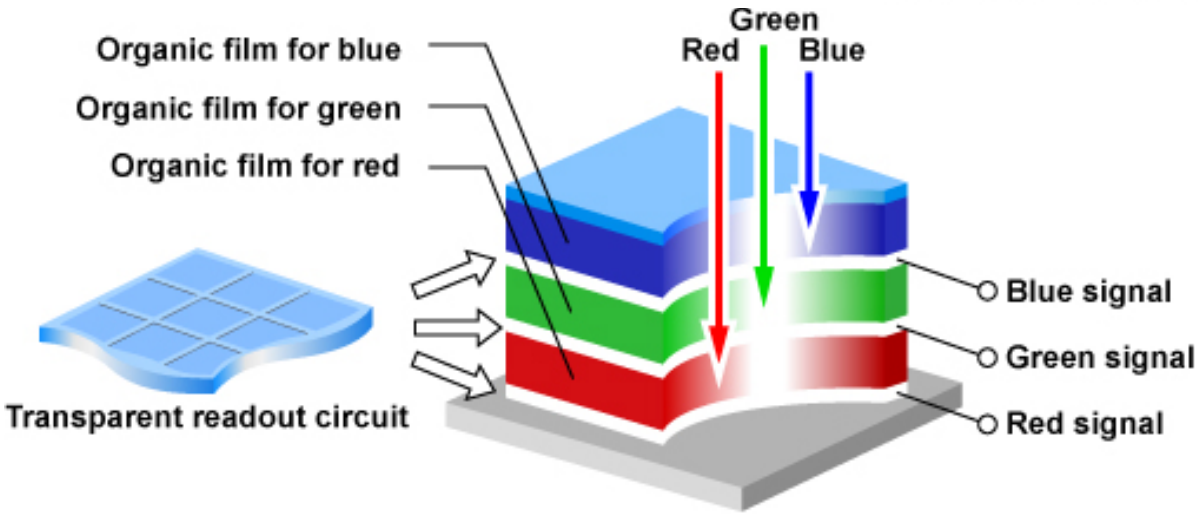
- Compact ultrahigh-sensitivity camera capable of vivid nighttime shots
- Imaging device using organic films for a palm-size camera system







Field emitter array image sensor with HARP target

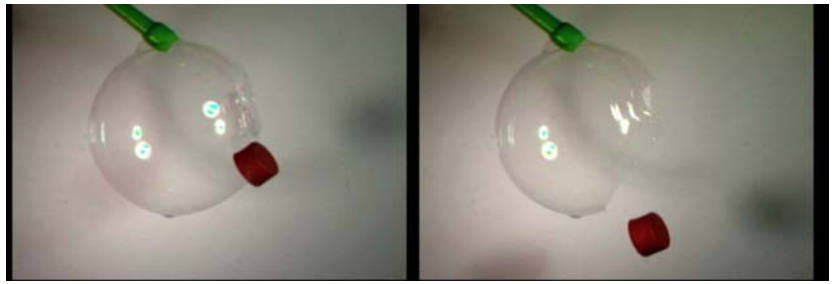


Conceptual image of future imaging device using organic films

Explanation

Ultrahigh-speed high-sensitivity camera

- Captures clear images of phenomena too quick for the naked eye under ordinary lighting conditions
- Shoots at 1 million frames per second (high sensitivity)



Picture example
Baseball ▶ Golf ▶ Soap Bubble ▶ Balloon ▶

Ultrahigh-sensitivity HDTV new-super-HARP handheld camera

- For emergency night time reporting
- Clear HDTV picture under moonlit conditions
- 200x the sensitivity of a CCD camera, 50,000x for still pictures

