



NHK STRL

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# Latest Research Activities of NHK Science and Technical Research Laboratories

-From Open House 2002-

Takayuki ITO  
NHK Science and Technical Research  
Laboratories



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# History of NHK STRL(1)

- Established in 1930
  - 5 years later since radio broadcasting started
  - Started with 16 researchers
- Major Research Themes
  - Television (1937-1953)
  - Color Television (1948-1964)
    - Color Video of Tokyo Olympic Game was broadcasted all over the world through relay satellite.



STRL building in 1930



TV camera developed in 1938



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# History of NHK STRL (2)

## —HDTV (1964-2000)

- Next generation television after color TV



## —PDP (1971-1998)

- From the beginning of HDTV research, 50'-size PDP was to be a standard display to enjoy full quality of HDTV.





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# History of NHK STRL (3)

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## —Broadcasting Satellite (1966-1990)

- STRL Pioneered toward the direct reception of TV signals from a satellite.
- The key was to develop a low noise receiver and small parabola antenna as well as high power transponder on the satellite.

## —Digital Broadcasting (1982- )

- **ISDB**: Integrated Services Digital Broadcasting
- Original ISDB scheme was proposed in 1982.
- BS digital services (ISDB-S) was launched in Dec. 2000.
- Digital terrestrial broadcasting (ISDB-T) be started in 2003.
- Biggest problem in ISDB-T has been settled because Japanese government decided to invest ¥180 billion (\$1.55 billion) for analog channel conversion in July 19.



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# Features of ISDB

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- **Varieties of services** such as
  - Digital Hi-Vision(HDTV)** as well as SDTV
  - Multi-media Data services including electronic program guide(EPG)
  - Audio specific channels
- **Flexible configuration**
  - ISDB-S:TMCC(Transmission and multiplexing configuration control) signal enables independence among services coexisting in one carrier.
  - ISDB-T:Independent parameter setting for each segment of BST-OFDM





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# Digital HDTV





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# Data Services

Weather information



Anytime news



Statistics and Analysis of sports



Program related information





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# Electronic Program Guide (EPG)

5月26日 11時34分



ハイビジョン

BS-1

BS-2

NHK総合



5/26

現在の時刻へ

録画

詳細

11

0

00 ハイビジョンでこんにちは  
登山家 田部井淳子

30 きょうの料理  
「コンビニクッキング」

00 美しき大河！四万十川よ！！  
－ 第1章・春 －

00 ワールドカップサッカー・アメリカ 9  
4

25 東京マーケット情報

50 BSニュース50

00 アメリカ・CNN  
ニュース

25 大好き！ガーデニング  
－すてきな午後・エンジョイライフー

50 BSニュース50

10:00 国会中継  
「参議院行財政改革・  
税制特別委員会 総括  
質疑」

00 ニュース

20 世界水中紀行  
30 ジャズ・セレクション

10:00 国会中継  
「参議院行財政改革・  
税制特別委員会 総括  
質疑」

00 ニュース

20 ひるどき日本列島  
「山のくらし・岩手県」

45 天うらら (43)  
－連続テレビ小説－

時刻表

スポーツ

ニュース

ドラマ

音楽

オススメ

データ

戻る



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# Features of ISDB

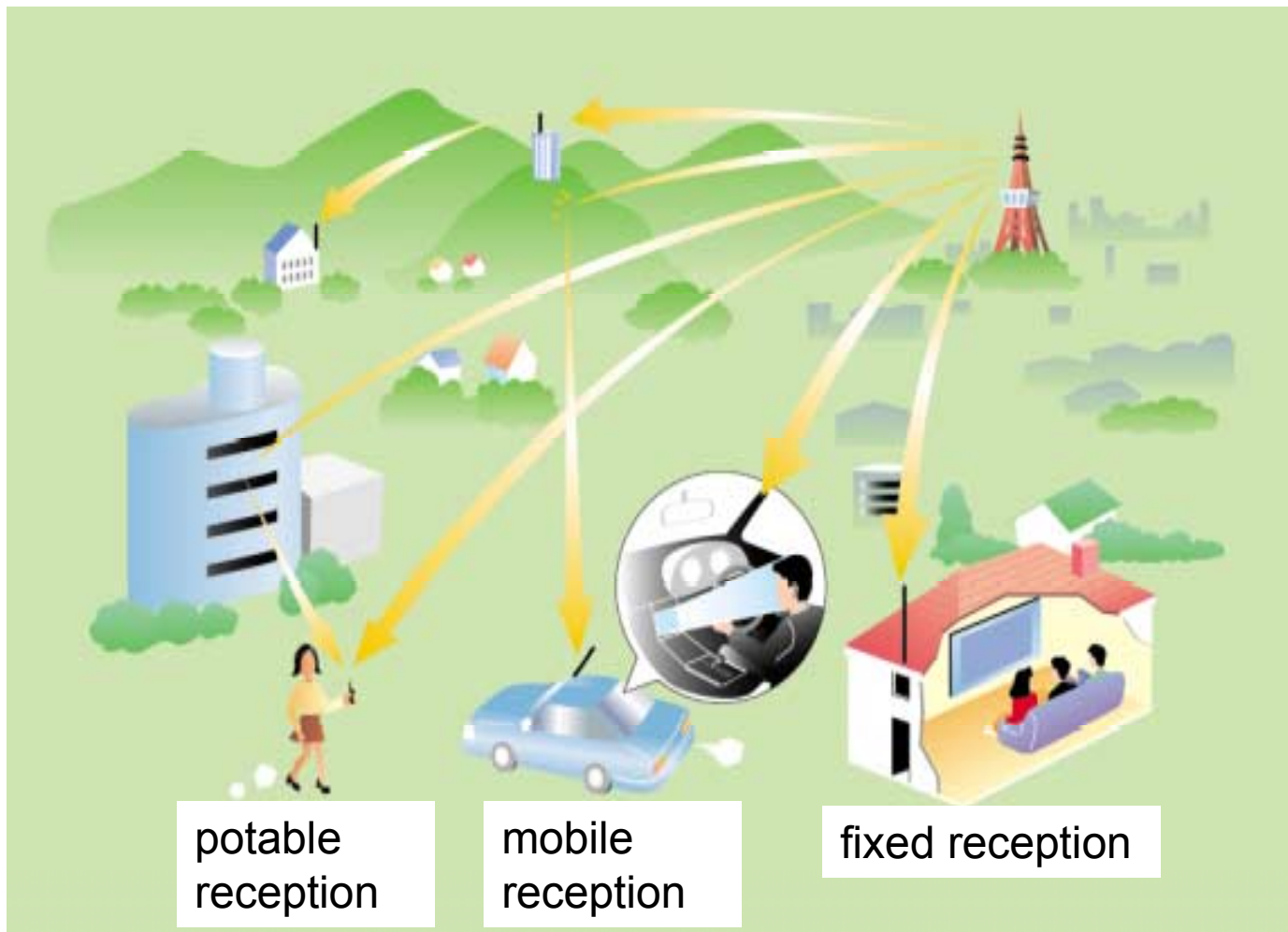
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- Varieties of services such as
  - Digital Hi-Vision(HDTV) as well as SDTV
  - Multi-media Data services including electronic program guide(EPG)
  - Audio specific channels
- Flexible configuration
  - ISDB-S:TMCC(Transmission and multiplexing configuration control) signal enables independence among services coexisting in one carrier.
  - **ISDB-T**:Independent parameter setting for each segment of BST-OFDM



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# Digital Terrestrial Broadcasting (ISDB-T)

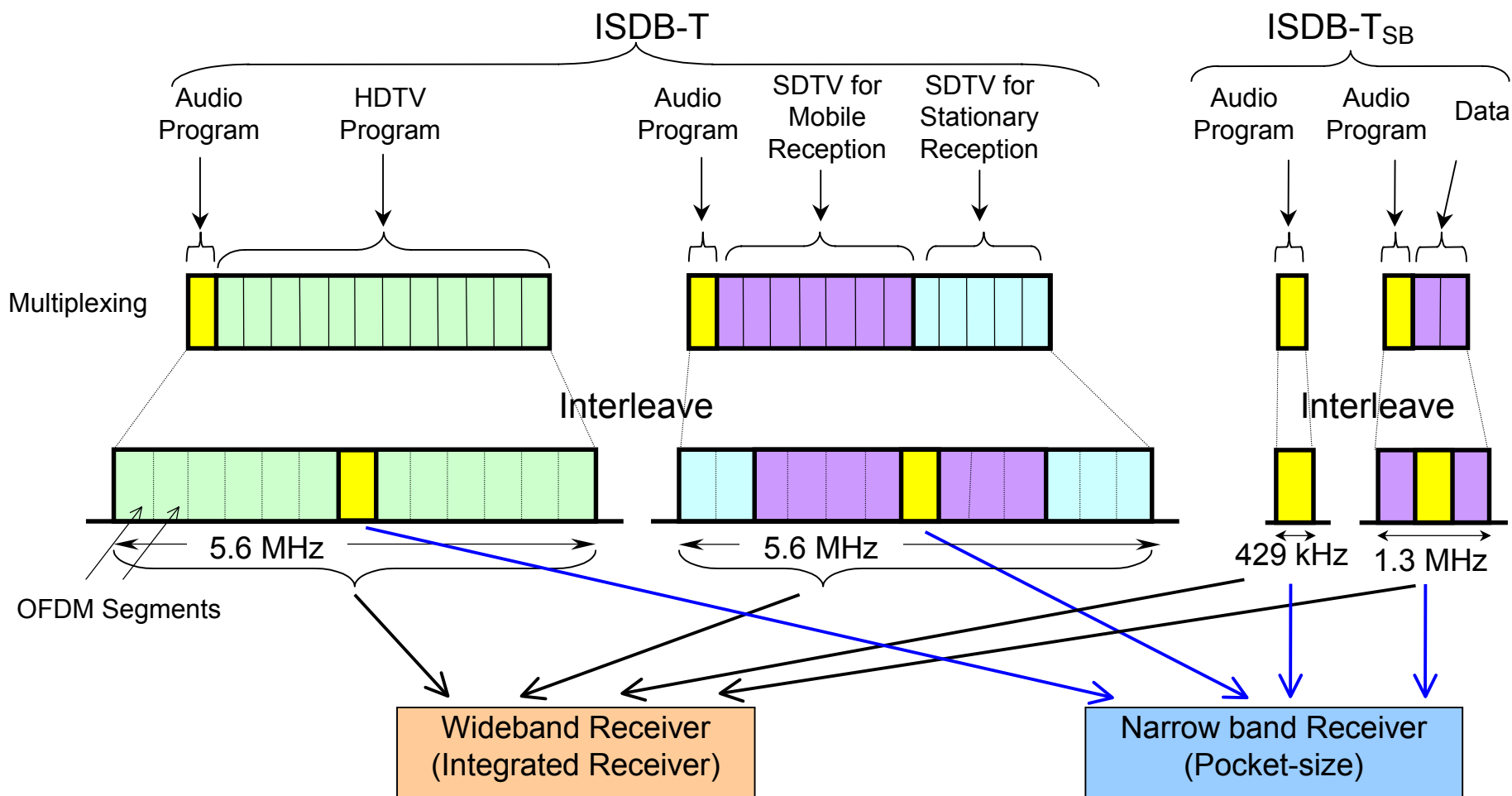






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# Transmission example of ISDB-T



