Seminar #7

Digital receiver

1th April , 2005

Digital Broadcasting Expert Group (DiBEG)

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In this section, digital receiver structure, contents of these elements, demodulator key technology, examples of product are introduced.
Mobile and portable receiver are introduced in seminar #9

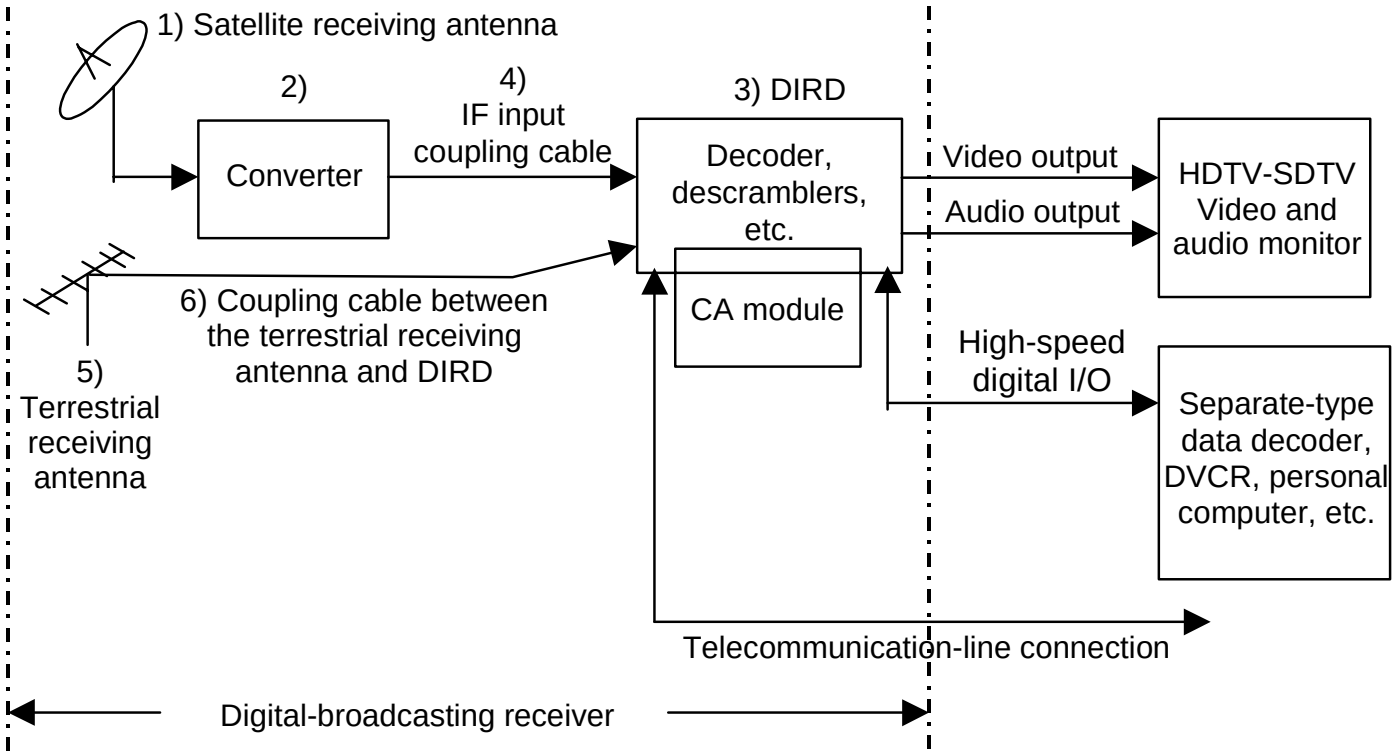
Contents

Contents (continued)

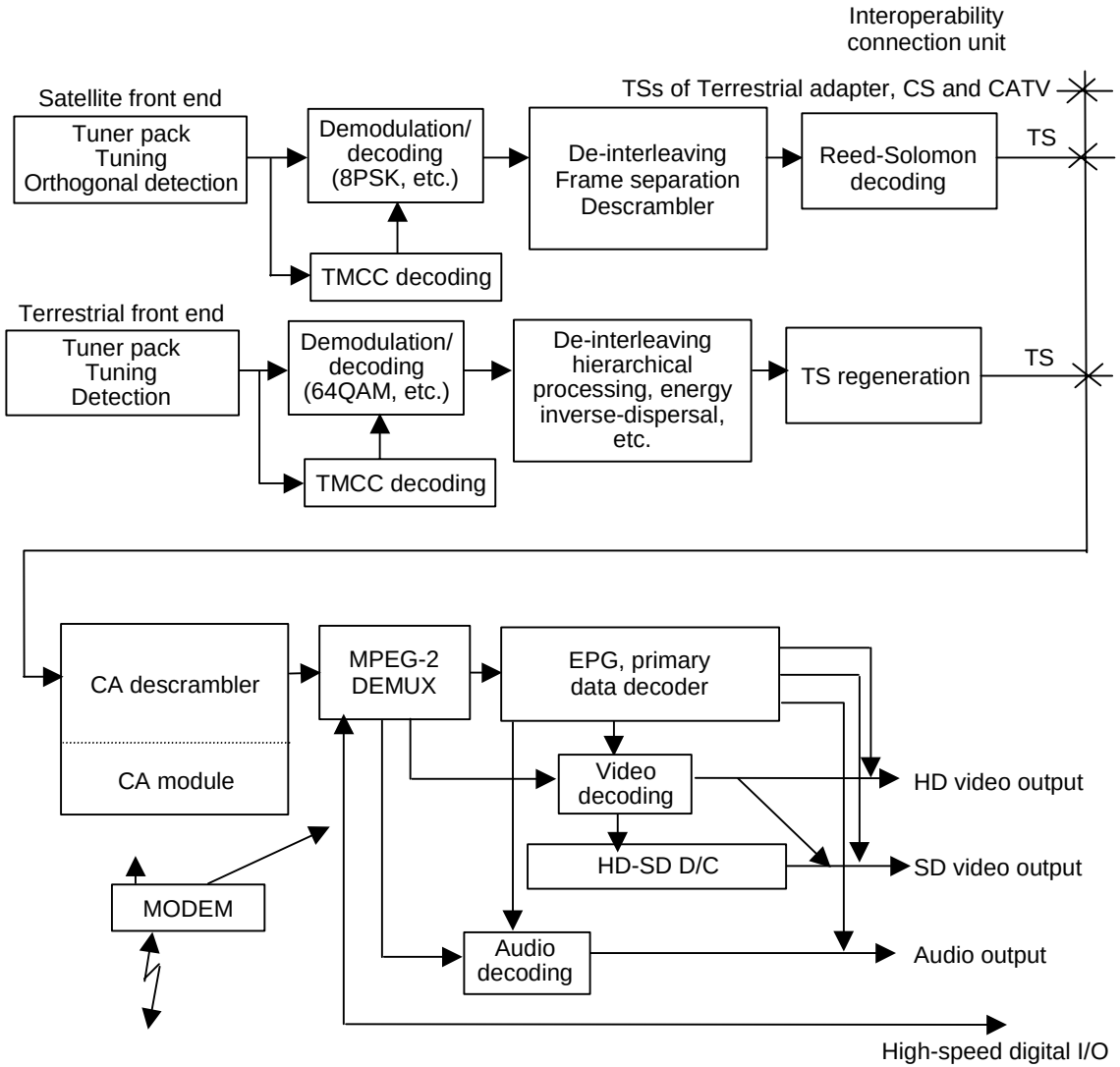
1. Configuration of digital receiver

1.1 Basic configuration of digital receiver

1.2 Specifications of tuner unit



Basic configuration of the receiver (see B21, Fig. 2-1)



Basic configuration of DIRD (see B21, Fig. 2-2)

2. Specifications of tuning unit (quoted from ARIB STD-B21)

(1) Input
Impedance: 75 Ω
Received frequency: UHF ch 13-62
Center frequency: 473 + 1/7 MHz (ch 13), 479 + 1/7 MHz (ch 14), . . ., and 767 + 1/7 MHz (ch 62)

(2) First intermediate frequency
Center frequency: 57 MHz (frequency reversed)
Local oscillator frequency: At the upper side of the received frequency

(3) Synchronization range of the received frequency
Synchronization range of the received frequency: ±30 KHz or wider

(4) Synchronization range of the received clock
Synchronization range of the received clock: ±20 ppm or wider

(5) tuning unit
Minimum input level: -75 dBm or lower (targeted value) (See Appendix 10.).
Maximum input level: -20 dBm or higher.

Protection Ratios of the 13-segment receiver (see B21,Table 5-2)

Undesired wave	Item	Protection Ratio
Analog television	From the co-channel	18 dB or less
	From the lower adjacent channel (undesired wave on the lower side)	-33 dB or less
	From the upper adjacent channel (undesired wave on the upper side)	-35 dB or less
Digital television	From the co-channel	24 dB or less
	From the lower adjacent channel (undesired wave on the lower side)	-26 dB or less
	From the upper adjacent channel (undesired wave on the upper side)	-29 dB or less

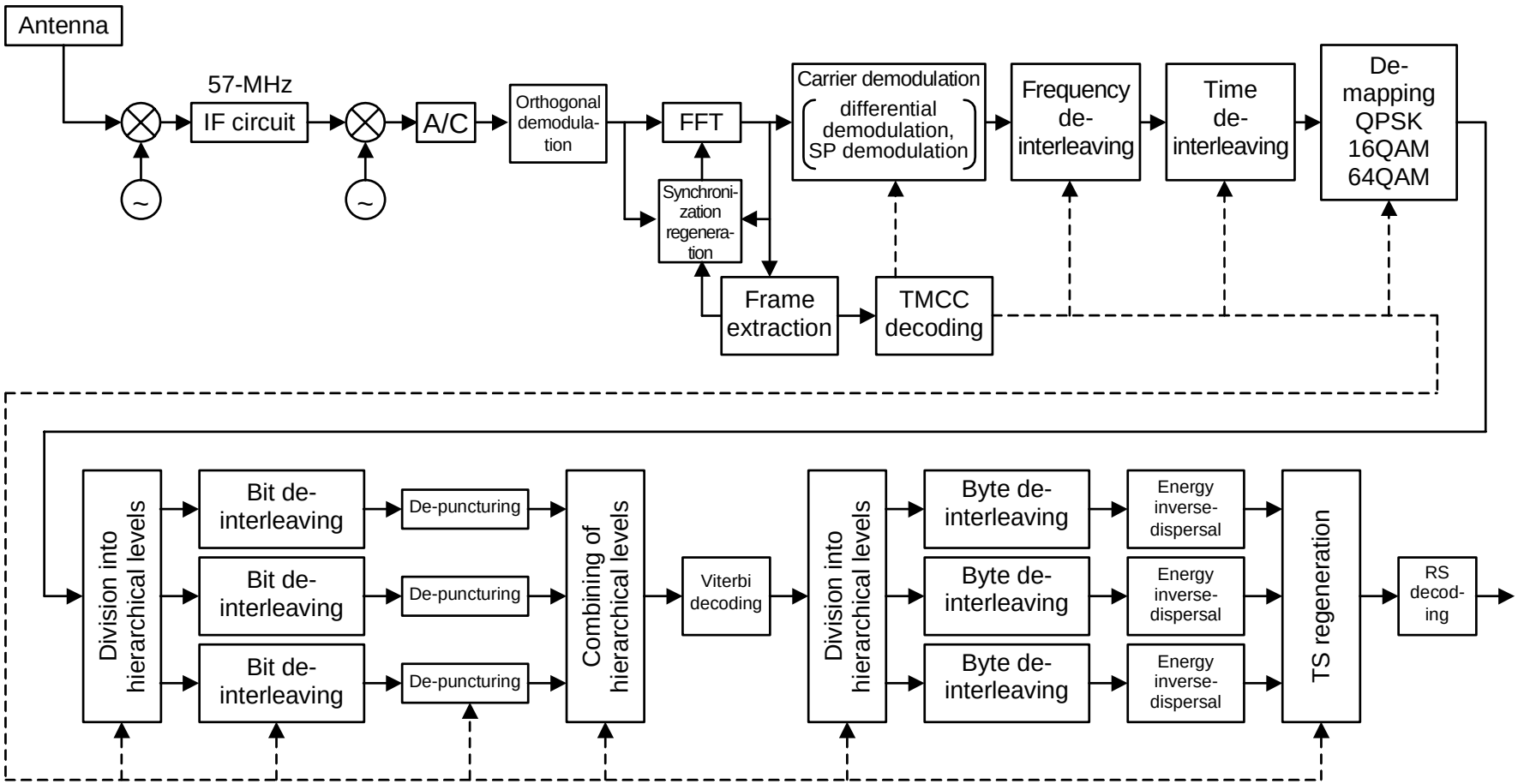
(Note) The transmission parameters used for the measurement must be as follows: Mode 3, guard interval ratio of 1/8, no time interleaving, modulation of 64 QAM, and an inner-code of 7/8 (See the Appendix.)