HDTV new-super HARP handheld camera

Picture captured by conventional CCD camera（Gain: ＋42 dB）

Picture captured by HARP camera

Explanation

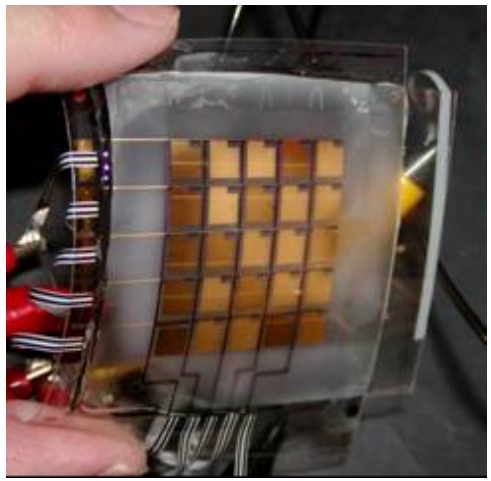
Research on Ubiquitous and Universal Services

Flexible displays

- Flexible organic electroluminescence (EL) display
- Flexible liquid crystal display

Flexible Organic Electroluminescence Display

Flexible Liquid Crystal Display (A4 size)

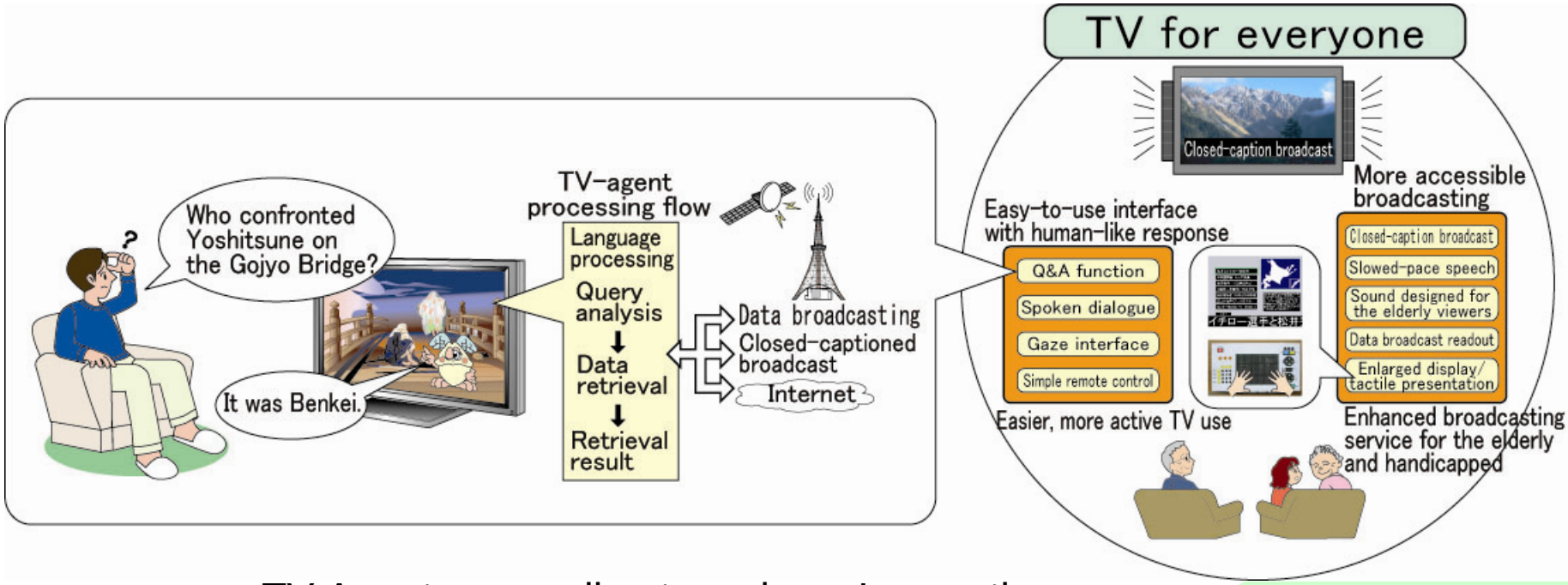


Organic TFT-driven Liquid Crystal Display (5x5 elements)

Explanation

TV agent system

- Let's anyone easily operate digital broadcasting receivers
- New Q&A function with a spoken dialogue TV operation capability.