## 3<sup>rd</sup> Generation Research Complex

- Opened in April 2002
  - 14 stories high  
(office tower)
  - 6 stories high  
(experiment building)



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



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# Open House 2002

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- 56<sup>th</sup> Open House :from May 17 to May 19, 2002.
- First since the new STRL research complex was completed.
- 32 exhibits presented research results under the catch phrase "We want Happiness to Bloom. -Egg or chick? Next Generation Broadcast Technologies"
- These included technologies categorized into three groups of MLRV
  - 1.Advanced ISDB
  - 2.Content Production Technology
  - 3.Next Generation broadcasting
- More than 20,000 attendance in three days (May 17, 18, 19)



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# Major exhibits

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## 1. Advanced ISDB

- Re-transmission Technologies for Digital Terrestrial Broadcasting
- Human-friendly Receivers for People with Visual and Hearing Impairments
- Program Request Service over Network

Other main exhibits

Broadcasting Service Based in Home Servers, TV4U (The Personal, Fun Future of TV)

## 2. Content Production Technologies

- Advanced Virtual Studio
- Digital Content Copyright Protection
- High-speed Recording on a High-density Optical Disk

Other main exhibits

Video Editing Support using Image Recognition Technology, Free Viewpoint Video Reproduction System

## 3. Future Broadcasting Services and Fundamental Technologies

- Ultra-high-definition, Wide-screen System with 4000 Scanning Lines
- RGB Phosphorescent Polymer EL Materials
- IC Microphone

Other main exhibits

3-D Audio System Conveying a High Sense of Reality, Next-generation Satellite Broadcasting System,  
Field Emitter Array Image Sensor with HARP Target





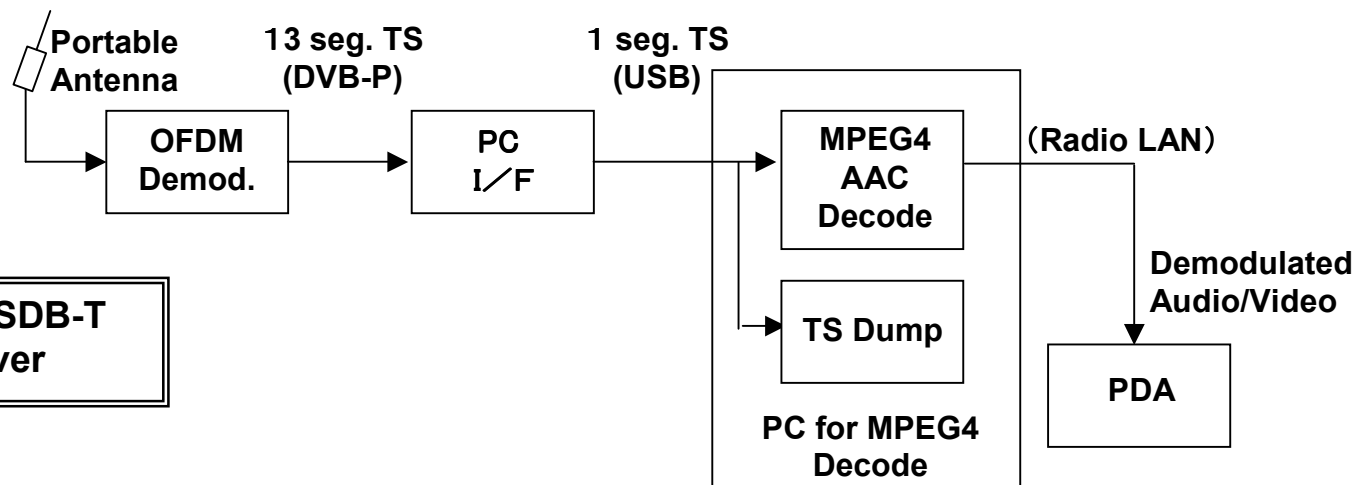
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# Next Generation Data Service Portable TV Receiver based on MPEG4

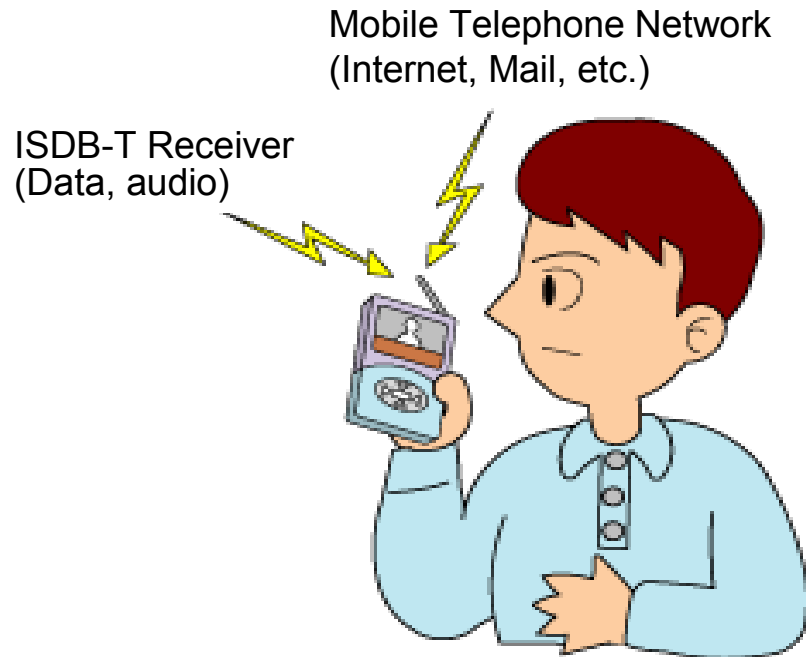
Prototype of ISDB-T Portable Receiver



Block diagram of ISDB-T Portable Receiver



# Mobile Reception in the future



- Recently MegaChips Corp. announced that they developed a new LSI which can decode OFDM signals based on ISDB-T spec.
- It plans to develop Both full(13)-segment-type and partial(3)-segment-type LSI

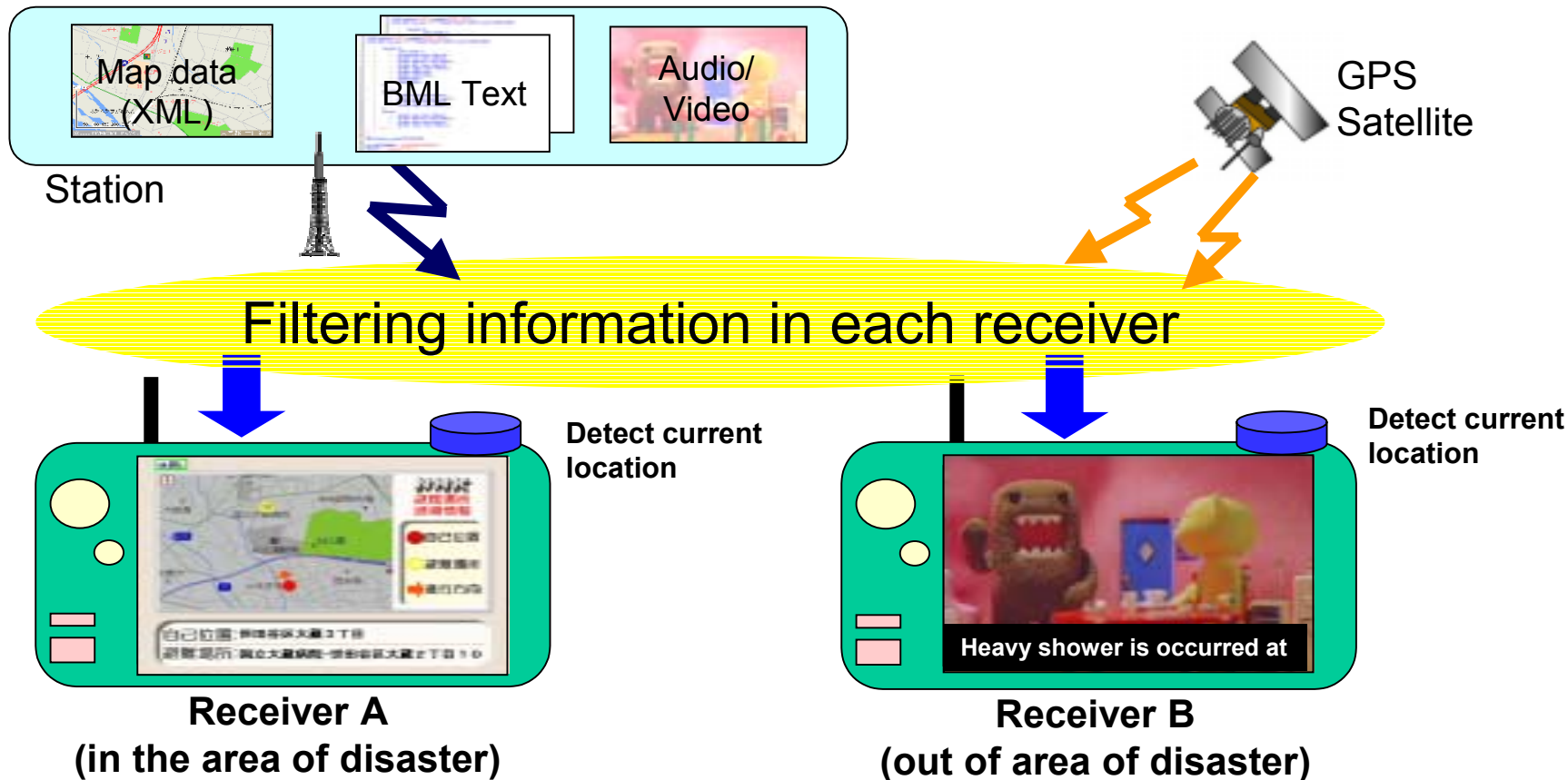


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# Next Generation Data Service

## Location-linked Service

- By combining a ISDB-T receiver with GPS, you can get appropriate information at your receiving site.
- Example: In the area of disaster, the nearest evacuation site is shown with a map and out of the area the news of the disaster will be shown.
- Receiver filters broadcasted data using the location information from GPS.