2. Synchronization technology in digital terrestrial receiver

2.1 outline of digital terrestrial receiver

2.2 synchronization technology

Outline of digital receiver (tuner and demodulator section)



2.2 Key Technology for RX Synchronization

*4-element synchronization is required

(1) Carrier Synchronization: AFC

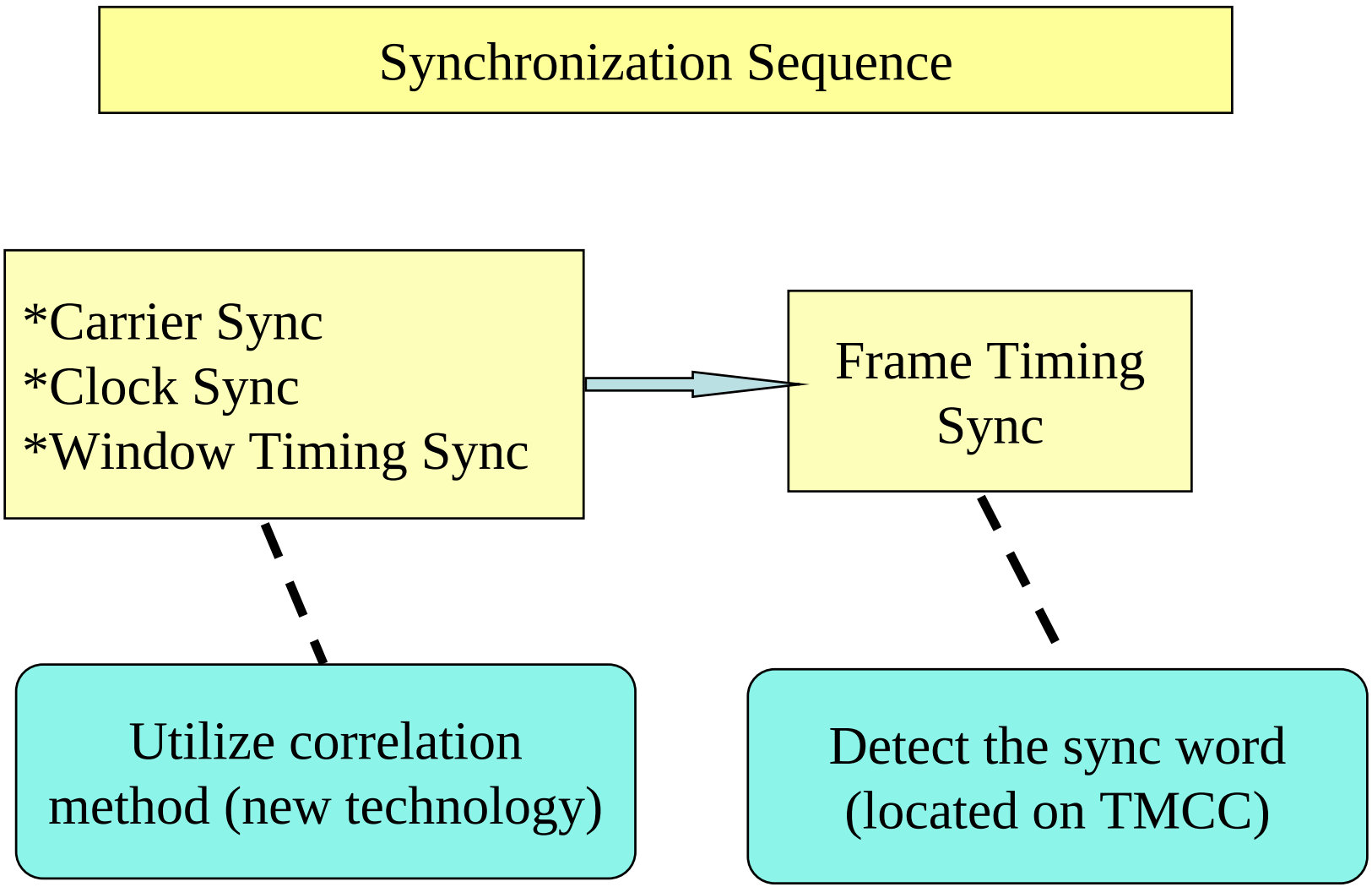
(2) Clock Synchronization

(3) FFT window timing

(4) Frame Synchronization

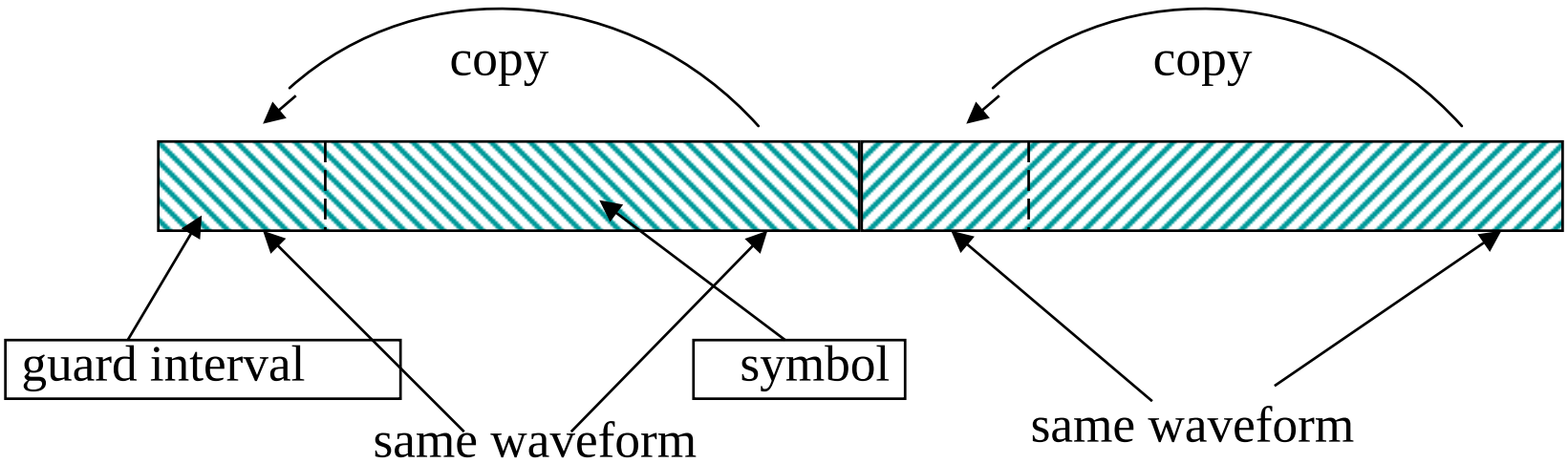
For Item (1) through (3), new synchronization methods are proposed