TV Agent responding to a viewer's question

Explanation

6. Other technologies from the Open House 2005

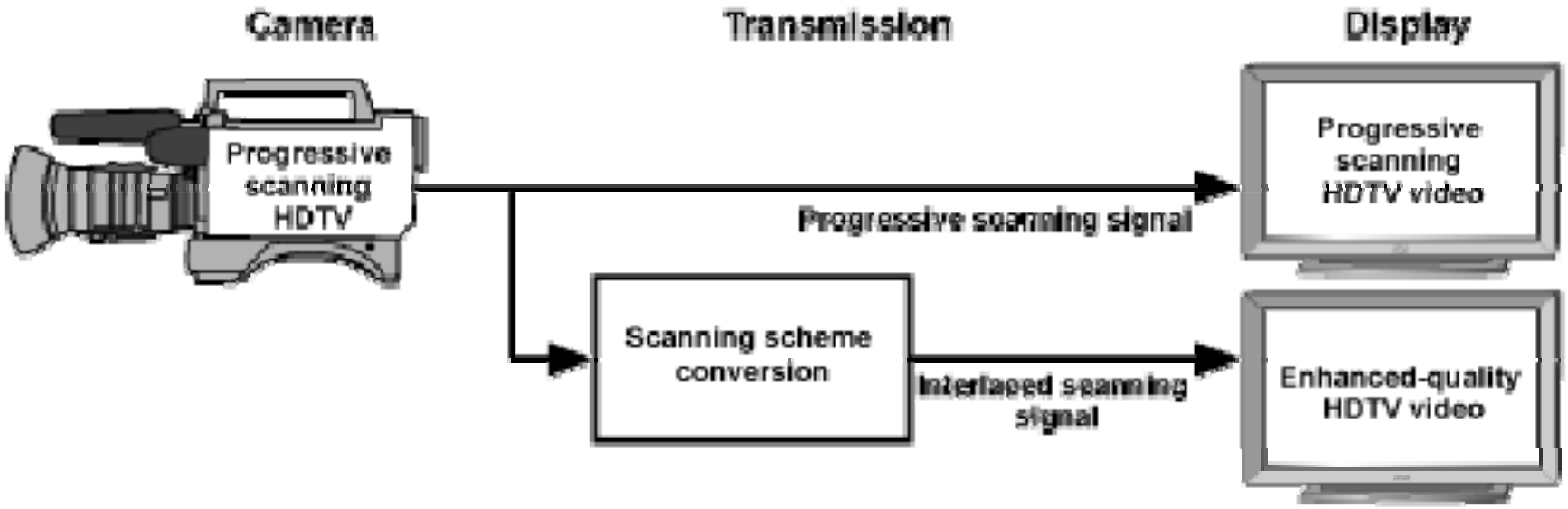
Other technologies

- Program productions
  - 1080/60p HDTV system
  - Bone conduction intercom headsets for broadcaster
- Transmission technologies
  - Millimeter-wave mobile camera
  - Luneberg lens antenna system for HDTV transmission
- Presentations
  - Field emission display
  - Tactile presentation system for visually impaired persons
- Fundamentals
  - Digital holographic memory
  - Spintronics

Program productions

1080/60p HDTV system

- For improving the quality of HDTV image
  - Progressive-scanning HDTV camera system