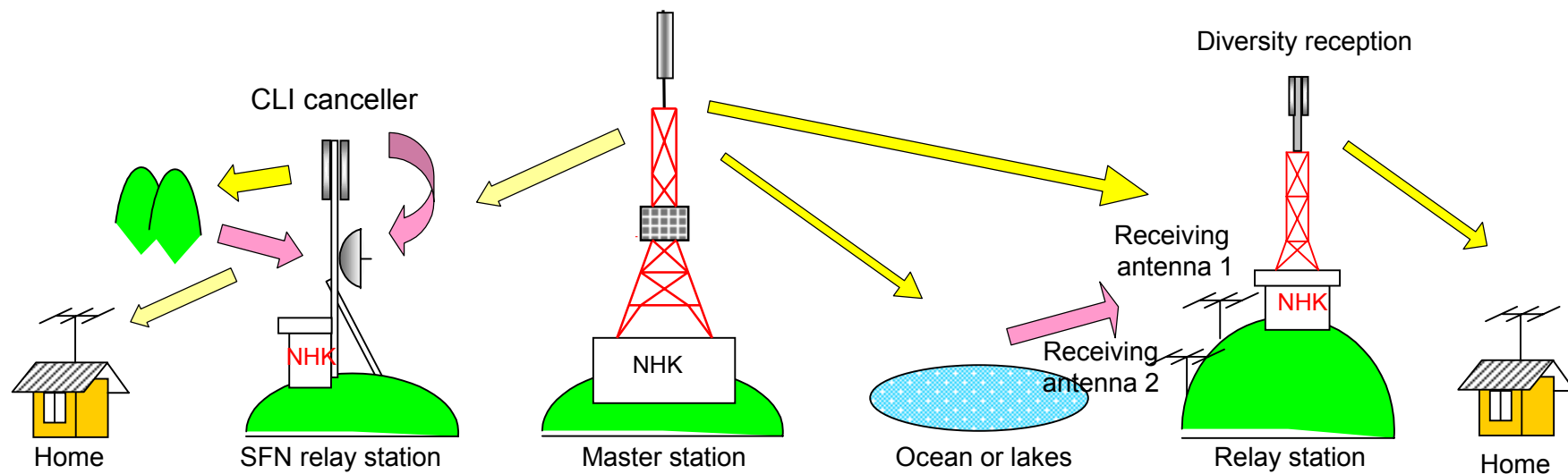
# Re-transmission Technologies for Digital Terrestrial Broadcasting

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-Toward the Construction of Countrywide Digital Terrestrial Broadcasting Networks -

Develop technologies for constructing stable and cost-effective relay networks so that digital terrestrial broadcasts can be delivered all over Japan.

- Coupling loop interference (CLI) cancellers can eliminate distortion when signals are relayed in a single-frequency network (SFN).
- A diversity reception system for relay stations can reproduce high-quality signals from those degraded through transmission.







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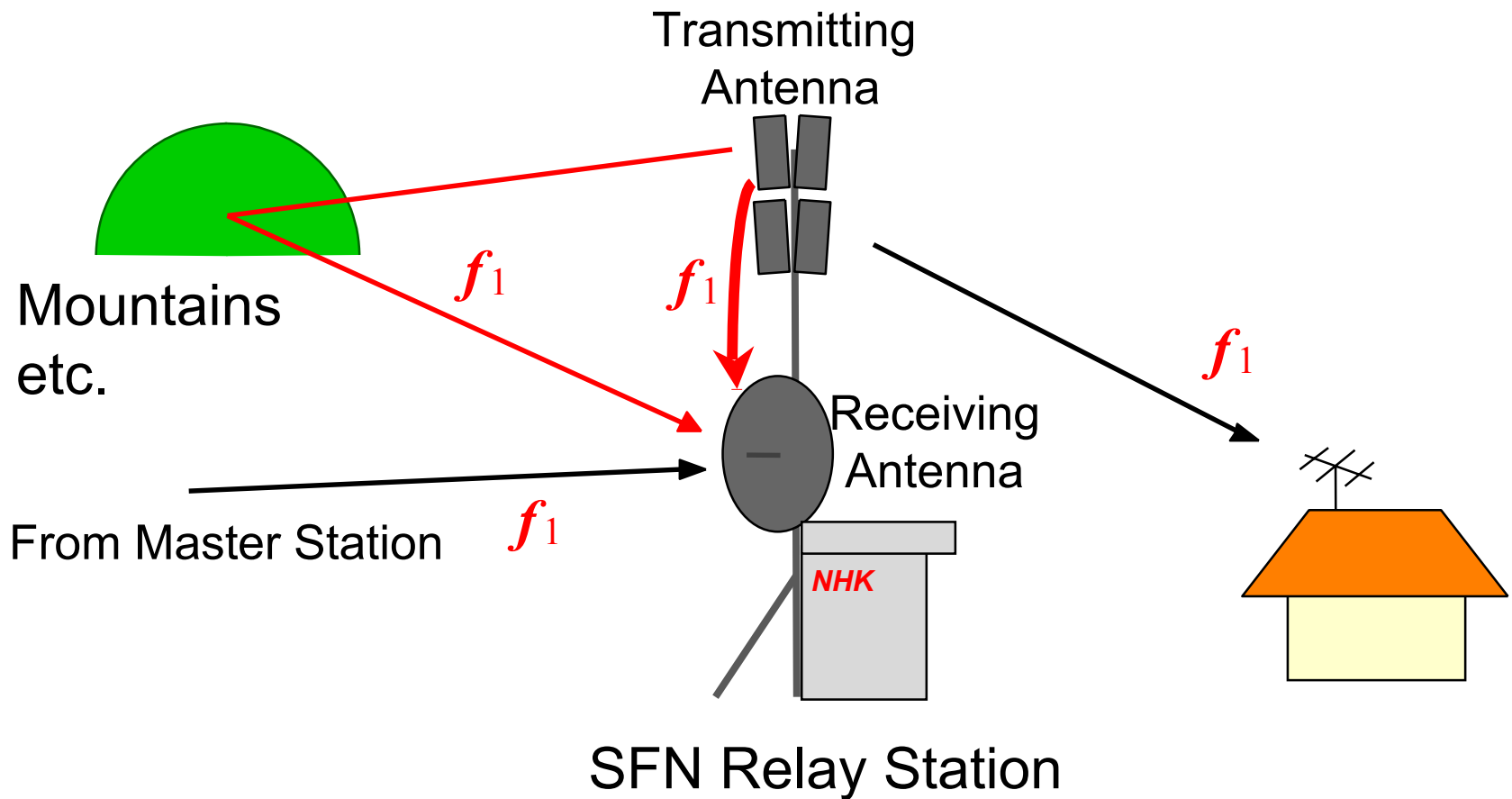
# Construction of SFN

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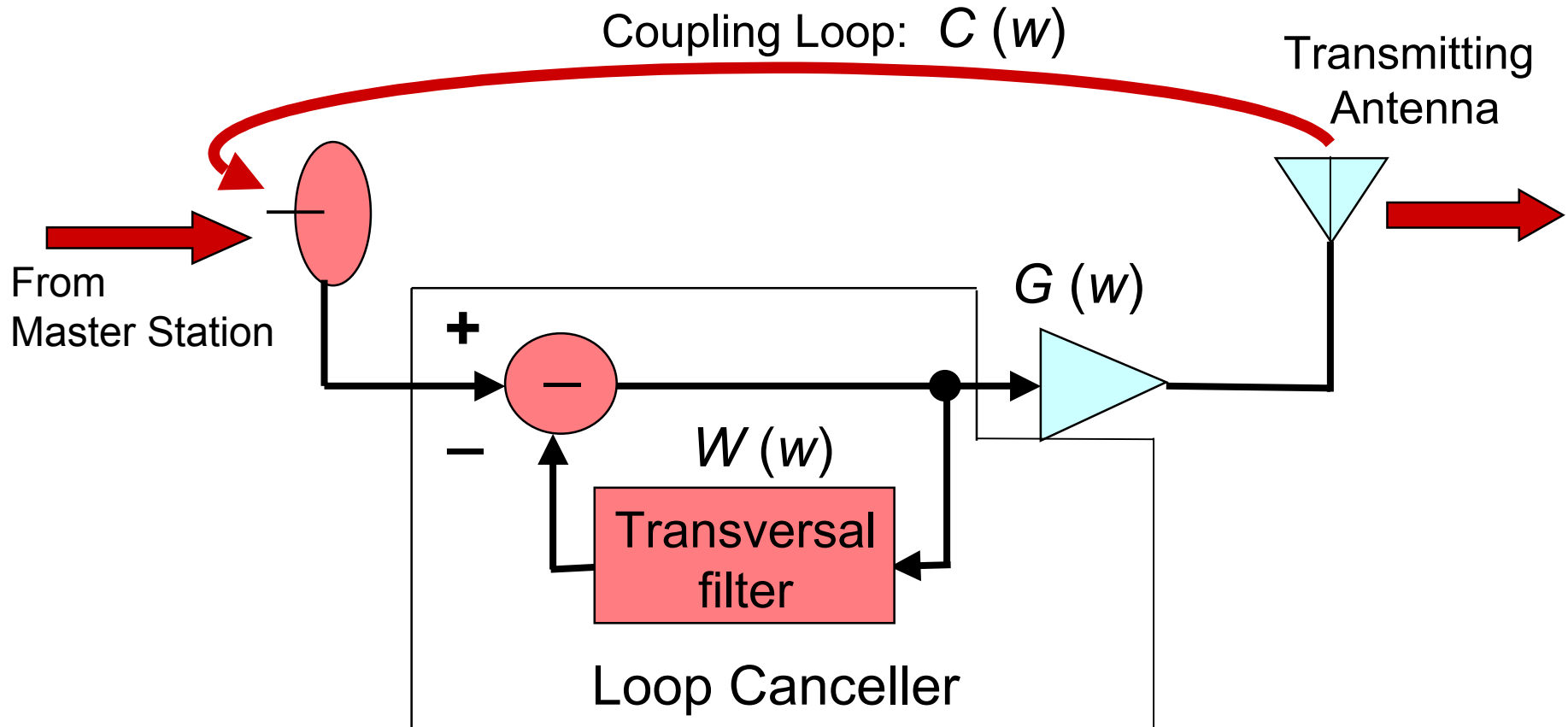
## Construction of Single Frequency Networks (SFN)