Key Technology: RX Synchronization



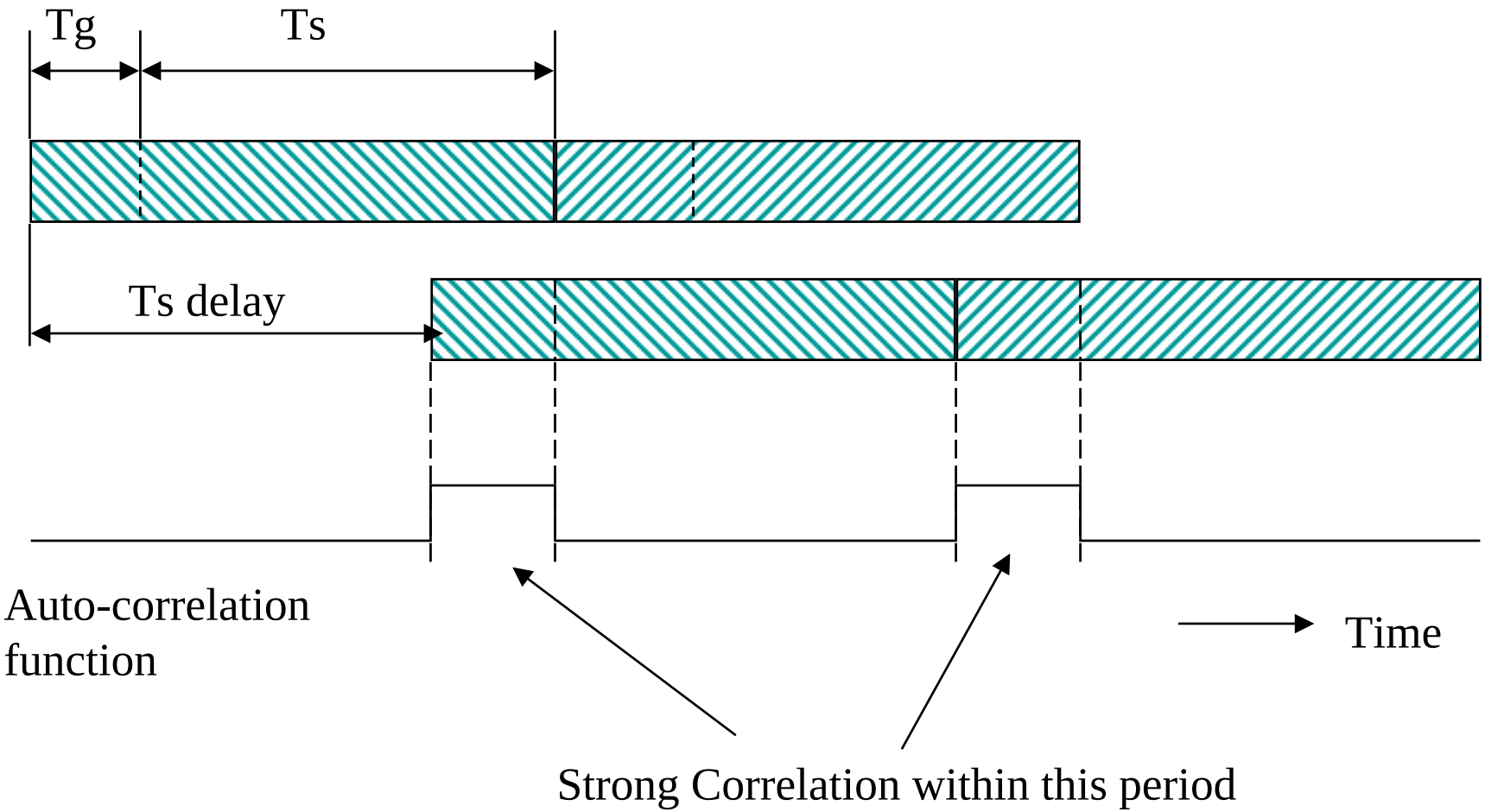
Key Technology-RX Synchronization

New Technology —Auto and Cross Correlation for guard interval

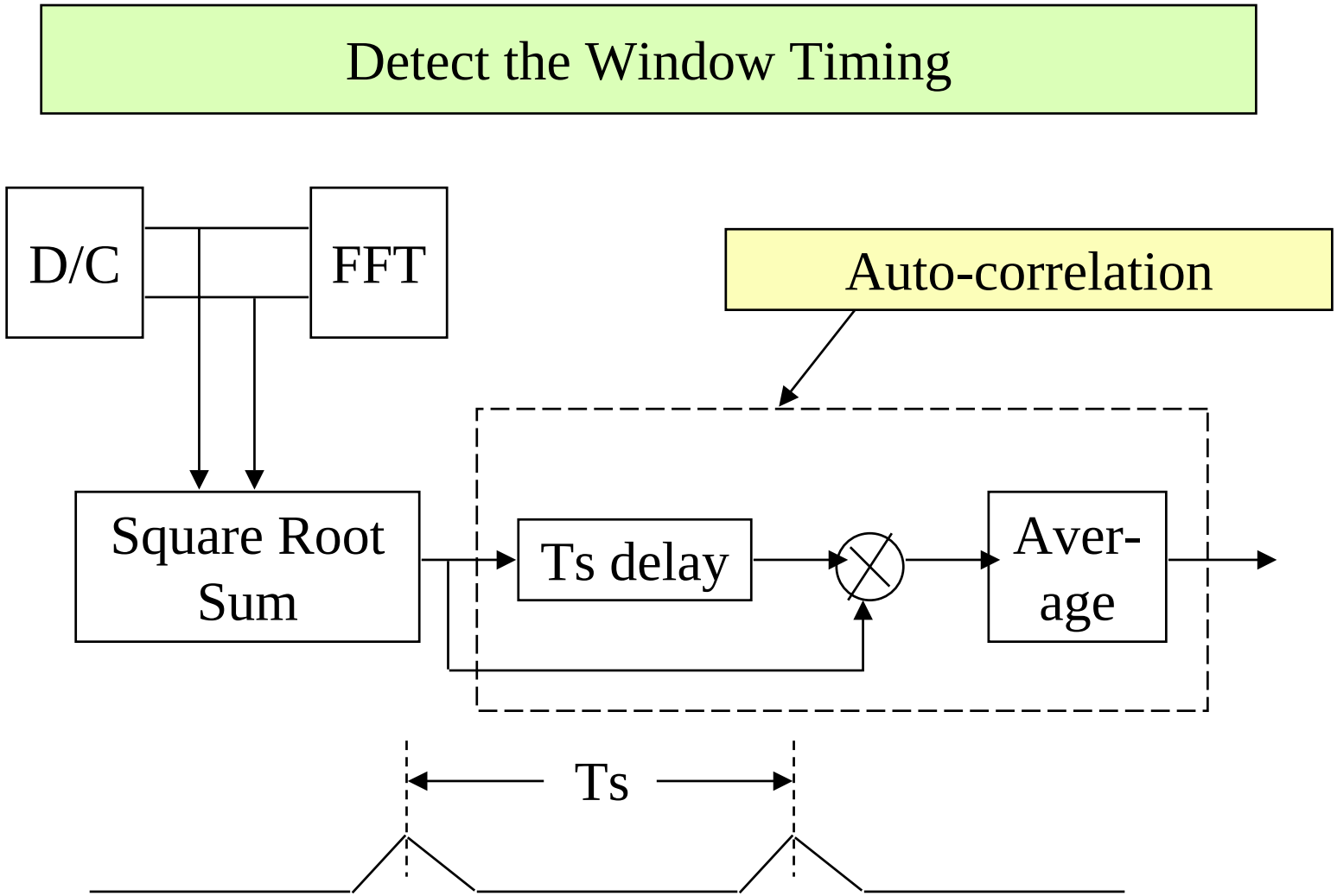


The waveform of guard interval is same as the one at end of symbol. Thus Auto-correlation between the guard interval and the end of symbol is high.