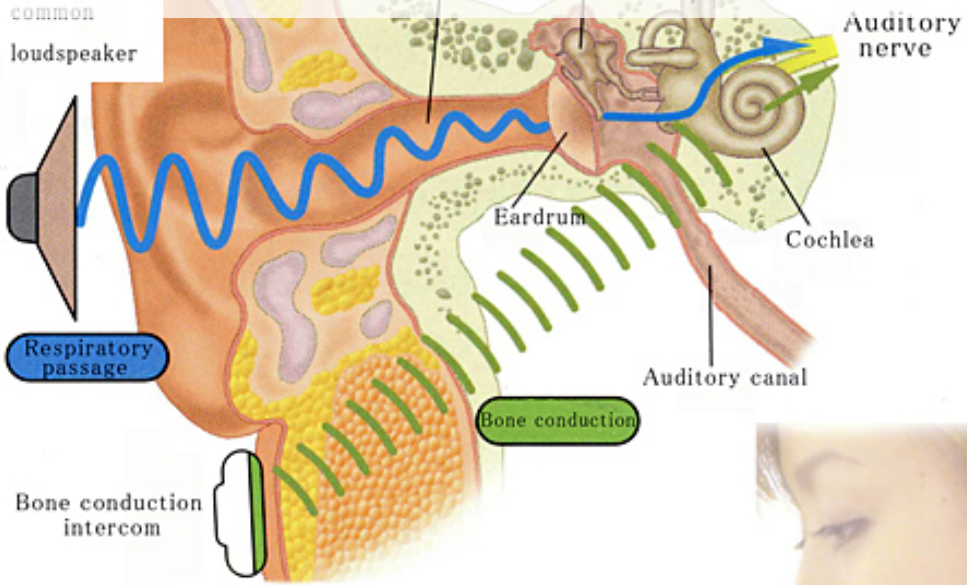


Conceptual Image of Improving HDTV Image quality by using progressive scanning

Explanation

Bone conduction intercom headsets for broadcaster

- To overcome difficulty for hearing sounds under some situation, a bone conductive intercom was developed.
- Bone conduction uses a mechanism whereby the human body's bones transmit sound by their vibration.

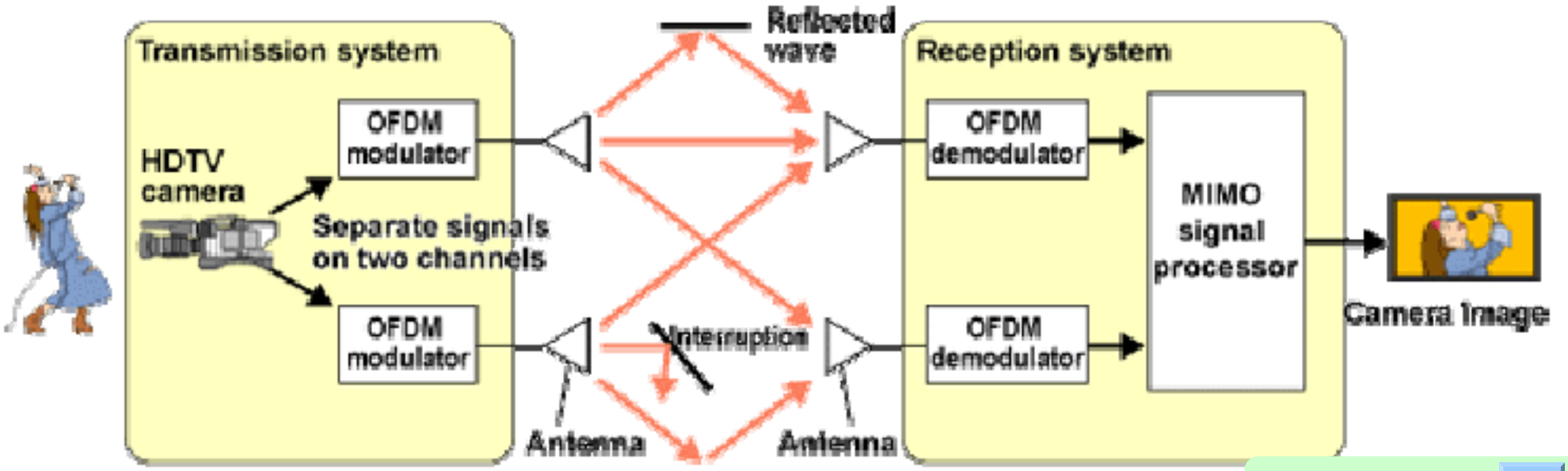


Bone Conduction Intercom Headsets for Broadcasters

Transmission technologies

Millimeter-wave mobile camera

- Wireless HDTV camera system using MIMO-OFDM transmission
- Wireless camera system free up camerawork