- Microwave Link
  - more frequency bands
- Optical Fiber
  - construction cost
- Broadcast Wave Relay System
  - low cost
  - problem: loop interference

# Loop Interference



# Principle of Loop Canceller

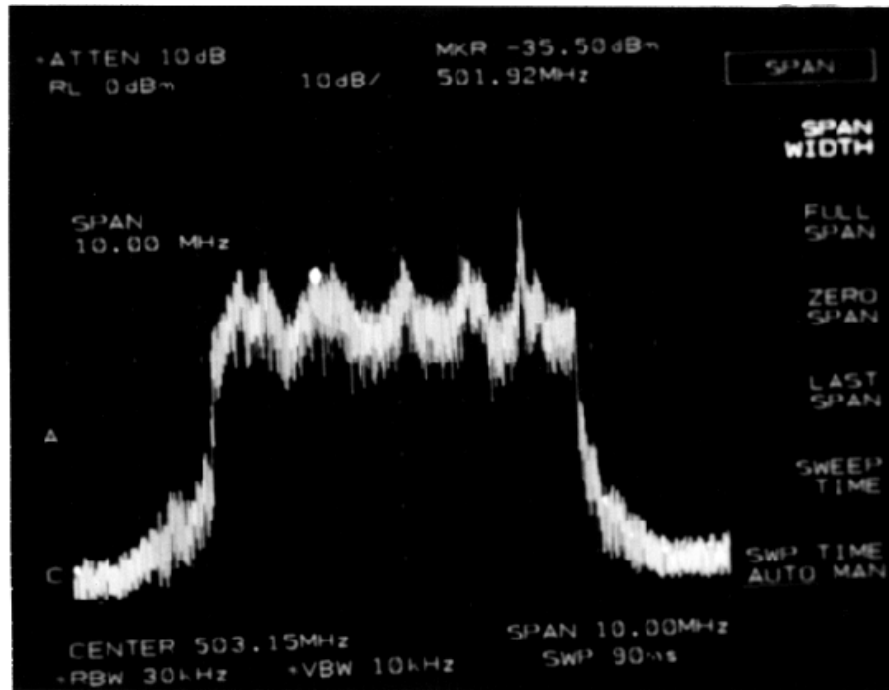


Condition for cancelling:  $W(w) = G(w) C(w)$

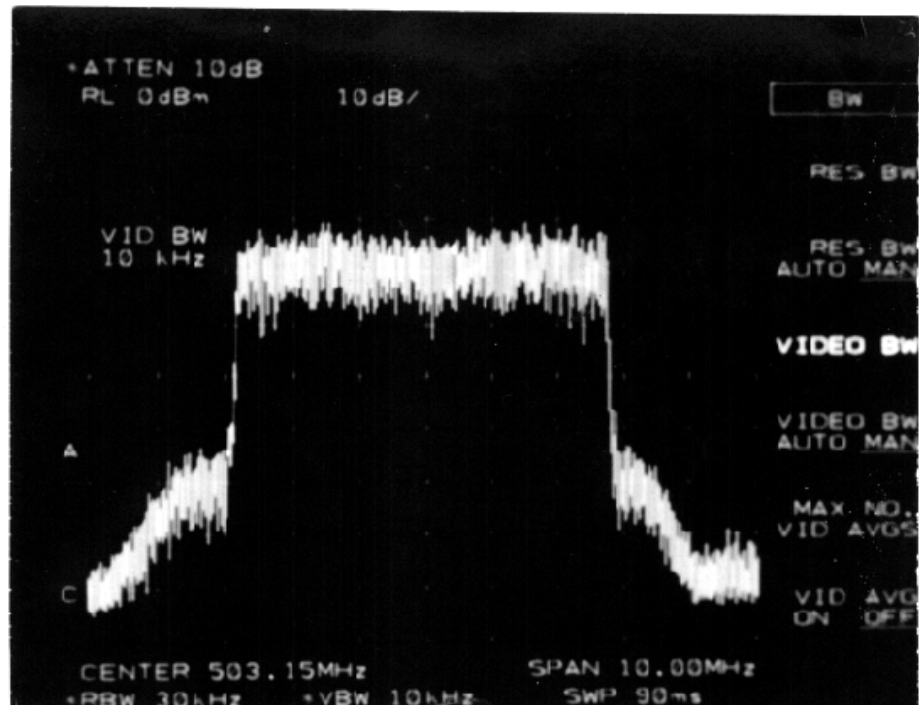


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# Effect of Loop Canceller



Booster output  
without loop canceller



Booster output  
with loop canceller





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# Human-friendly Receivers for People with Visual and Hearing Impairments (I)

- Aiming at Barrier-free Information Provision -

- For visually impaired people, we develop a terminal using tactile presentation and synthesized voice to show the contents of data broadcasts.
  - Displays menus and graphics on the screen using a two-dimensional tactile display.
  - Reads out the text in a natural quality voice.



Advanced ISDB

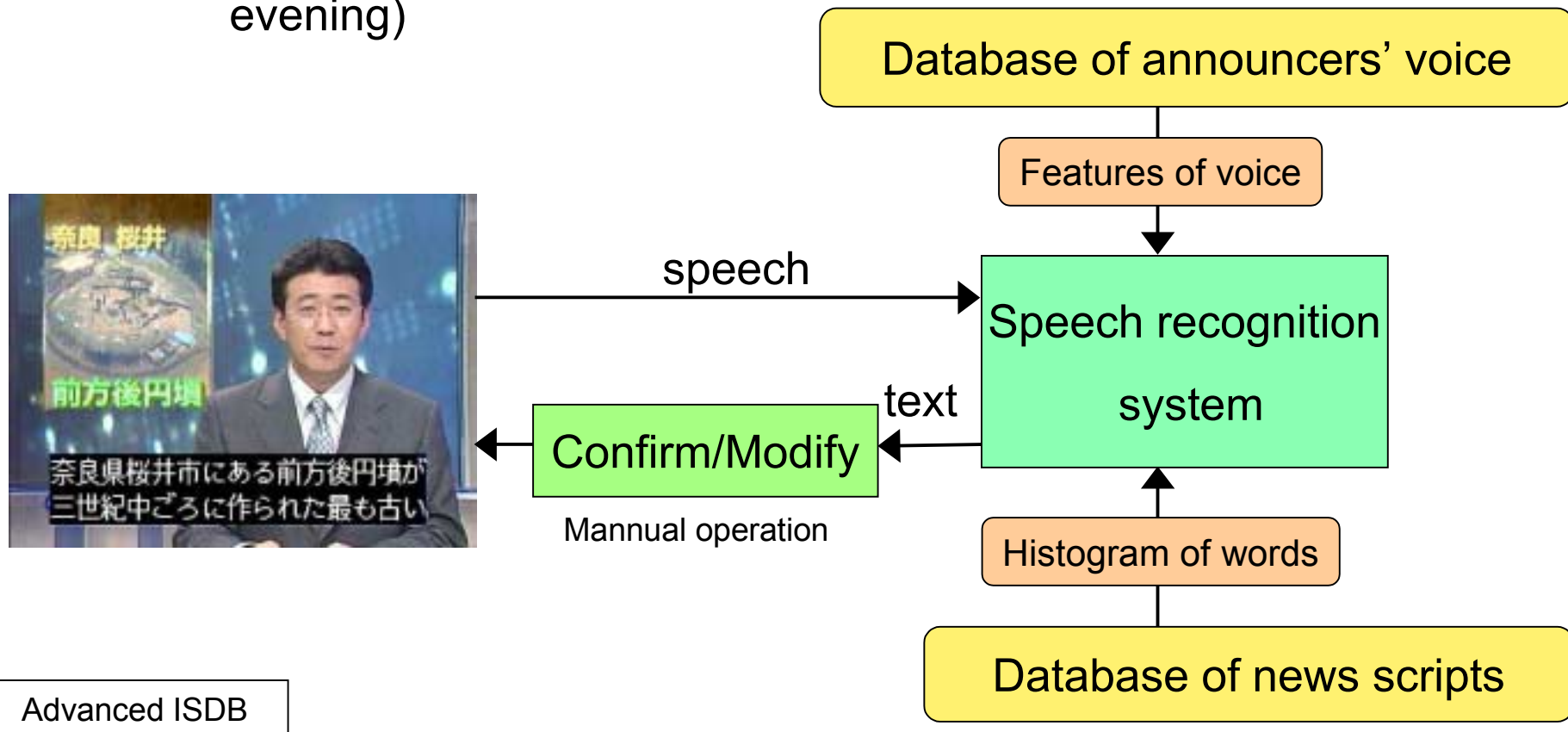


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# Human-friendly Receivers for People with Visual and Hearing Impairments (II)

- Aiming at Barrier-free Information Provision -

- For hearing impaired people, we developed a closed captioning system which converts news announcers speech into a transcript.
  - Recognition accuracy for announcer-read speech exceeds 95%.
  - Now used in News7 and News9 (major news programs in the evening)



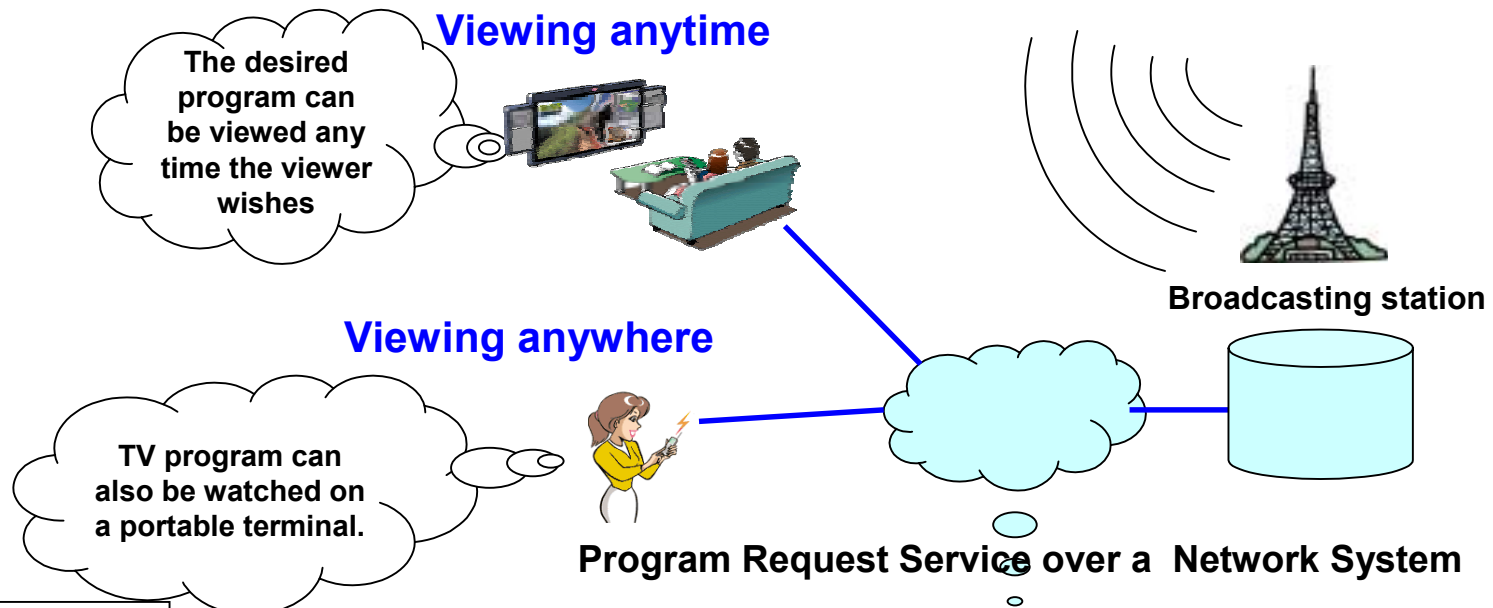


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# Program Request Service over Network