Key Technology: RX Synchronization



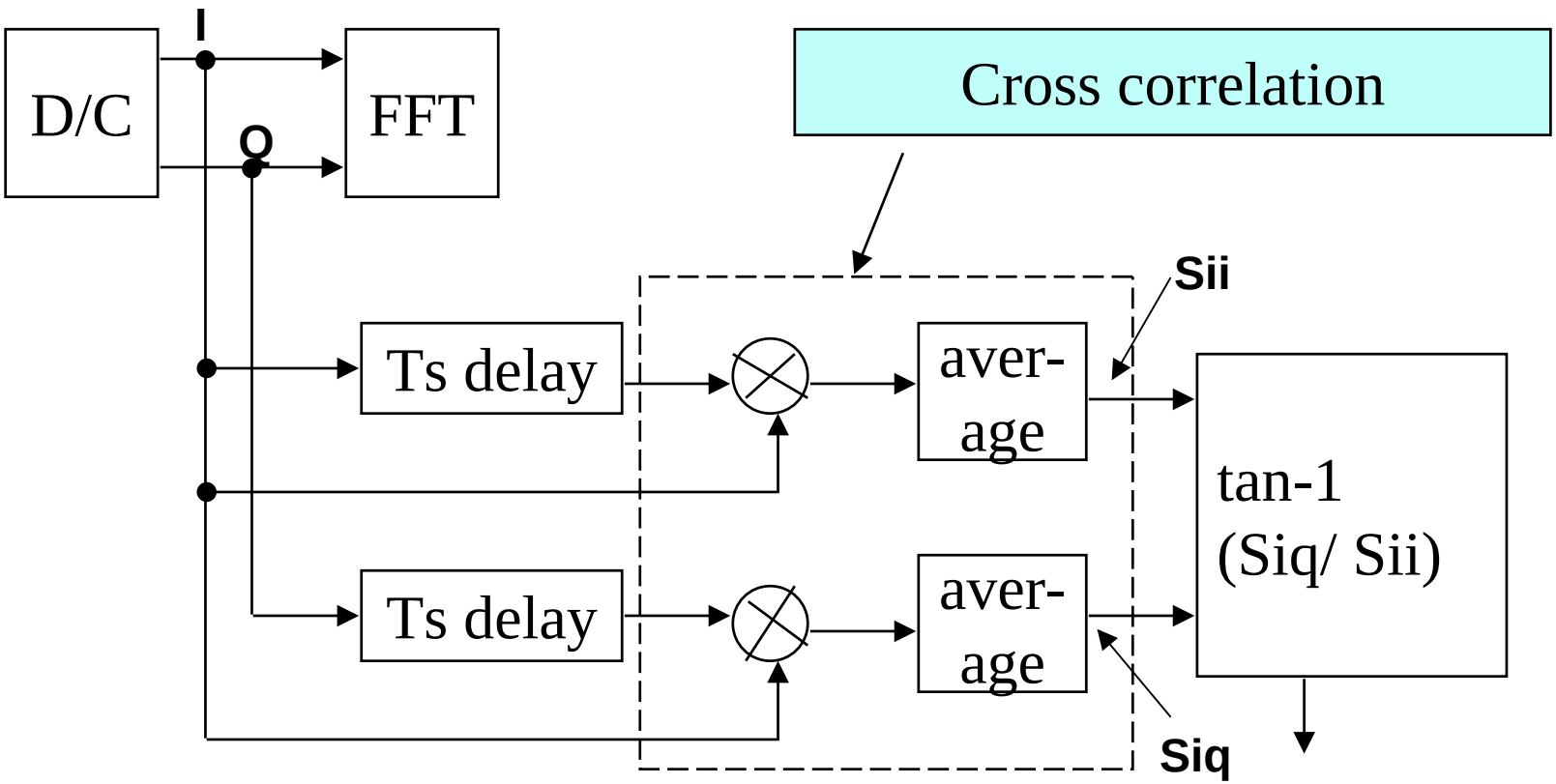
Key Technology-RX Synchronization



Auto-correlation Waveform

Key Technologies-RX Synchronization

AFC: frequency offset error detection



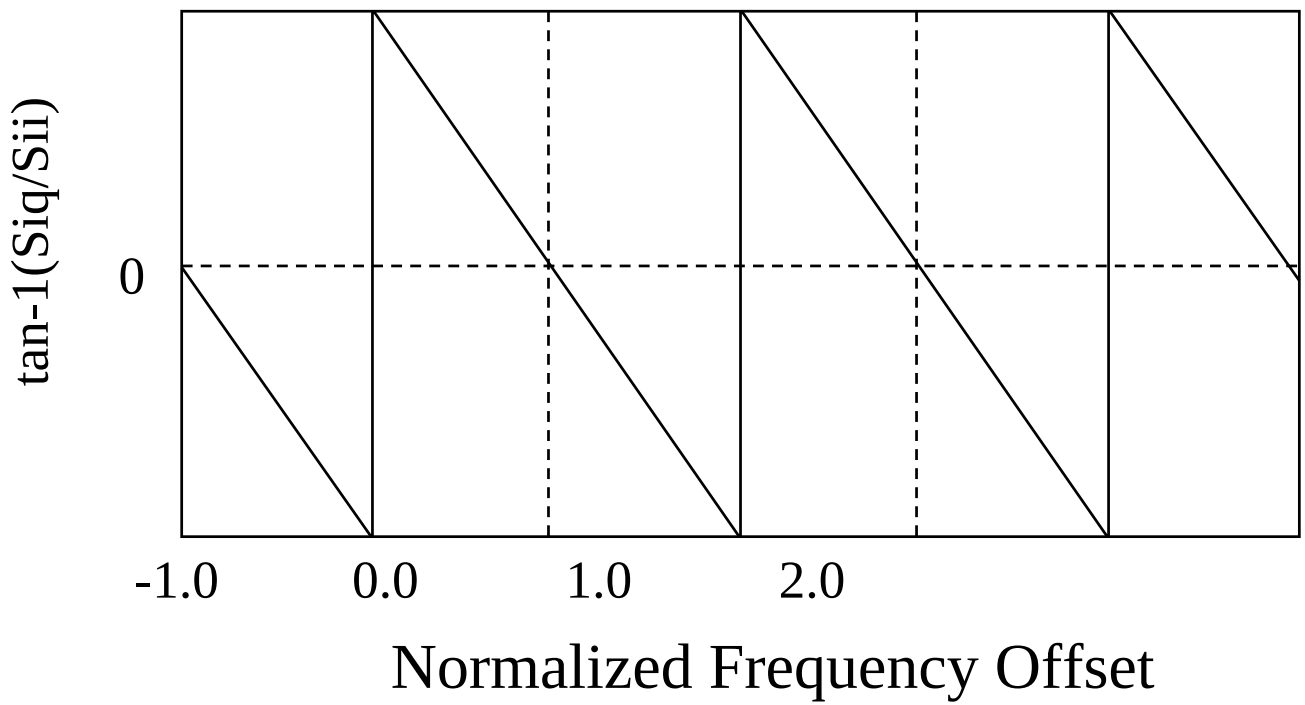
Frequency offset error

Key Technology-RX Synchronization

AFC: frequency offset error detection

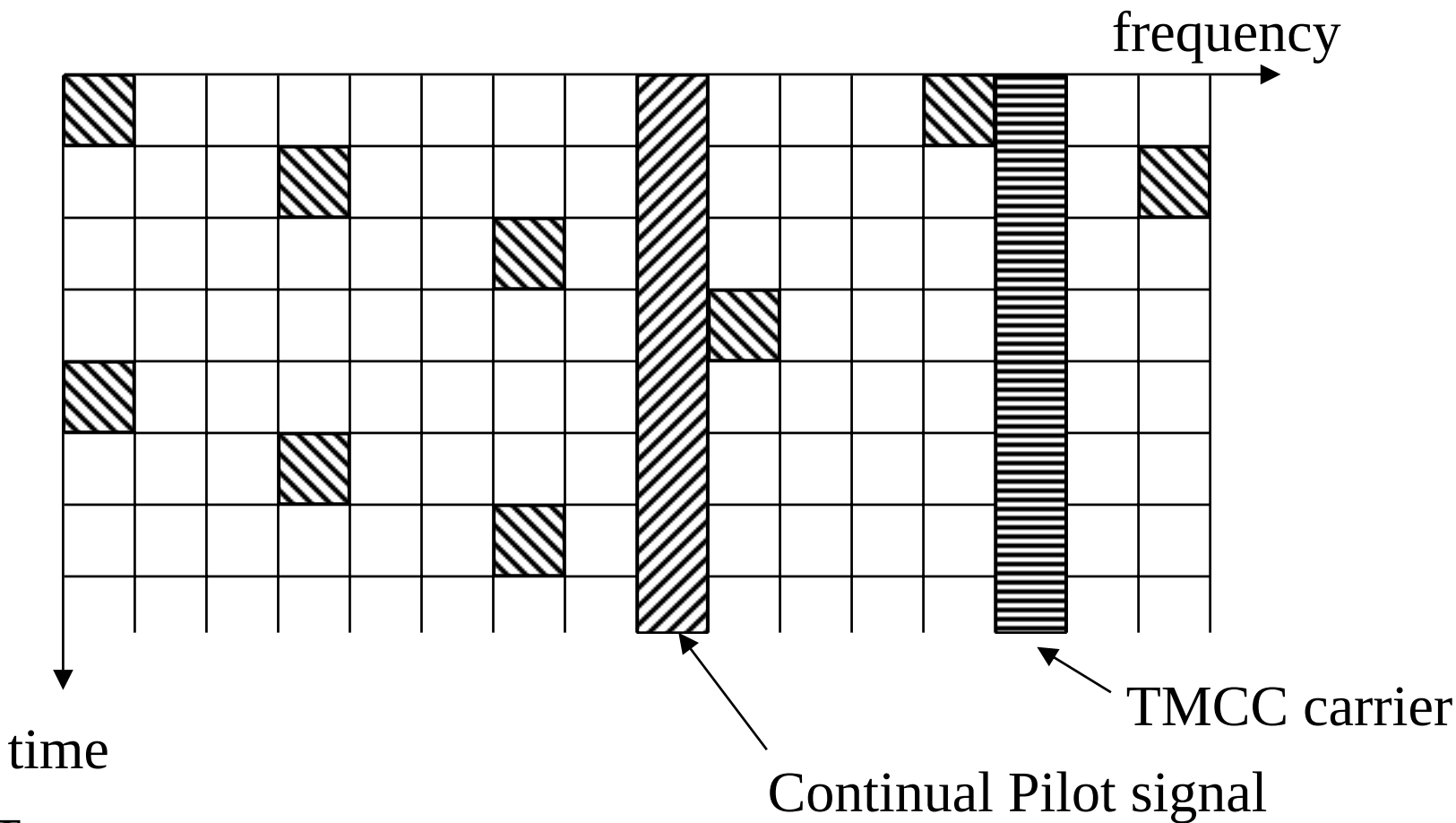
Sii:cross correlation between I and delayed I

Siq:cross correlation between I and delayed Q



Key Technology-RX Synchronization

Composition of OFDM Frame



Key Technology-RX Synchronization

Composition of OFDM Frame

SP: scattered pilot signal; used for equalizing of information signal

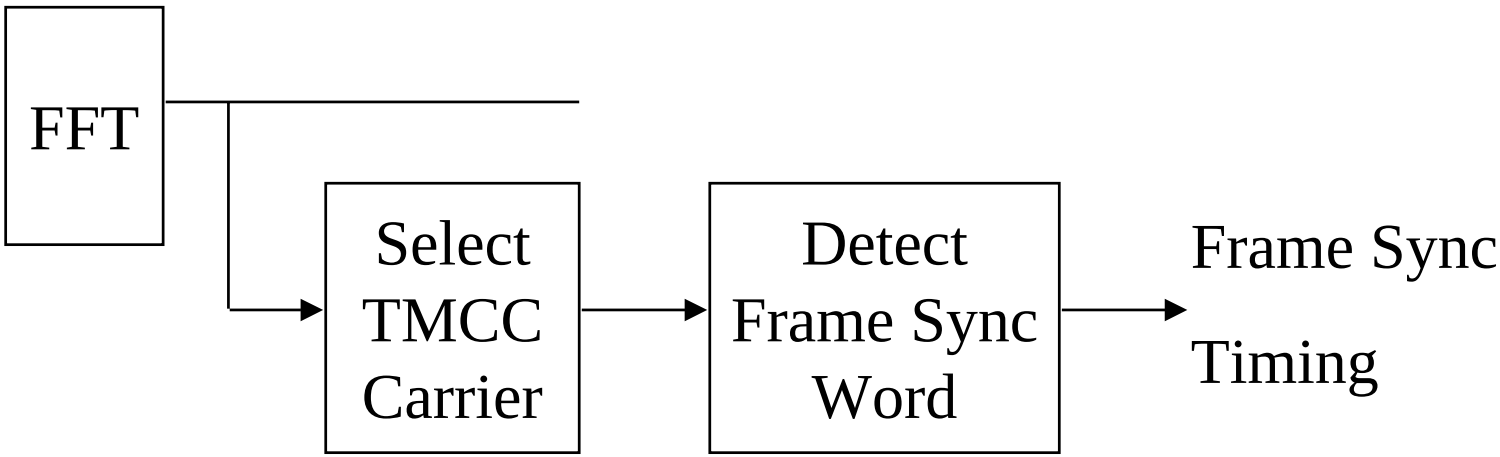
AC&CP; used for the frequency offset detection and carrier reference

TMCC(note): Transmission and multiplex configuration control: used for the transmission status information and frame synchronization

(note)In DVB-T, called TPS (Transmission parameter signal)

Key Technologies-RX Synchronization

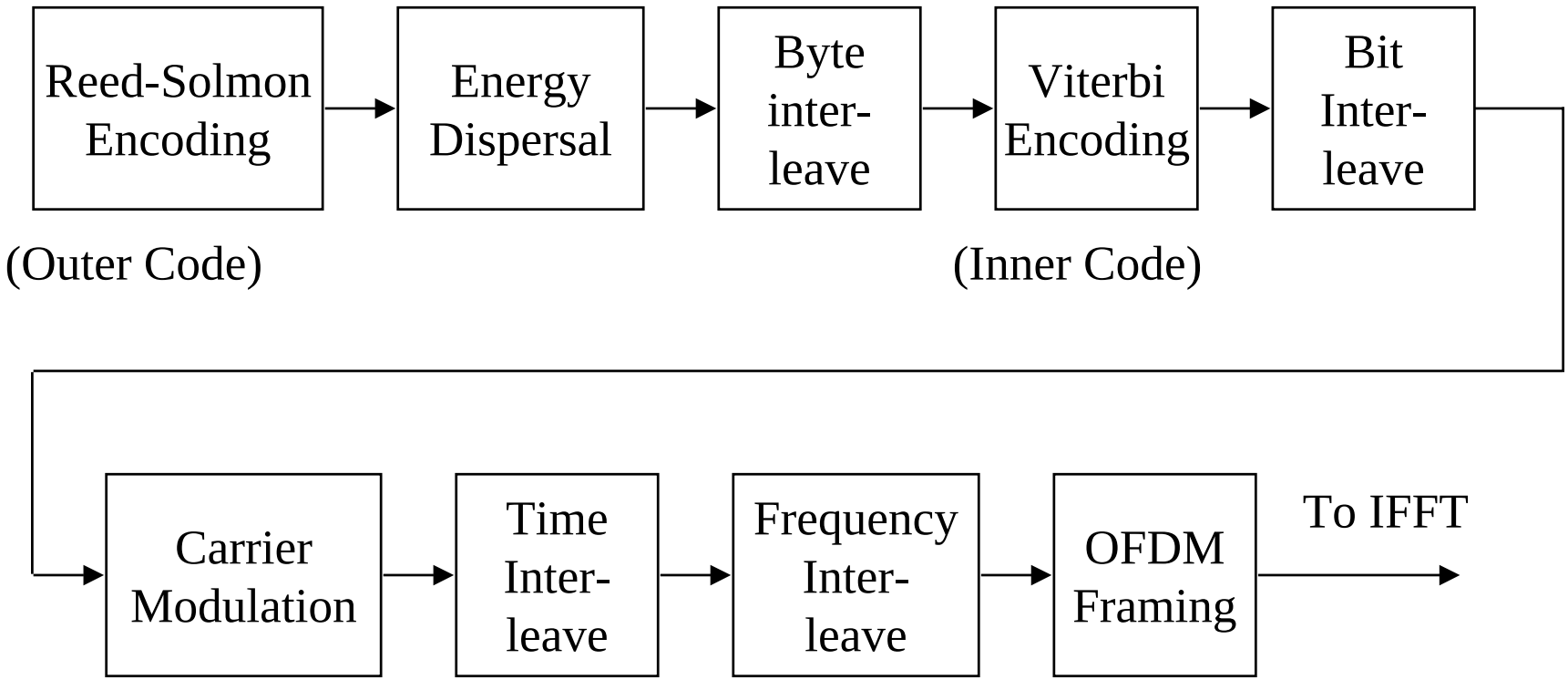
Detection of Frame Timing



Note: The Frame Sync Words are located on the top of TMCC carrier

Key Technologies-Error Control

Blockdiagram of FEC Encoder



3. Digital receiver system

3-1 Function of digital receiver

3-2 Configuration of digital receiver

3-3 Outside view of digital receiver

3-1 Basic function of digital receiver

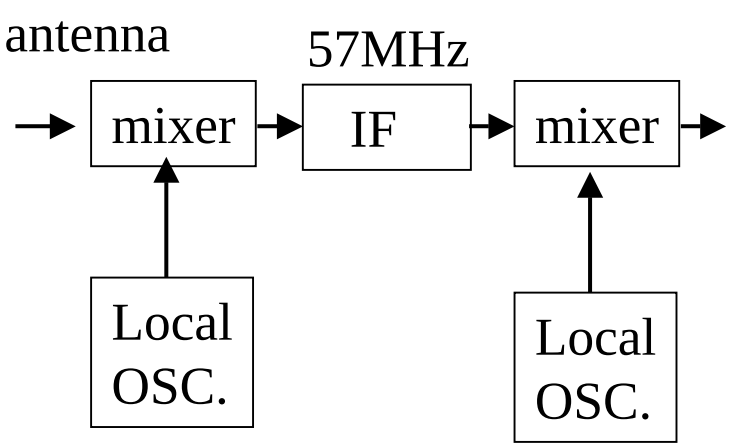
media	Reception style	Transmission system	decoding
BS-digital	**fixed**	**8 PSK**	**MPEG2-video AAC-audio BML-data**
CS-digital	**fixed**	**QPSK**	**Same as above**
Terrestrial-digital	**Fixed (note)**	**OFDM**	**Same as above**
	handheld	**OFDM (1segment)**	**H.264-video AAC-audio Simple BML-data**

(note) mobile reception service is possible in fixed reception service

3-1 function of digital terrestrial TV receiver

(1) Receiving antenna;UHF 13-62 Ch（470-770MHz), 14 element Yagi-antenna(7dB/UHF 13Ch) or more performance is desirable