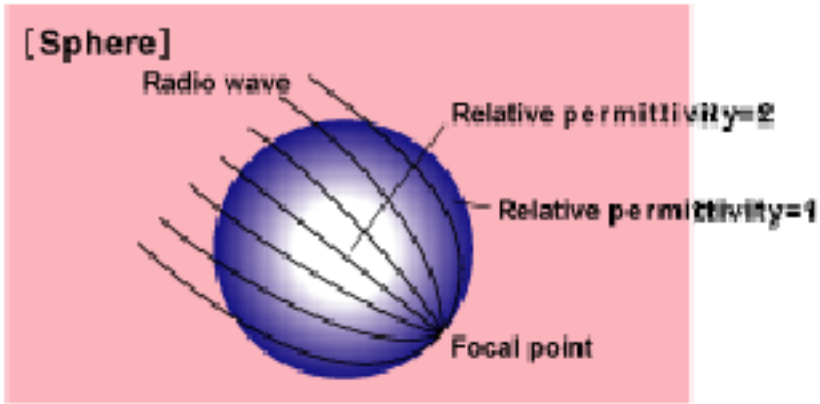
Explanation

By forming many radio-wave paths, the camera can send high-quality video signals containing twice the information that would be possible otherwise.

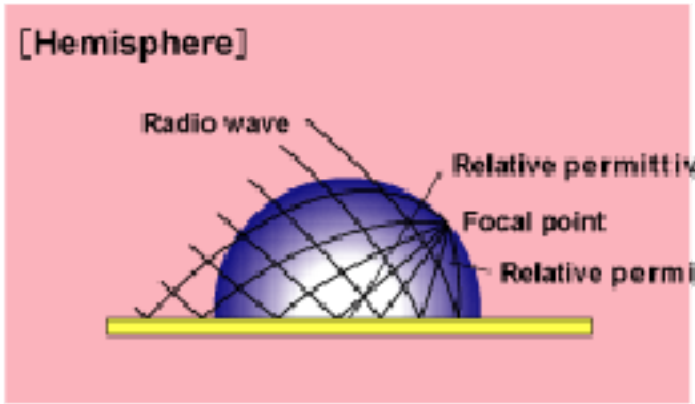
Millimeter-wave mobile camera using MIMO-OFDM transmission system

Luneberg lens antenna system for HDTV transmission

- Luneberg lens antenna instead of parabolic antenna for satellite communications
  - Small, lightweight antenna
  - Prompt stellite transmission



A radio signal entering from the focal point refracts at the boundary surfaces of thirteen dielectric layers, which have different relative permittivities between 1 and 2, and it radiates from the opposite side as a plane wave.



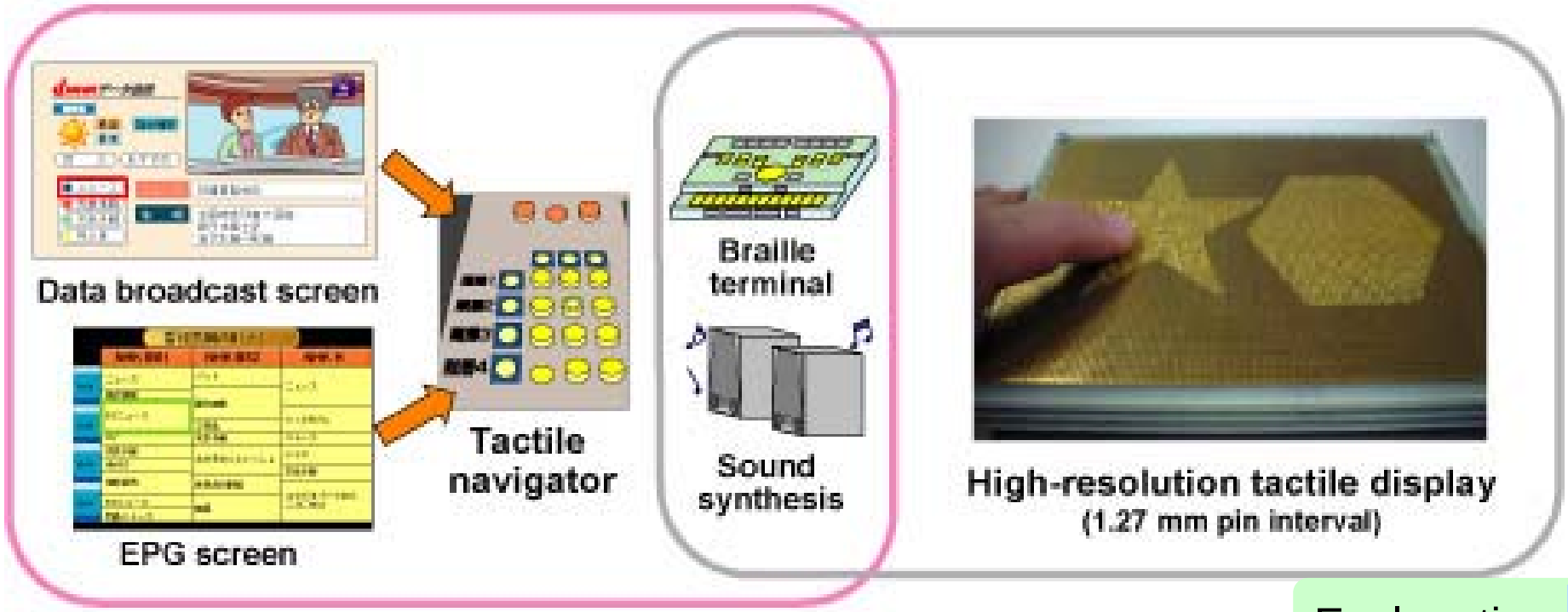
A spherical shape is difficult to fix in place, but a hemispherical shape obtains the same effect as a sphere if a reflector is installed at the bottom.