- Viewing Your Favourite Programs Any time and Any where -

- To verify the technical possibility of broadcast on demand, experimental system is being developed which allows viewers to request and view their favourite programs via network.
  - A receiver is connected to a broadband network to view programs of HDTV format in 20Mbps for home use.
  - A portable receiver is also developed which utilizes low bit rate video channels such as IMT2000.



Advanced ISDB



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# Advanced Virtual Studio

- Virtual Studio Based on Real Studio Sets -

- An advanced virtual studio where you can freely combine real studio sets with a virtual space created using computer graphics .
  - Allows real and virtual sets to be combined seamlessly without using any special blue background.
  - An **Axi-Vision camera** makes for a natural interaction between a real performance and a CG character through consideration of their relative positions.
  - Intelligent robot cameras smoothly and accurately track invisible CG virtual objects.



Content Production  
Technologies



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# HDTV Axi-Vision Camera

- HDTV Axi-Vision Camera is capable of detecting depth information of an object in real-time as well as color HDTV video images. This camera can present a new image synthesis using the depth information in advanced virtual studio without blue-back screen.



Camera Image



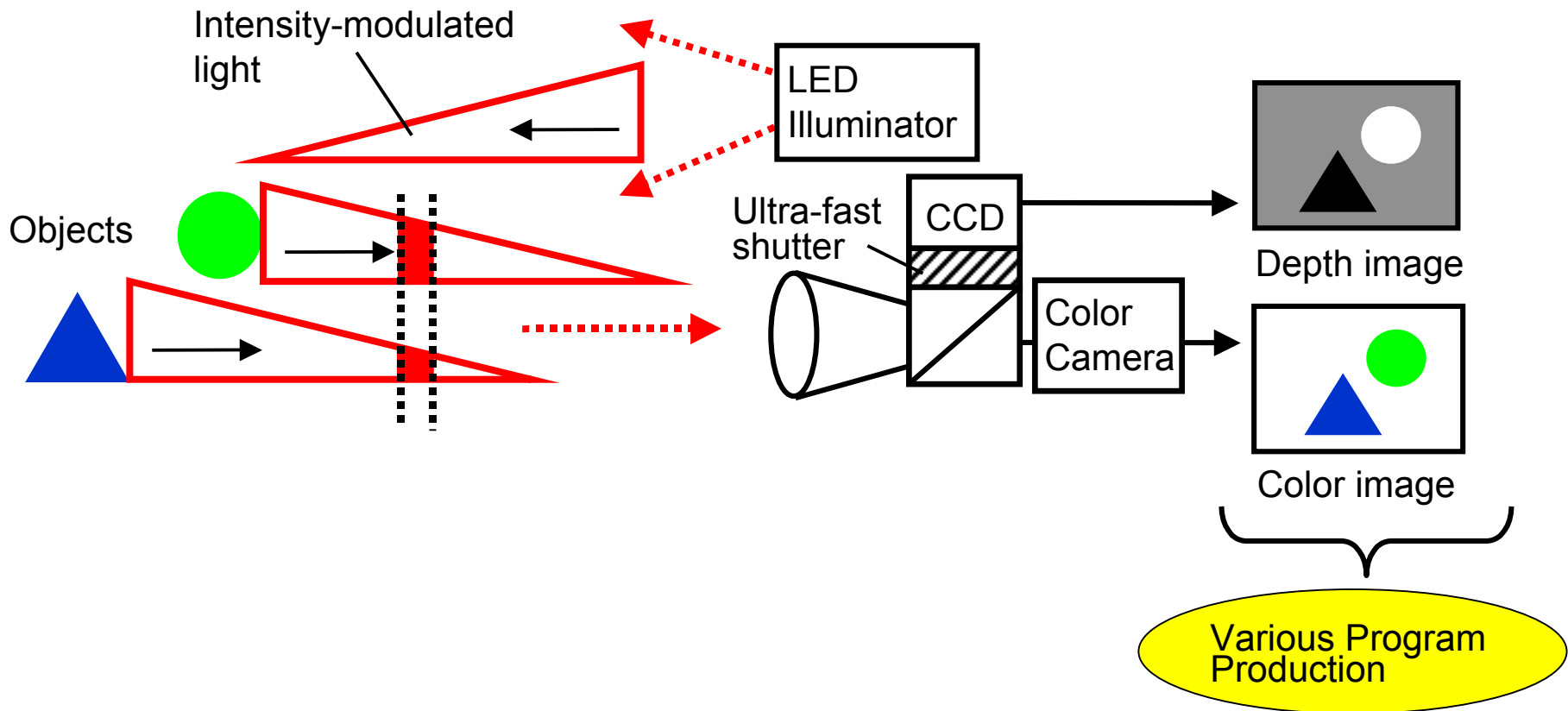
Image Component



Synthesized Image

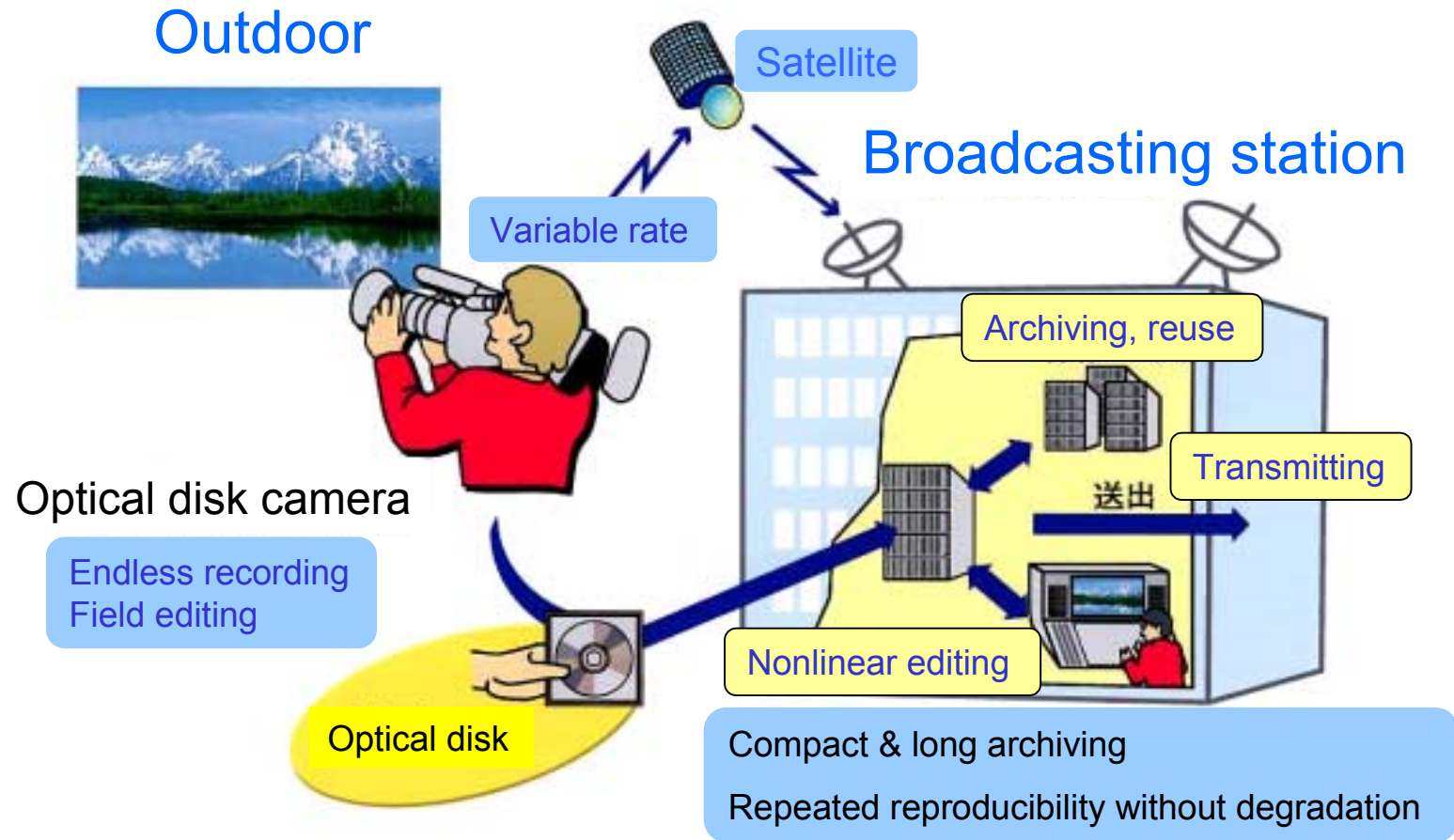
# Principle of HDTV Axi-Vision Camera

- In HDTV Axi-Vision Camera, depth information is detected by illuminating infrared intensity-modulated light to the object and measuring the intensity of light reflected by the object. Depth image can be represented by the black and white gray scale.





# HDTV optical disk camera





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# High-speed Recording on a High-density Optical Disk

- Towards HDTV Optical-disk Cameras -

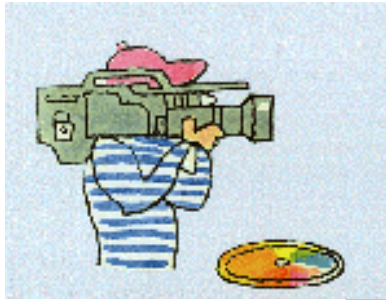
- With two channels using dual optical heads, we developed a system which can provide 200 Mbps high-speed recording and playback required for HDTV video recording.
- The 12 cm disk size and 2.6 GB/cm<sup>2</sup> recording density allow recording of up to 20 minutes of HDTV video.