(2) Receiver tuner; minimum input level is as low as -75dBm



Required D/U against interference

interference	item	ratio
Analog TV	Co-channel	18dB>
	Lower-adjacent	-33dB>
	Upper-adjacent	-35dB>
Digital TV	Co-channel	24dB>
	Lower-adjacent	-26dB>
	Upper-adjacent	-29dB>

3-1 function of digital terrestrial TV receiver

(3) Signal processing at front end portion;

A/D, Quad. Demodulation, frequency/time de-interleave, 64QAM, Viterbi decoding, hierarchy division, de-interleave, TS recover, RS decoding

(4) TS(Transport stream) processing;

Recover the section data and PES data from TS

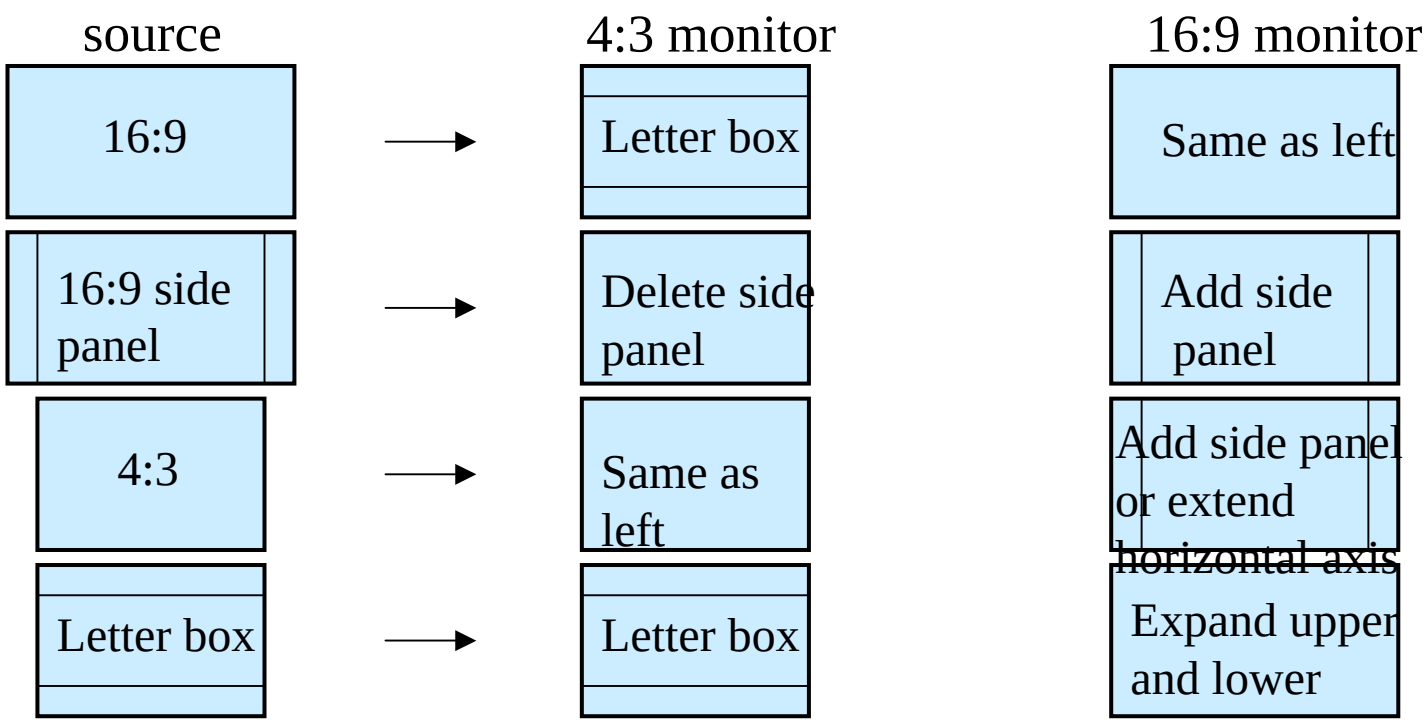
(5) Audio signal processing;

Decode AAC LC profile of MPEG-2. Decoding systems are mono, stereo and multi-channel(3/1, 3/2, 5/1 CH)

3-1 function of digital terrestrial TV receiver

(6) Video decoding processing;

Decode HL, H14, ML, LL of MPEG-2 main profile. The output format is either of 1125i, 750p, 525p, 525i format.



3-1 function of digital terrestrial TV receiver

(6) Video signal processing;

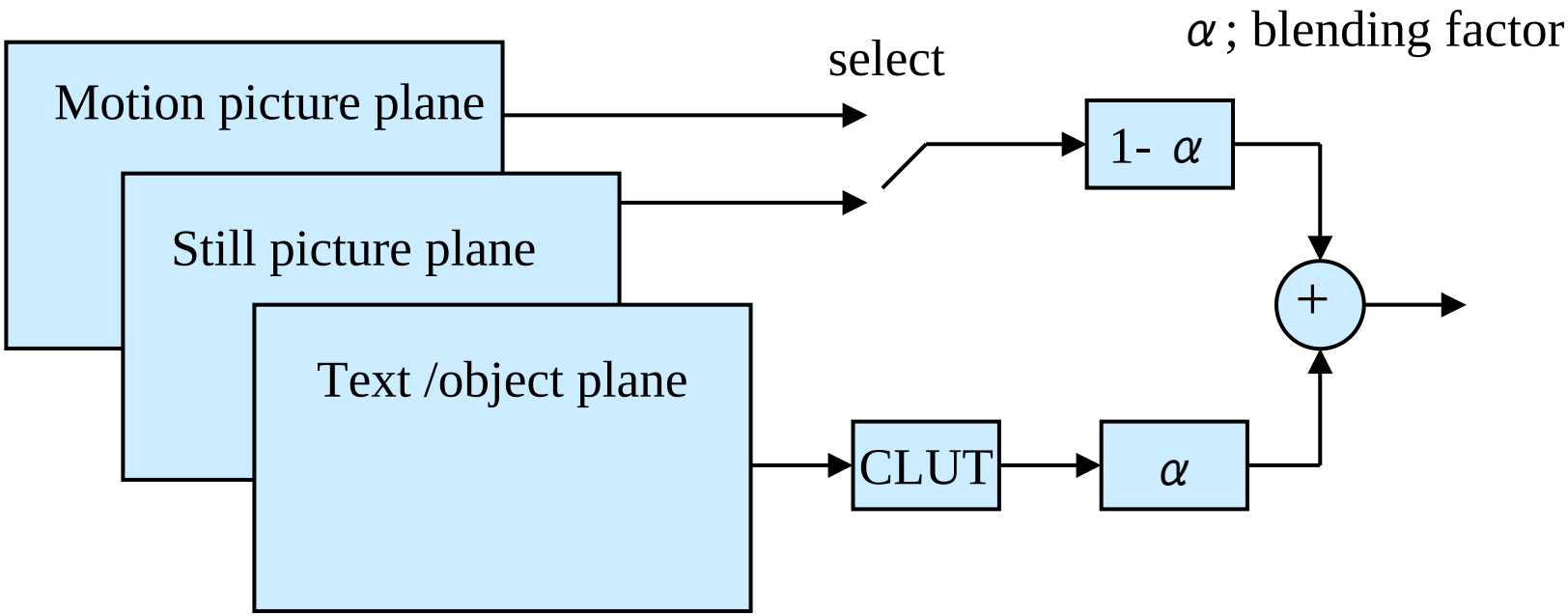
D type output terminal

D terminal spec.	480i	480p	1080i	720p	1080p
D1	**x**				
D2	x	x			
D3	x	**x**	x		
D4	x	x	**x**	**x**	
D5	**x**	x	**x**	**x**	x

Y, Pr, Pb + control signal

3-1 function of digital terrestrial TV receiver

(7) Display of data broadcasting (graphic display)
display pixell; 960 *540 (half of 1920* 1080)



CLUT; color look up table

3-1 function of digital terrestrial TV receiver

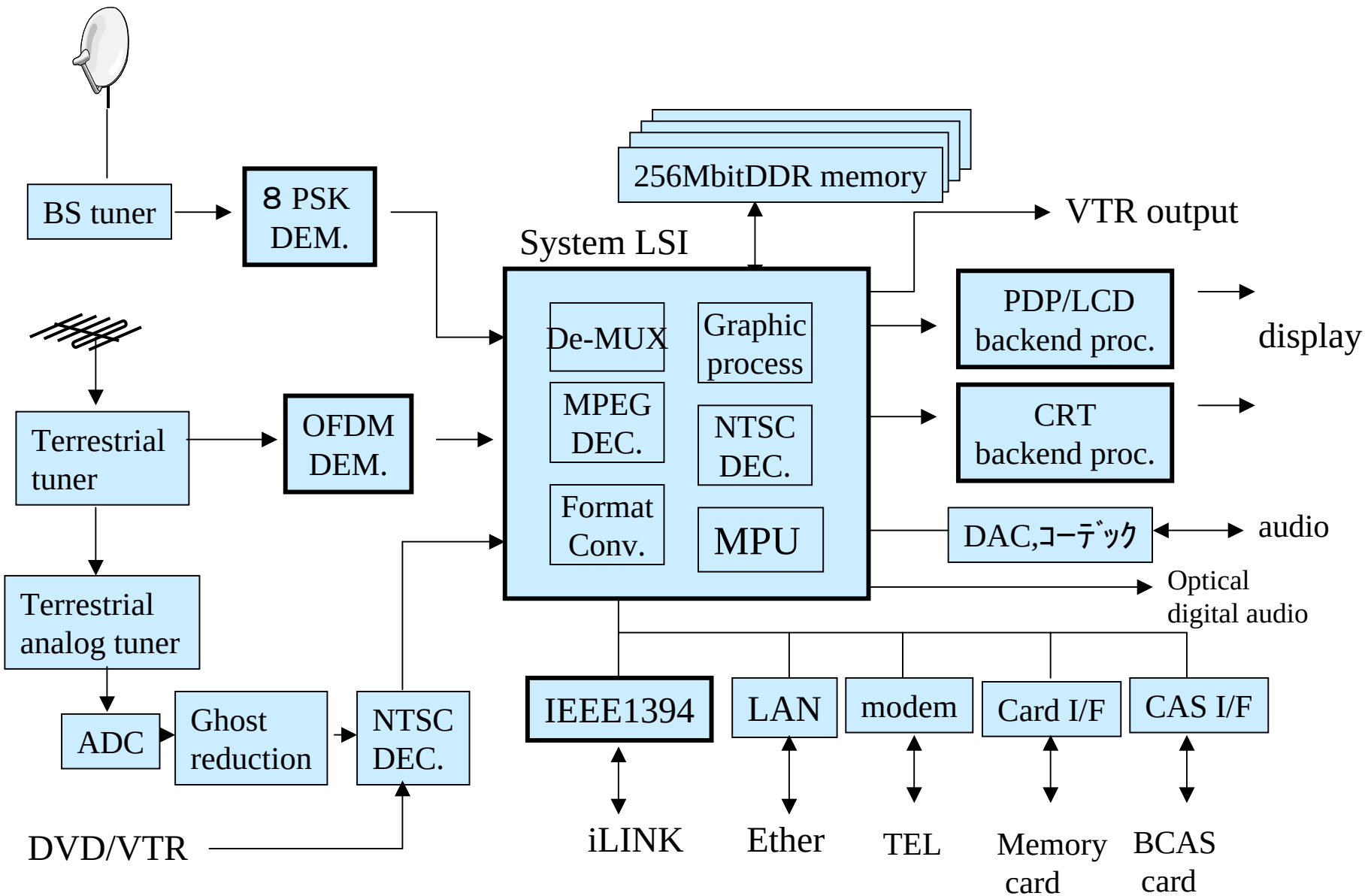
(8) Function of bi-directional communication