Lens antenna mechanism

Presentations

Tactile presentation system for visually impaired persons

- High-resolution tactile display for graphical information
- Tactile navigator enables a user to navigate a GUI's screen or table through touch

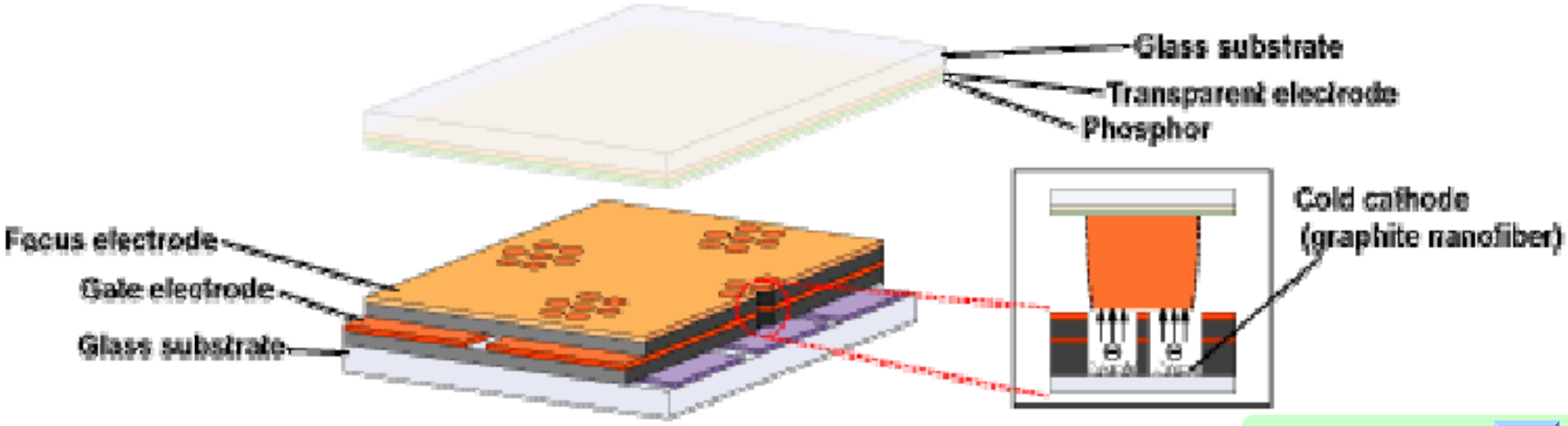


Explanation

Tactile presentation system to display GUI and graphical data

Field emission display

- For Super Hi-Vision programs to be viewed in the homes of the future
- Thin field emission displays with high luminous efficiency
- Compact flat display with high picture quality and low power consumption