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# Target Performance of HDTV Optical Disk Camera



- HDTV recording
  - Bit rate: > 150 Mbps
- Recording time (120mm $\Phi$  & one side)
  - > 20 min.
  - Capacity: > 23 GB / side
- High reliability (shock resistant)
- Low noise
- Low power consumption

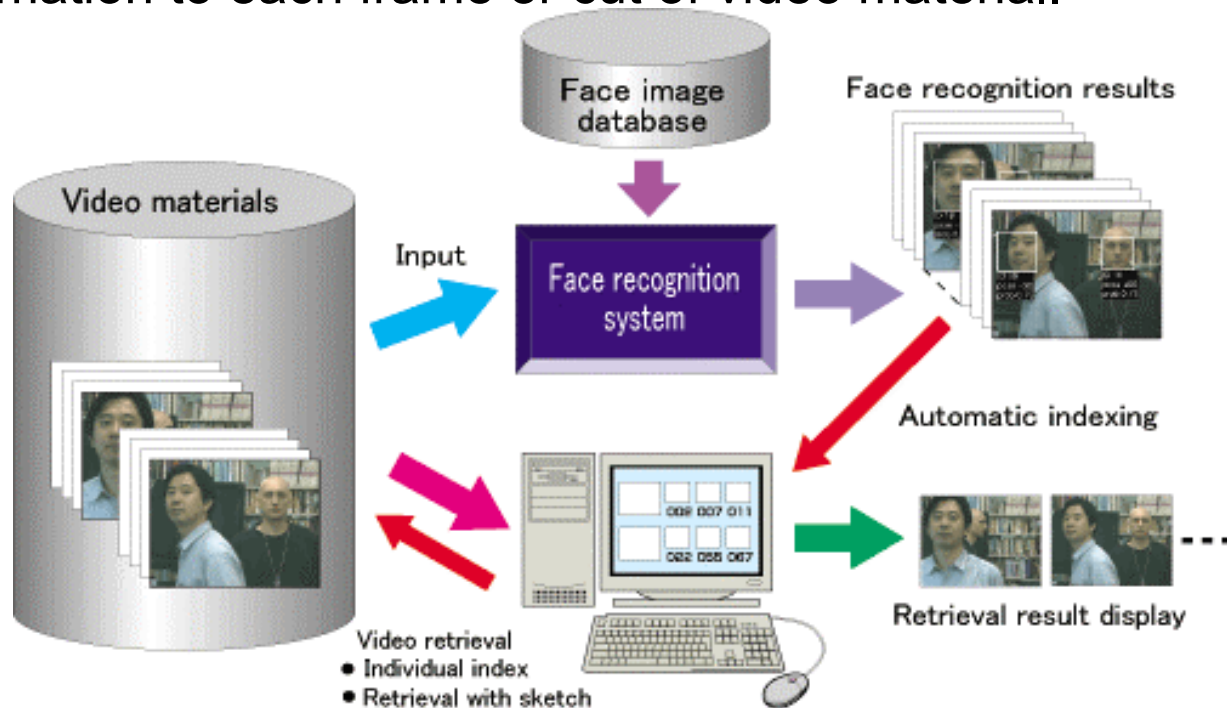


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# Video Editing Support using Image Recognition Technology

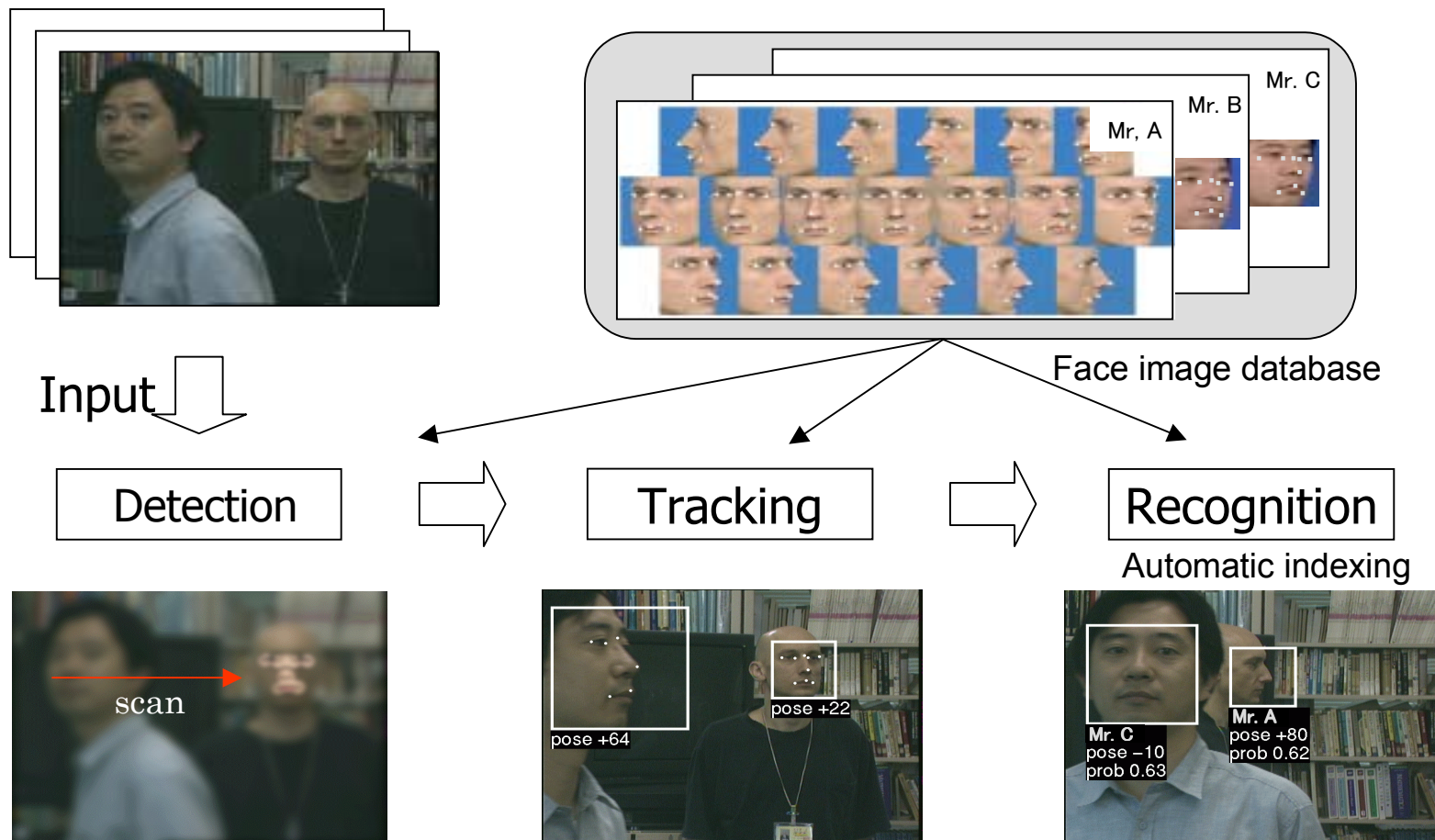
- Towards Efficient Video Retrieval and Editing -

- The process of editing large volumes of video material can be made more efficient if target scenes in the video can be selected and retrieved promptly.
- With the aim of realizing such prompt retrieval of desired video scenes, we are pursuing research on a variety of technologies for data retrieval and the automatic generation and attachment of index information to each frame or cut of video material.



# Face Recognition Technology

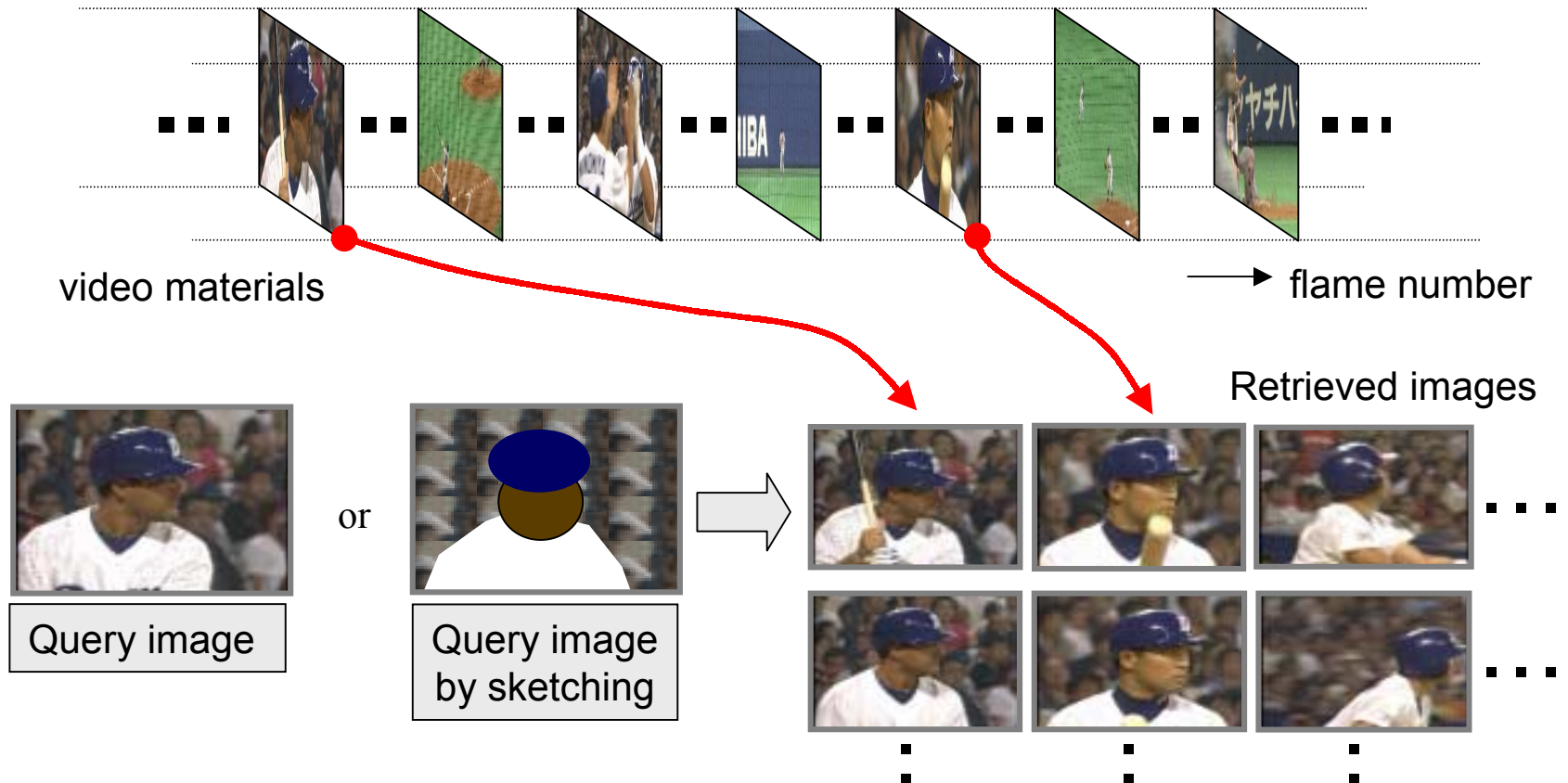
This face recognition technology can recognize individuals despite variations in facial angle and size.