-communication by Ether-net (TCP/IP)

(9) Digital interface

- IEEE1394 (DVHS, etc)

Example of digital receiver block diagram



3-2 composition of digital receiver

(1) Tuner block; 2 type of tuners, analog and digital

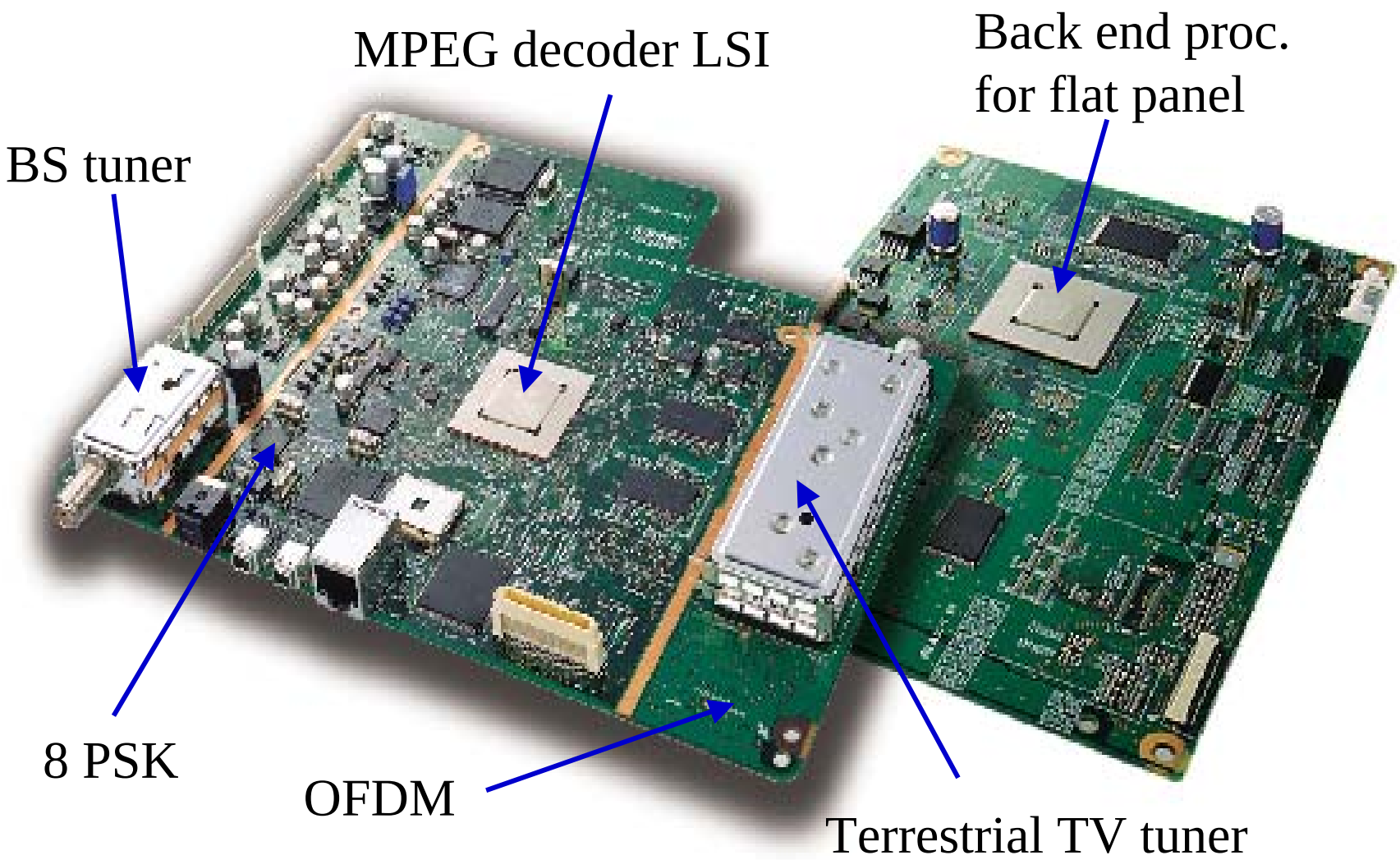
(2) Analog signal proc. block; Analog tuner input and external NTSC input is decoded and output as digital signal.

(3) System LSI; divide digital broadcasting stream processing, decode MPEG-2 video/audio decoding, format conversion, graphic processing, capture of NTSC, NTSC encoding, system control and data broadcasting processing by 32 bit on-chip RSIC processor

(4) input/output; IEEE 1394 terminal to DVHS, LAN connector, MODEM connector, slot of multi-memory card, optical output for digital audio.

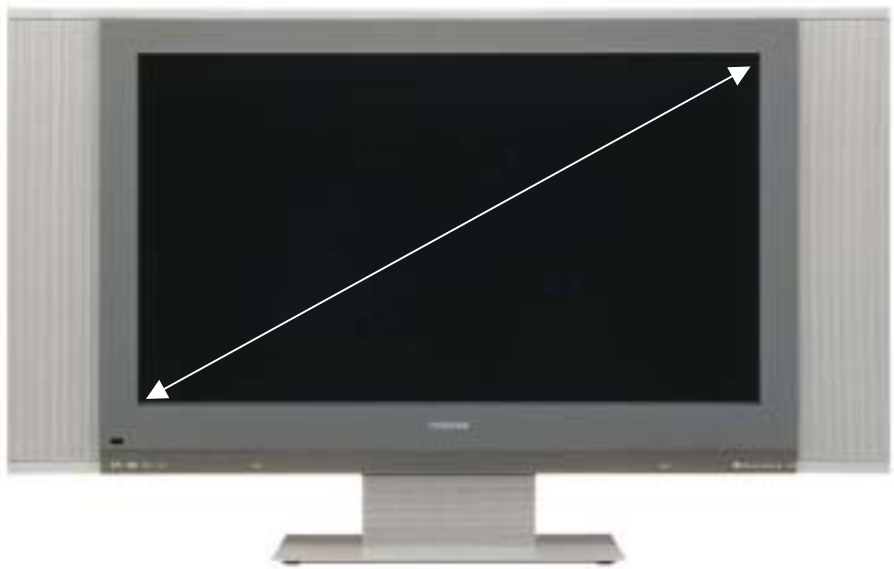
(5) Back end processor; separate CRT and LCD/PDP signal processing circuits

3-3 digital TV LSI board



3-3 Hi-vision TV for digital terrestrial TV broadcasting

32D4000



26L400, 32L4000, 42P4000

Price of Wide screen digital TV

In Japan, all type of wide screen digital TV sets have HDTV performance. For this reason, it seems to be slightly expensive, but in a couple of years, the price of digital TV with wide screen for HDTV become cheap rapidly. The target price is as much as 100 $/1 inch.

(note) in Japan, more than 50 % of program of digital TV should be HDTV, therefore, all types of wide screen digital receiver is compatible to HDTV display.