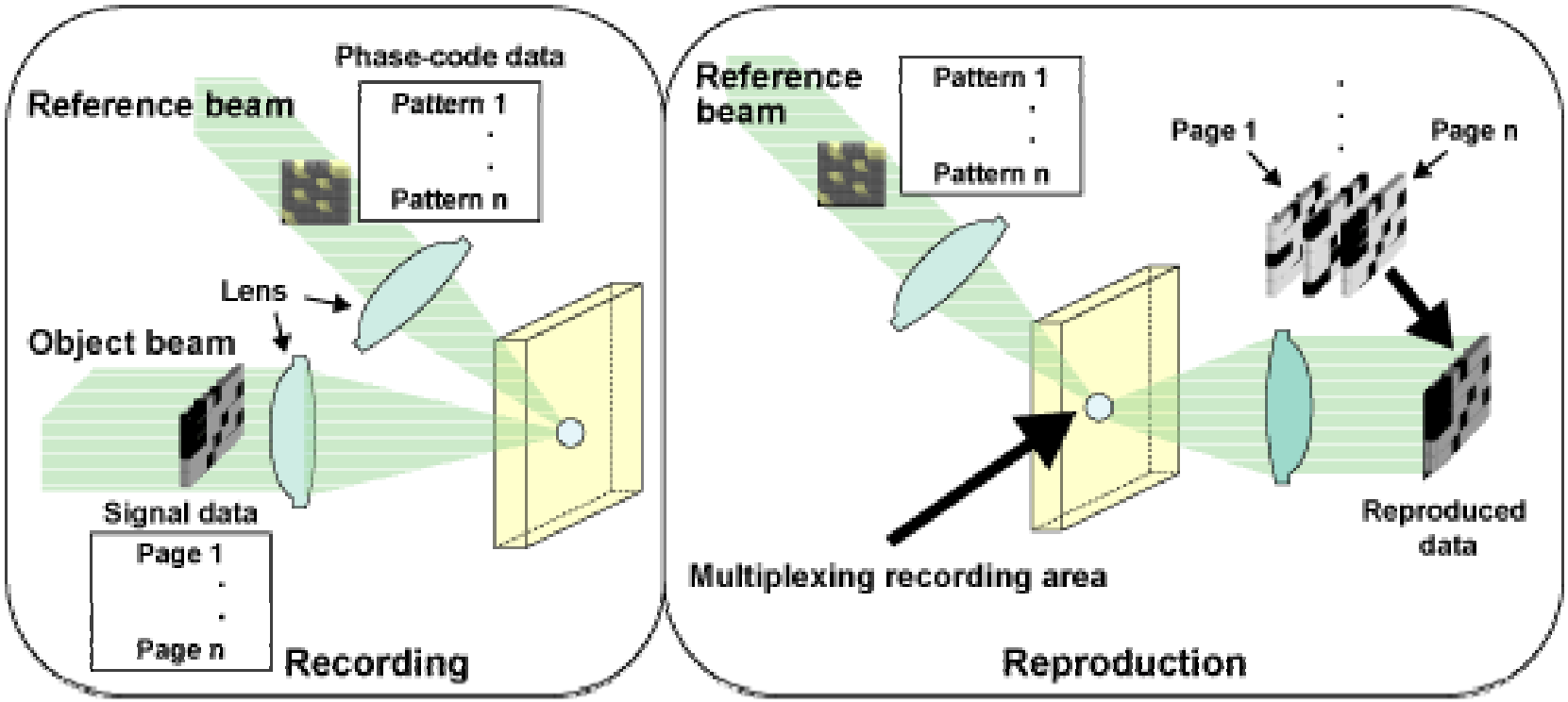
Explanation

Structure of field emission display using graphite nanofiber

Fundamentals

Digital holographic memory

- Holographic recording using optical interference as an advanced recording technology