# Retrieval with an Image

To retrieve scenes that might be difficult to describe in words, we developed a way of searching video material for scenes that are similar in structure, pattern, and color to an image.







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

- For Future Broadcast conveying a strong sensation of reality-

- Aiming at **the extreme audio-visual system** of post HDTV
  - To realize a space surrounded by audio and video
  - To pursue basic research on psychological phenomena related to wide and large screen image such as wide view effect, motion sickness, and audio-visual multiplier effect.
- We are now at the first step of development
  - An experimental system of camera, display, and recording device was developed.

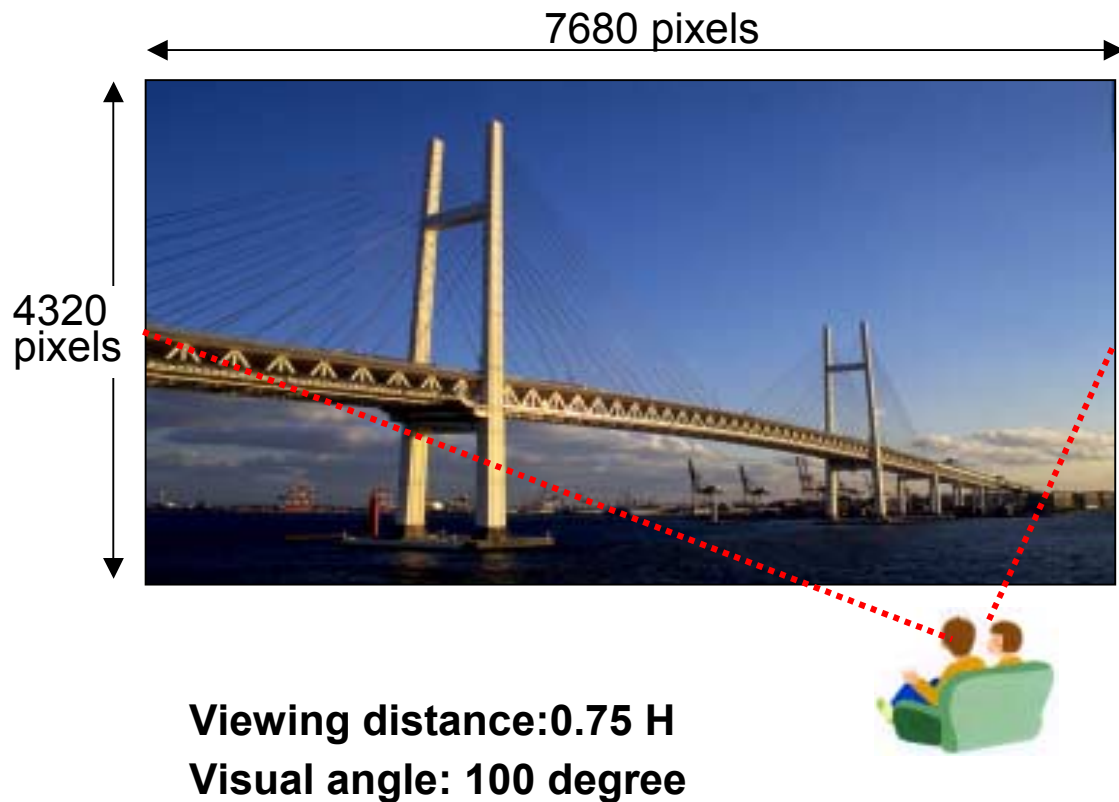




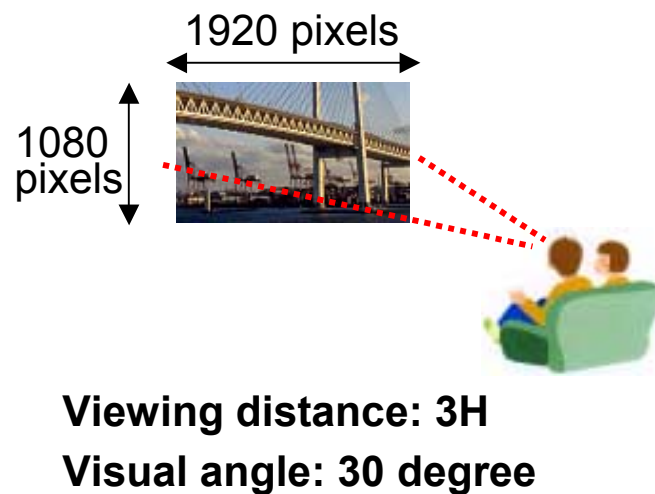
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# Viewing Distance and Visual Angle of 4000 Scanning Line Display