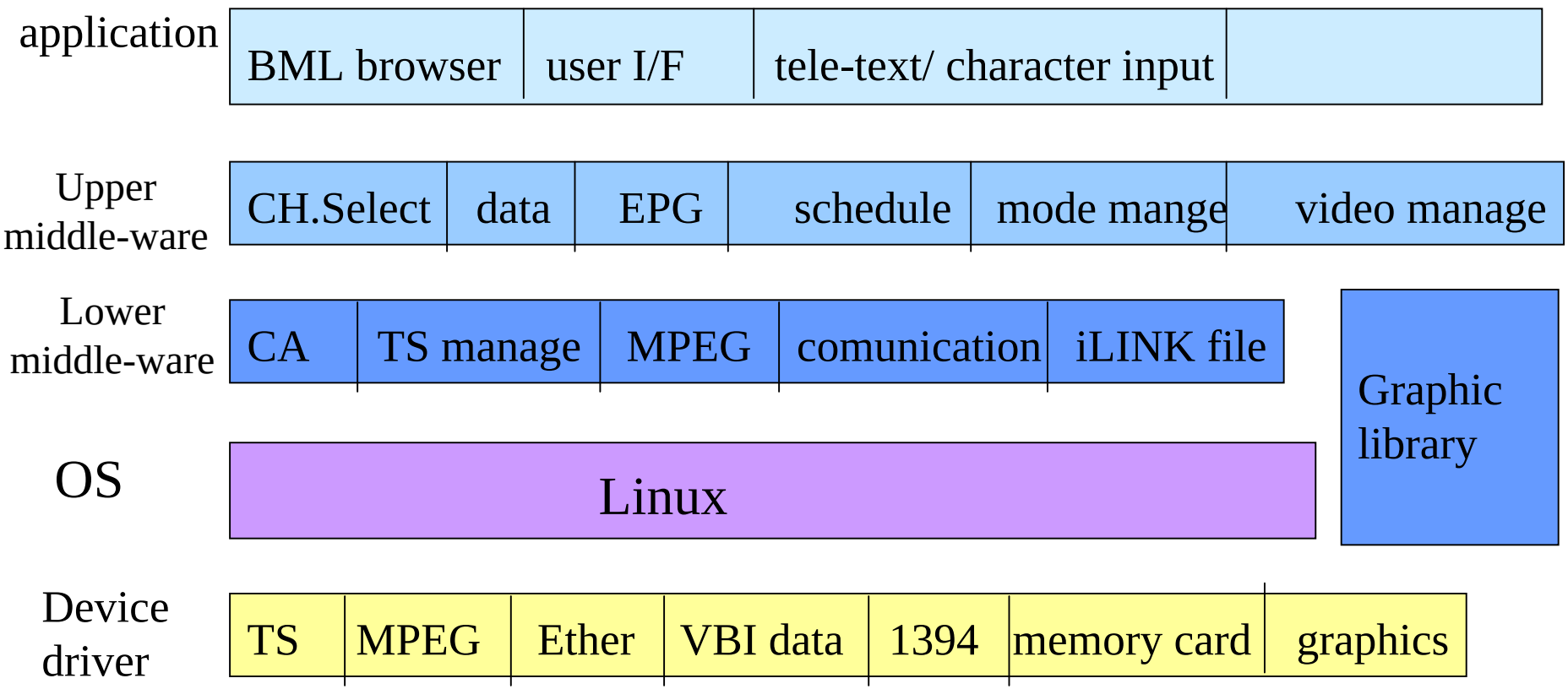
4. Software of digital receiver

4-1 composition of software in digital receiver

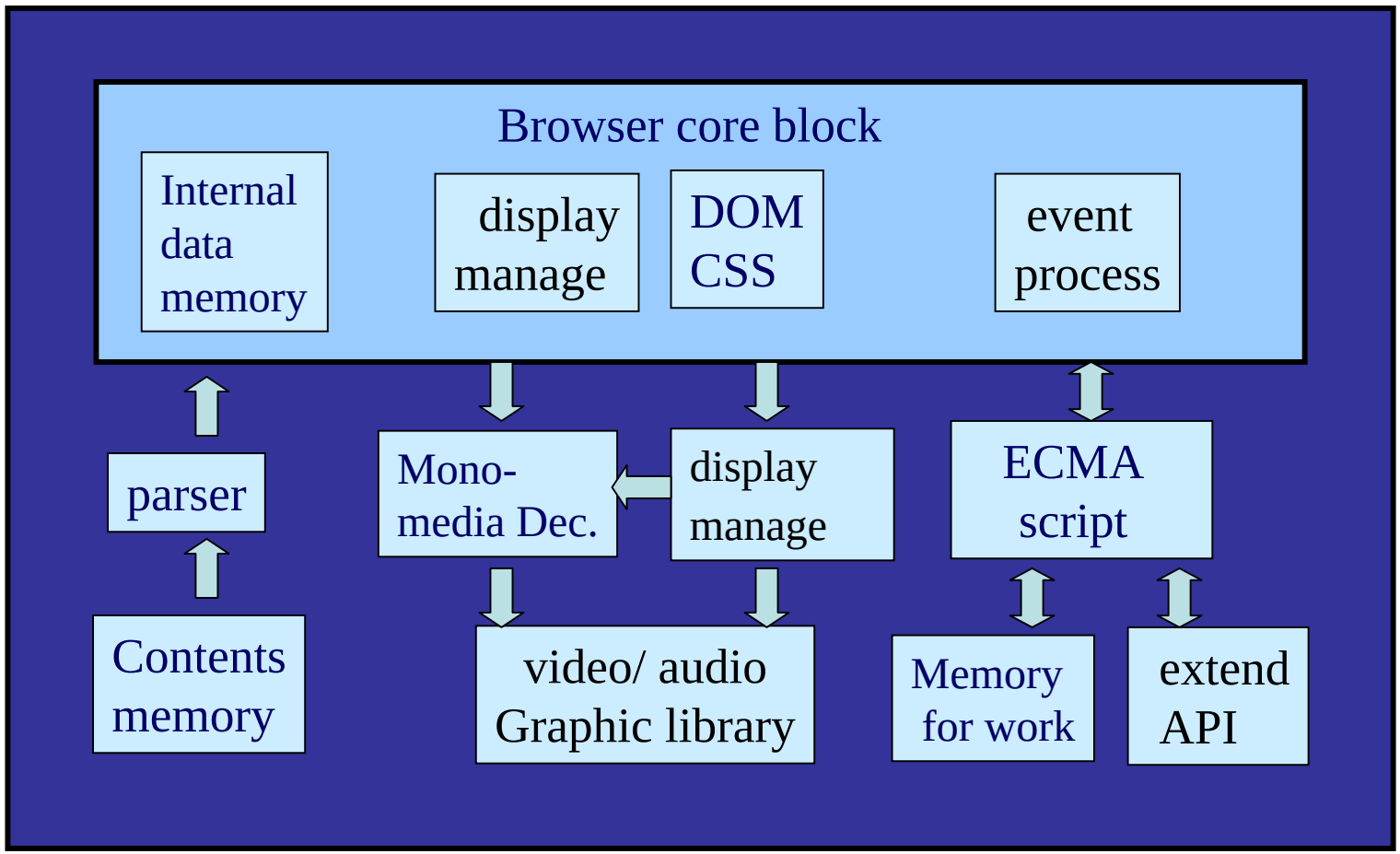
4-2 version up of soft ware

4-3 function of communication of digital receiver

4-1 Software stack of digital receiver



4-1 Structure of BML browser



4-2 software version up

method of down load	contents of soft ware
(1)broadcast wave (auto)	improved software
(2)broadcast wave (any)	add function
(3) memory card	individual user

(1)mainly correct bug of software (mainly used)*
(2)up version of function (HTML)
(3) up version of function (TV set)
*version up automatically at stand by mode

4-2 software download

(1) Information is broadcasted through all channels such as service ID, schedule, receiver type which should be downloaded, etc.

(2) Receiver gets the download data during stand by mode.

The download data is different for maker ID, type No., group No., and version No.

(3) Download data is transmitted through the engineering Ch of BS-3 for satellite media, and NHK general Ch and NHK educational Ch for terrestrial media.

4-3 communication function of digital receiver

- Data broadcast: The contents on the web servers related with the broadcast program can be displayed through TCP/IP communication. Text data is also transmitted by IP packet.
- Download function: Software can be downloaded not only through the broadcast channel but also through the internet.
- Home networking: Digital TV receiver can be connected with the DVD recorder by TCP/IP communication.
- Web browsing: By installing HTML browser into the digital TV, the internet Web browsing will be possible.