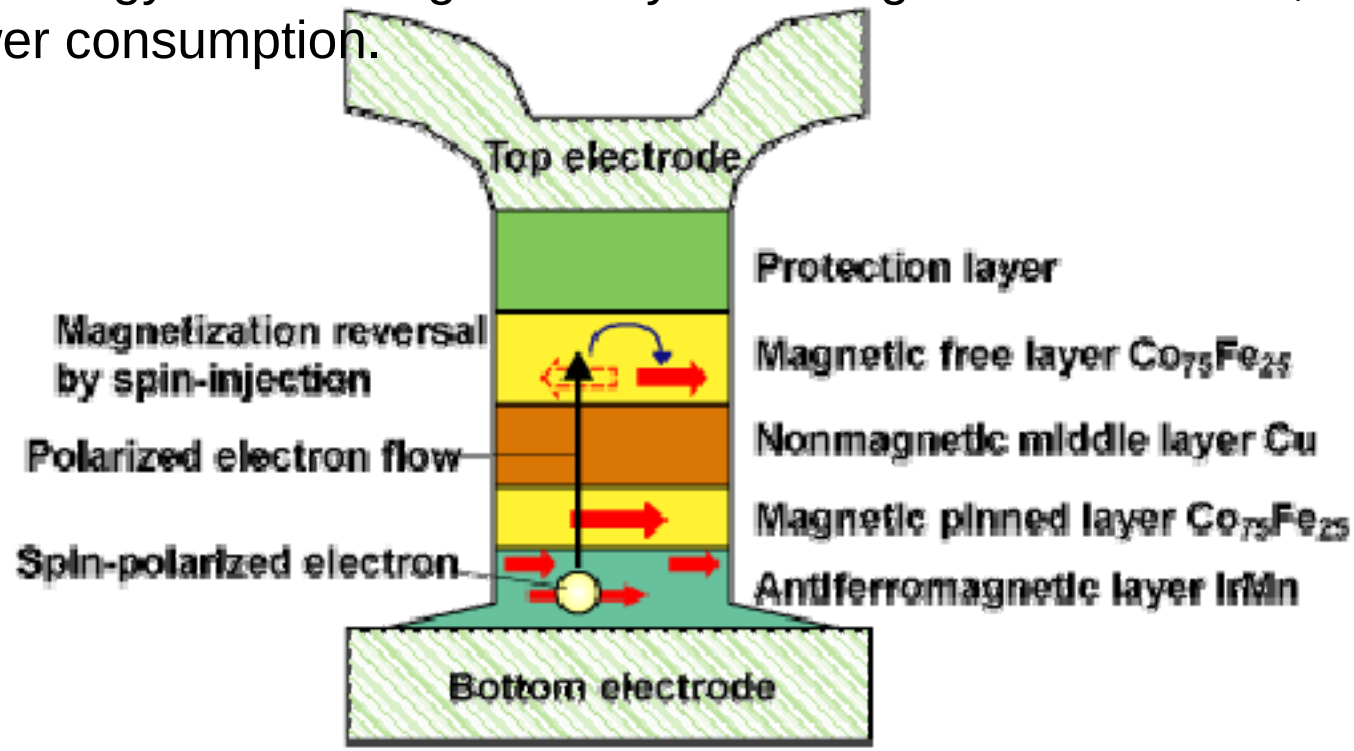


Phase-code multiplexing holographic recording

Explanation

Spintronics

- Key technology for a future recording device.
- The spin-injection magnetization reversal technology is capable of performing pinpoint recording onto a small magnetic dot, without magnetic field spread.
- This technology enables high-density recording at lower current, which means less power consumption.



Prototype CPP-GMR* spin-injection magnetization reversal device

7. Summary

Summary

- R&D based on NHK STRL vision “NEXT”
  - “NEXT”: NHK EX Technology (Express, Excel and Expand)
  - Broadcasting technology that learns from human possibilities
  - for ultimate broadcasting systems
  - for advanced program production and news-reporting systems
  - for ubiquitous and universal services

- Broadcasting will play an important role in the creation of culture and in the lives of people.
- Collaboration with organizations in the world

Thank you for your attention!