<4000 scanning lines>  
Get sensation of immersion

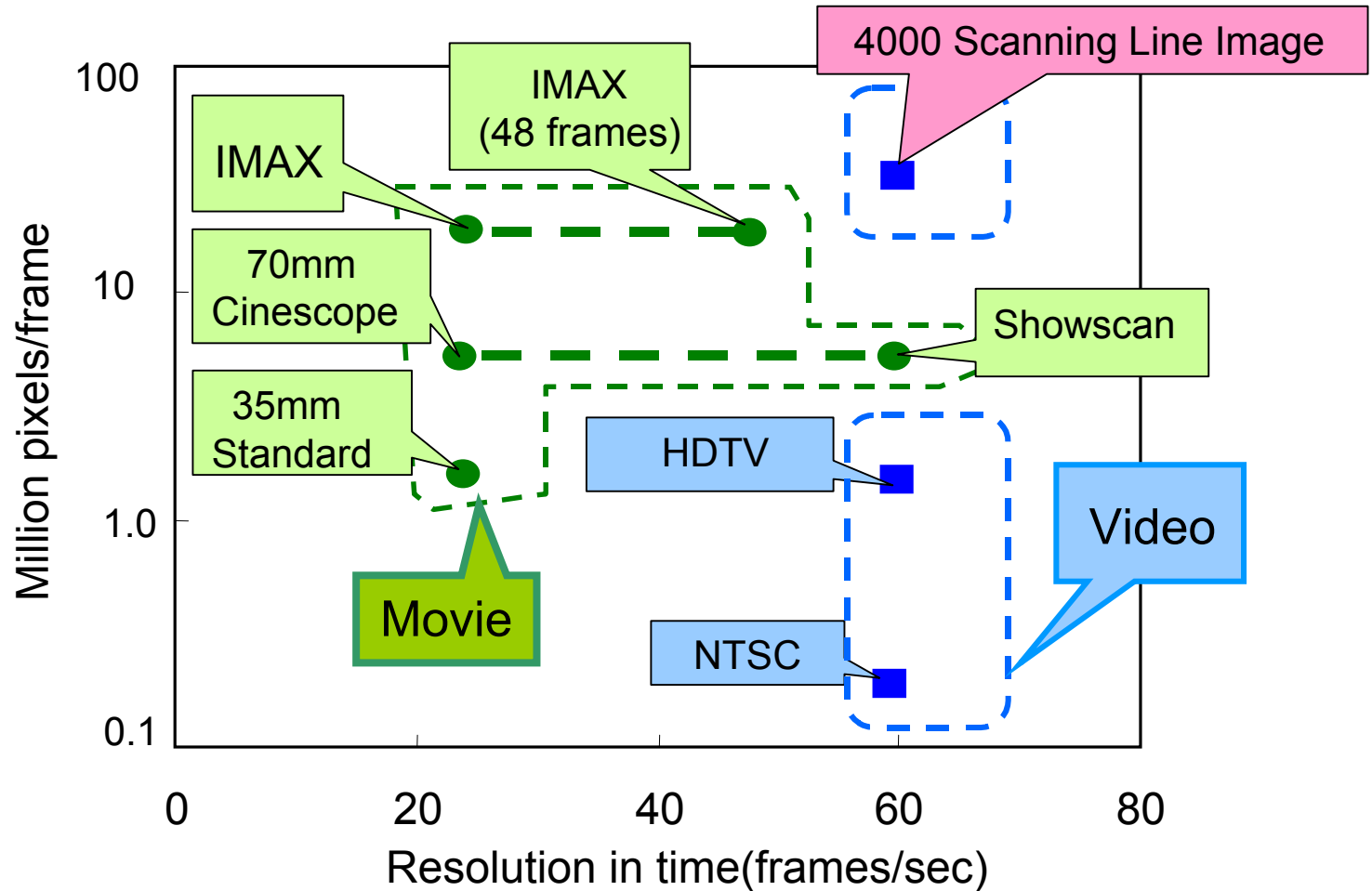


<HDTV>  
Get sensation of presence



# Comparison of Resolution

- 4000 scanning line image is **outstanding**

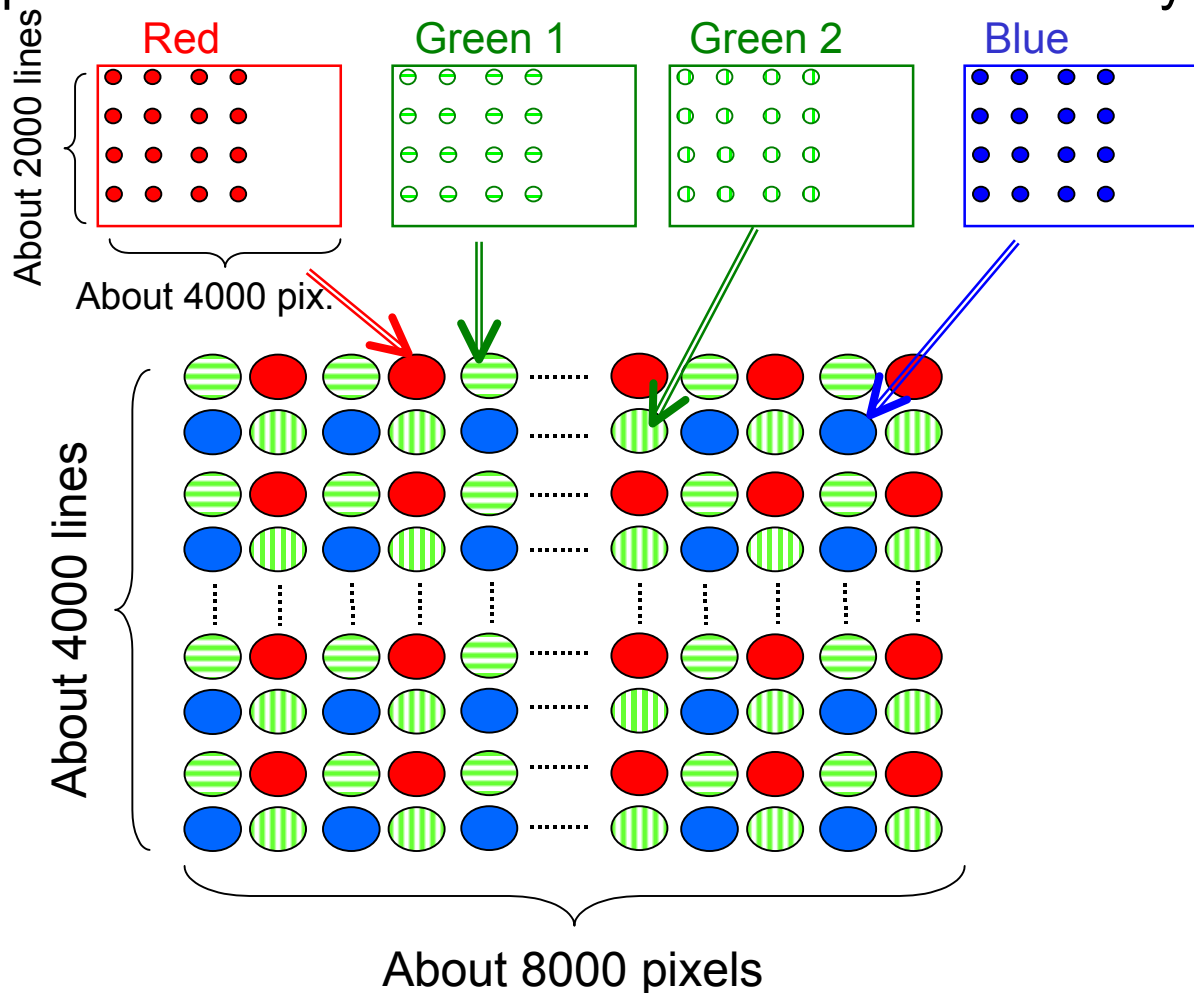




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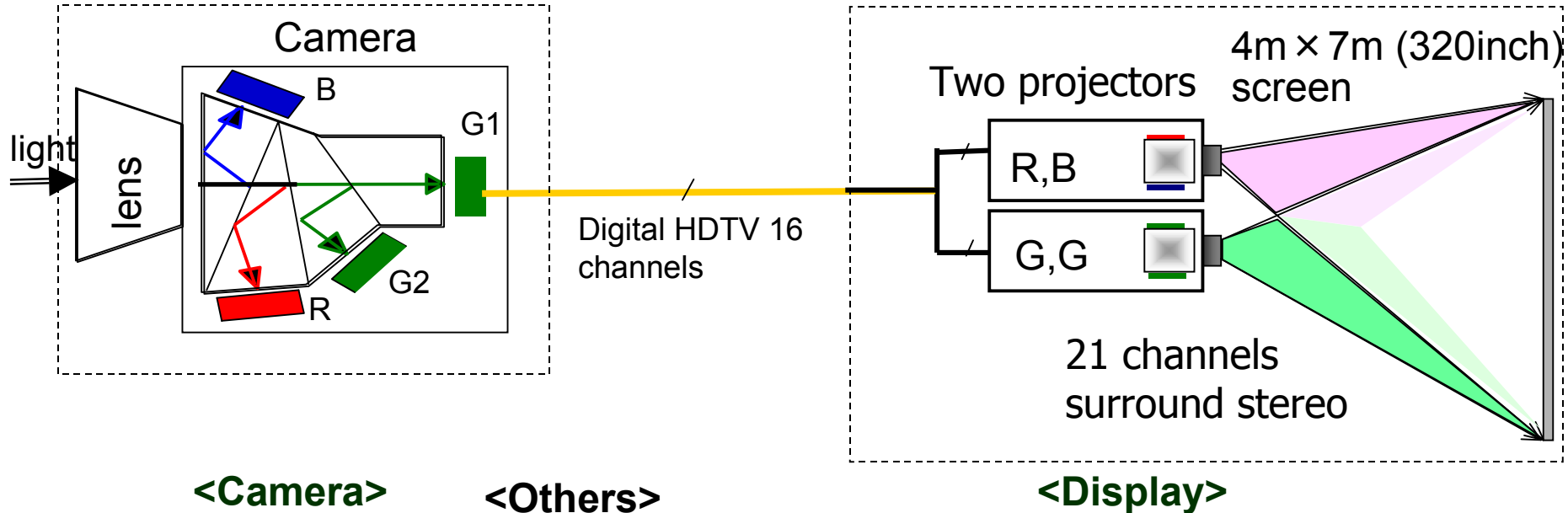
# Implementation of 4000 Scanning Line Video system by four panels

- Both camera and display has double resolution in green which is most important for resolution sensation in human visual system.



# Outline of Experimental System

- Four 8 million-pixel panels for both camera and display (2 for **G**, 1 for both **R** and **B**)
- The devices are connected with 16 parallel HD SDIs.



Recording: about 34 seconds for video  
 Storage capacity: 64 Gbytes  
 (=14 DVDs = 28 hours NTSC video)

# Floor Plan and Viewing Condition

## Projectors:

Light output : 5000  
lumen

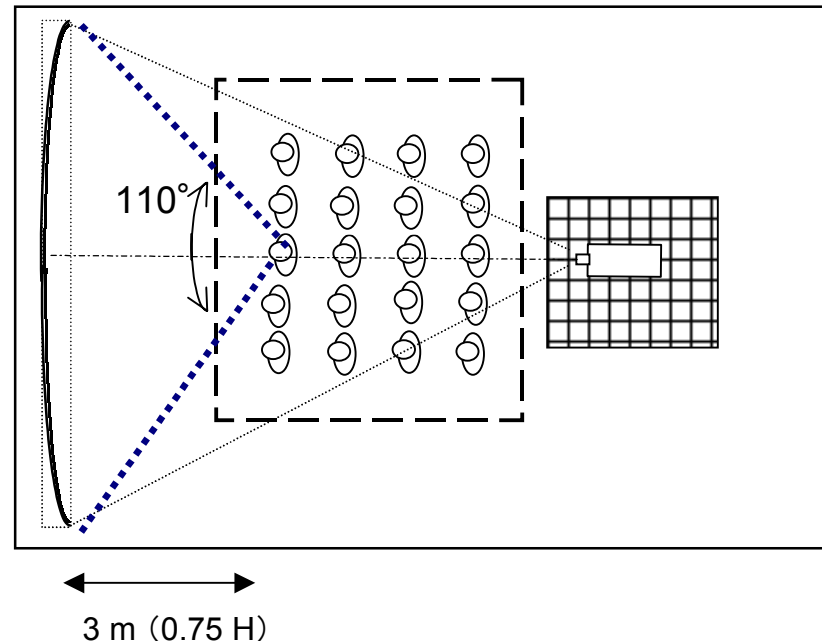
## Screen:

Size: 4m × 7m

gain : 0.85

Scattering:  $\pm 80^\circ$   
(gain: 1/3)

Luminance: 50 cd/m<sup>2</sup>



## Viewing angle of screen

Front: app. 110° horizontally

Back: app. 60° horizontally





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## External View of the Room





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# Problems to be solved

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- Break throughs in essential technologies are required.
  - Shooting device of higher sensitivity
  - Display of large, thin and light, and foldable
  - Wide band recording and transmission
  - Sound technology which can supply presence and immersion



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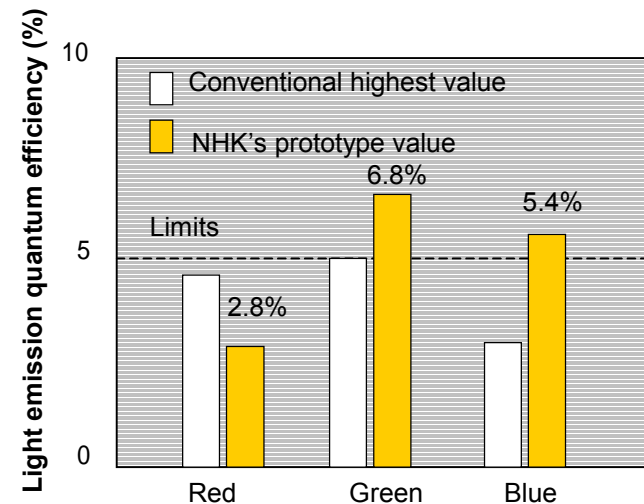
# RGB Phosphorescent Polymer EL Materials

- Progress Made on a Self-emitting Foldable, Flexible Display -

- Promoting basic research into polymer-based organic electro-luminescent (EL) materials that will give higher light-emission efficiencies and allow the achievement of flexible displays that can be folded and bent in any direction.
  - Development of high-efficiency RGB light-emitting materials using a new light emission mechanism (phosphorescence) that breaks through the 5% ceiling on conventional (fluorescent) light emission efficiency.
  - Ideal for flexible displays since they are made from polymer-based organic electro-luminescent (EL) materials



Phosphorescent Polymer-based EL Display



Obtained RGB emission efficiency compared with highest value reported so far, and efficiency limit fluorescence

Future Broadcasting Services and Fundamental Technologies



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# Concluding Remarks

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- Broadcasting is a culturally creative activity based on the latest technology. As technology continues to advance, broadcasting will keep evolving.
- In 21<sup>st</sup> century, it is our determination to confidently meet the challenge of realizing our viewers' dreams.
  - Seamless Service: the broadcasting service of 5A; “anytime, anywhere, any program, through any media, and for anybody.”
  - Content Production Technologies: more creative, more adaptive, and more efficient.
  - Ultrahigh reality audio-visual system: ultrahigh-definition system, 3D TV system