5. LSI for digital receiver

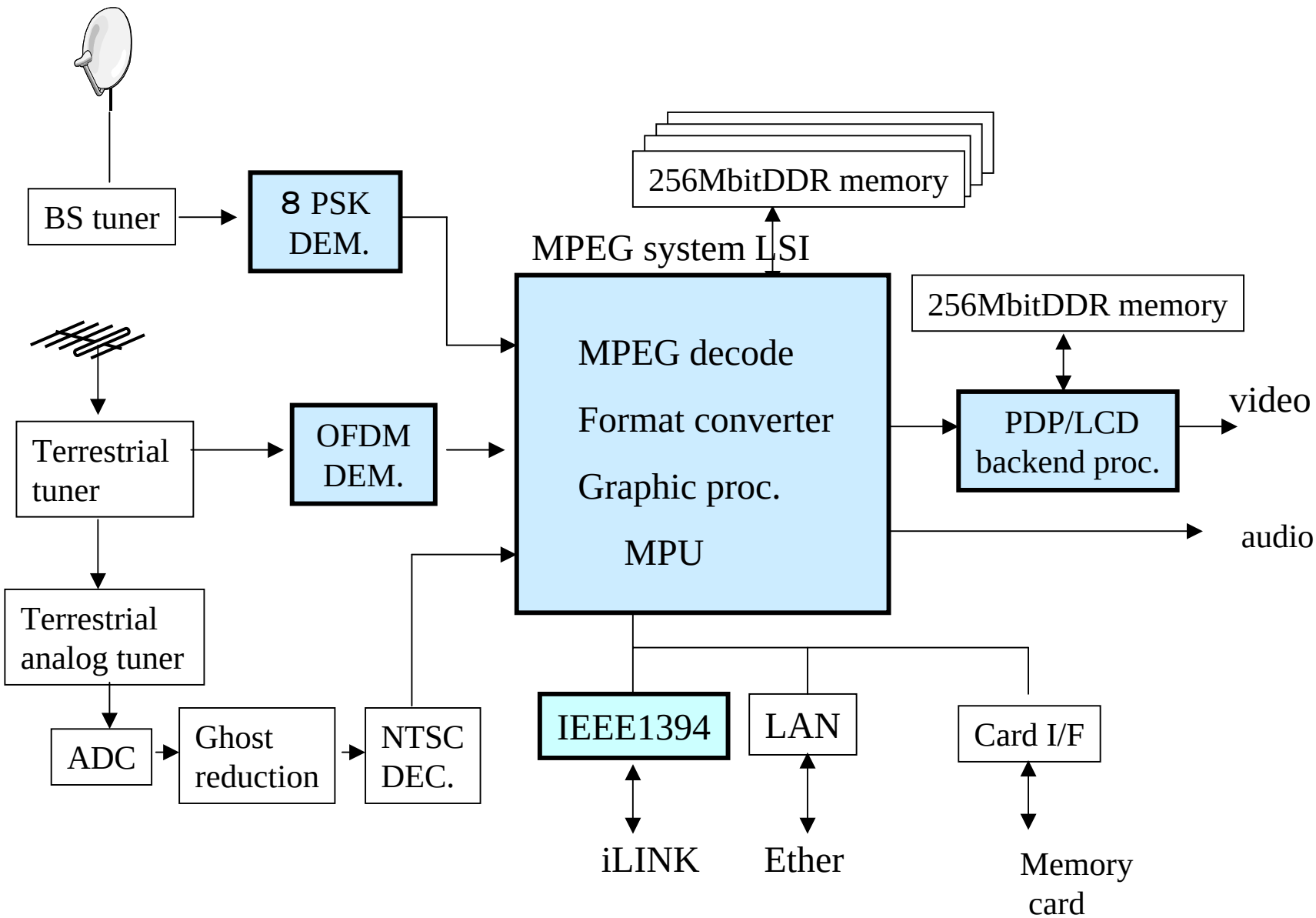
5-1 LSI system of digital receiver

5-2 OFDM demodulator LSI

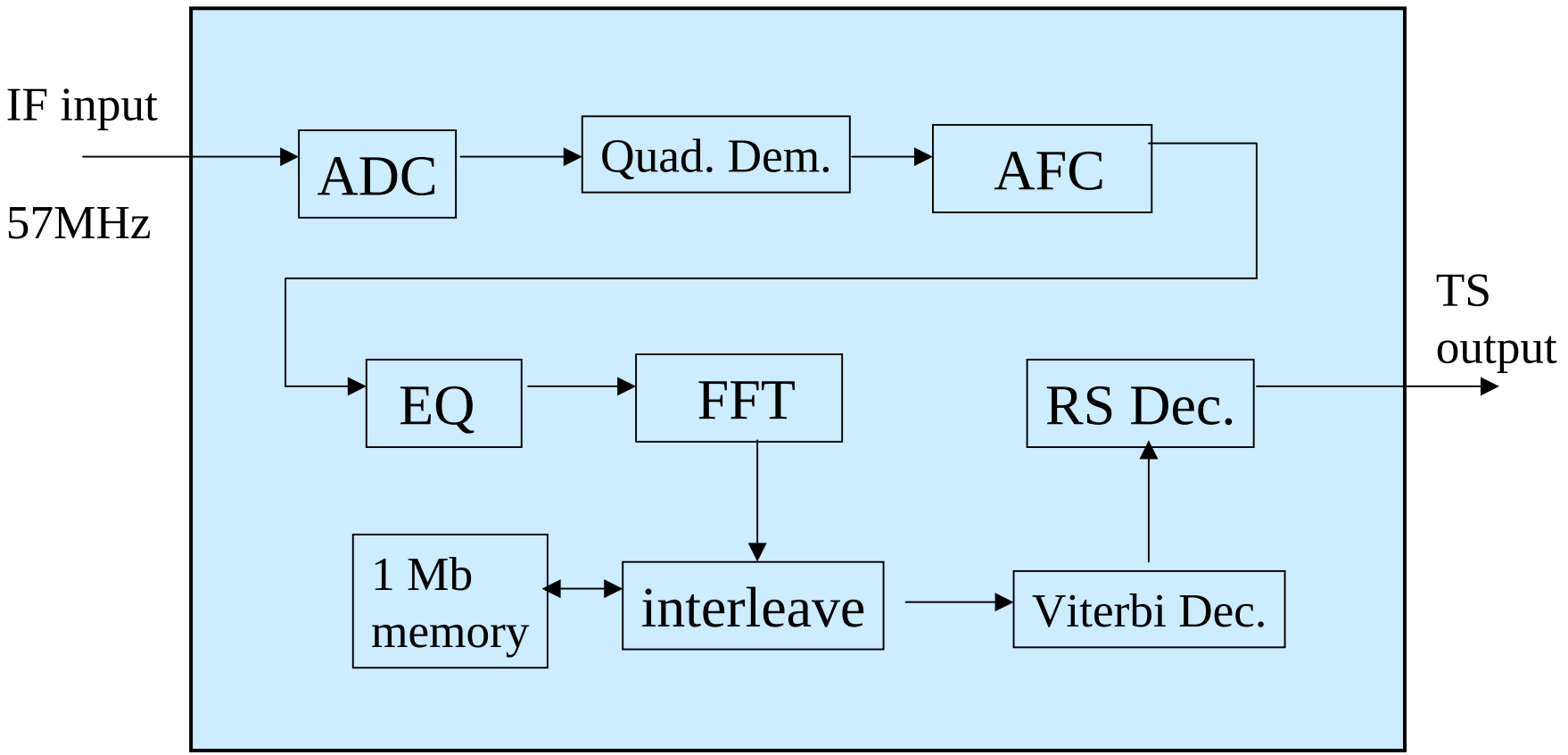
5-3 MPEG decoder system LSI

5-4 back end video processing LSI

Example of digital receiver block diagram



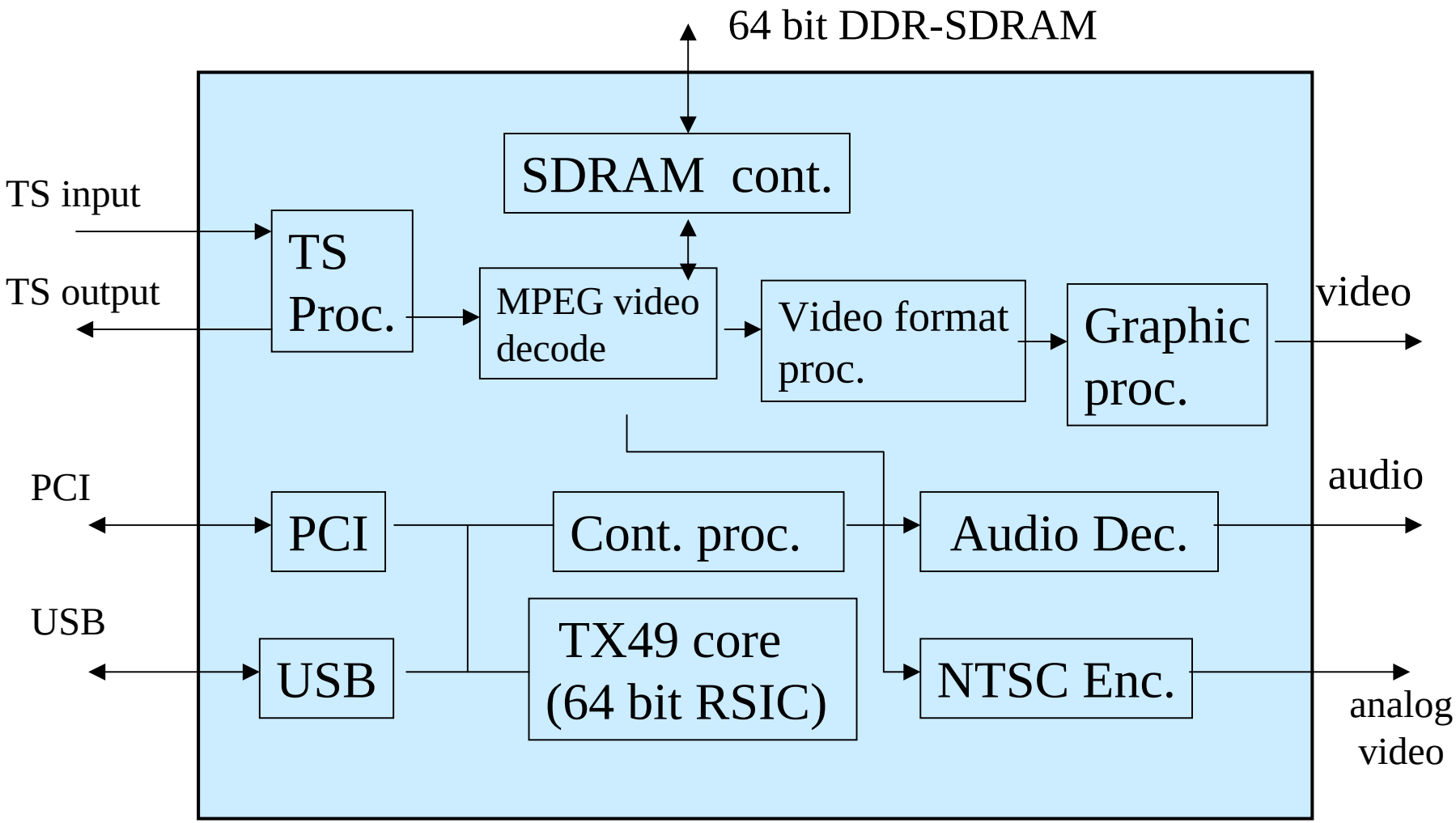
5-2 OFDM demodulator LSI (TC90A87FG)



5-2 Feature of OFDM Dem. LSI

- Compatible to all parameters defined in ARIB spec.
- Compatible to 13 segment, 3 segment and 1 segment transmission.
- Use wideband ADC. Possible to input 57 MHz IF signal directly.
- Equip the interference reduction circuit against analog TV signal interference.
- Equip the memory ,decision circuit in LSI. Only crystal is required as a outside part.
- 2 type of package, 114 pins QFP and 13 mm square BGA.

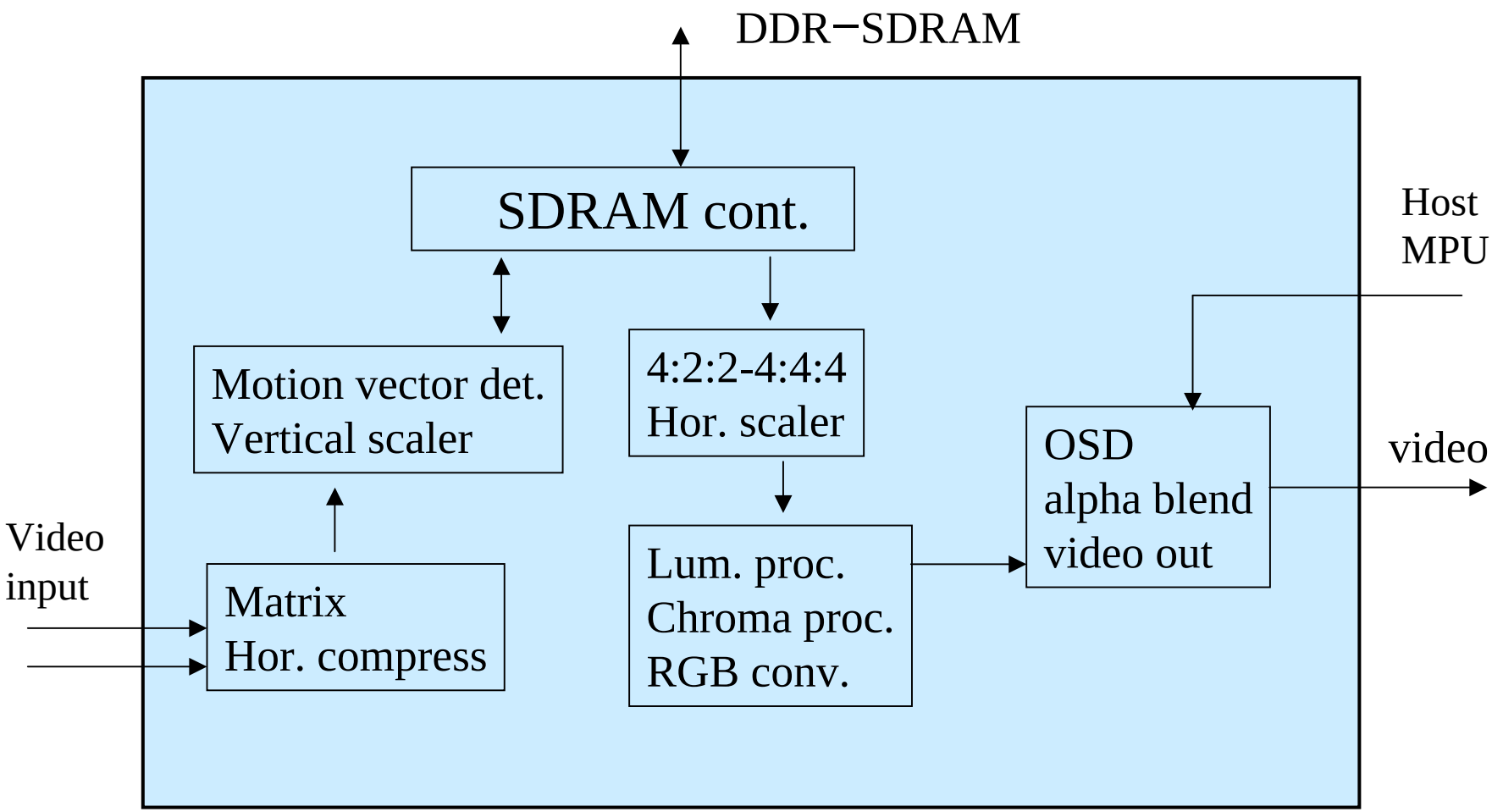
5-3 MPEG decoder system LSI (TC81240TBG)



5-3 Feature of MPEG decoder LSI

- Host MPU; 64 bit RISC (TX49 core), 230 MIPS processor
- TS processing; 3 input, 48 section filter/TS
- De-scrambler; MULTI-2, DMULTI2, DES/TDES , DVB
- Audio; AAC, AC3, MPEG1,2
- MPEG video decode; 2 CH HDTV decode
- Display plane; video 2, graphics 2, carsol/background 1
- Graphics; bitBLT, scaling, alpha blending
- Progressive scan conversion; motion adaptation, intra field, intra frame.
- Noise reduction; motion adaptation, frame recursive type
- Video encoder; NTSC/PSL/SECAM
- Number of gate; 2.7 M gate, BGA 648 pin

5-3 back end video processing LSI (TC90A94TBG)



5-4 Feature of Back End Video Processing LSI

- Input signal: TV signal(480i/p,720p,1080i) and PC signal (VGA,SVGA,XGA,UXGA PC)
- Output signal: Panel size of 853x480, 1024x768, 1280x768, 1366x768, 1920x1080
- Format conversion: Motion compensated i/p conversion (480i) and motion adaptive conversion (1080i)
- Scaling: Horizontal/Vertical 1/3-3 nonlinear
- Picture quality control: Horizontal/vertical enhancer, Black enhancer, gamma correction
- Noise reduction: Motion adaptive frame recursive type
- OSD: 128 colors, 256 alpha blending
- Number of transistor: 12.6M Transistor, Package: BGA480pin

6. Recording and RMP (note) in digital broadcasting

(note) Right Management and Protection

6-1 digital recorder for broadcasting

6-2 recording time of digital broadcasting

6-3 specifications of IEEE1394

6-4 copy control for digital broadcasting contents (RMP)

6-1 Recorder for digital broadcasting

(1)digital VHS：
digital record on VHS tape
(via IEEE1394(iLINK))

(2)hard disk recorder
(with tuner, via iLINK)

(3)next generation(blue laser) DVD
23GB recording on DVD disk

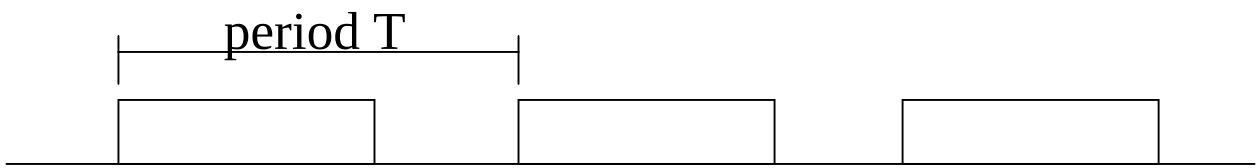
6-2 recording time of recorder

Media For recording	capacity	Recording time	
		BS(22Mbps)	Terrestrial (15Mbps)
D-VHS	60GB	6 hours	8.8hours
Hard disk	200GB	20 hours	15.5 hours
DVD (red)*	4.7GB	28 minutes	41 minutes
DVD (blue)	23GB	2.3 hours	3.4 hours

* in case of DVD (red), record after down conversion to 525i

6-3 IEEE1394 interface

(1) iso- chronus transmission



(2) Copy control by TCP system

-equipment authorization

-Key exchange

-transmit encryption data(M6)

-copy is controlled by CCI

00 Copy free
10 Copy once
01 No more copy
11 Never copy

6-4 RMP application for digital broadcasting

(1) BS and terrestrial broadcasting;

even though free program, scrambled by BCAS. Apply copy once mode. Started April 2004.

(2) BCAS card;

provide to user within same carry box. The card does not provided to unauthorized equipment.

(3) Authorization for new type equipment;

according to application, check and give authorization Authorized; DTCP,CPRM, Bluray

For memory card, DTCP over IP, wireless LAN, future discussion

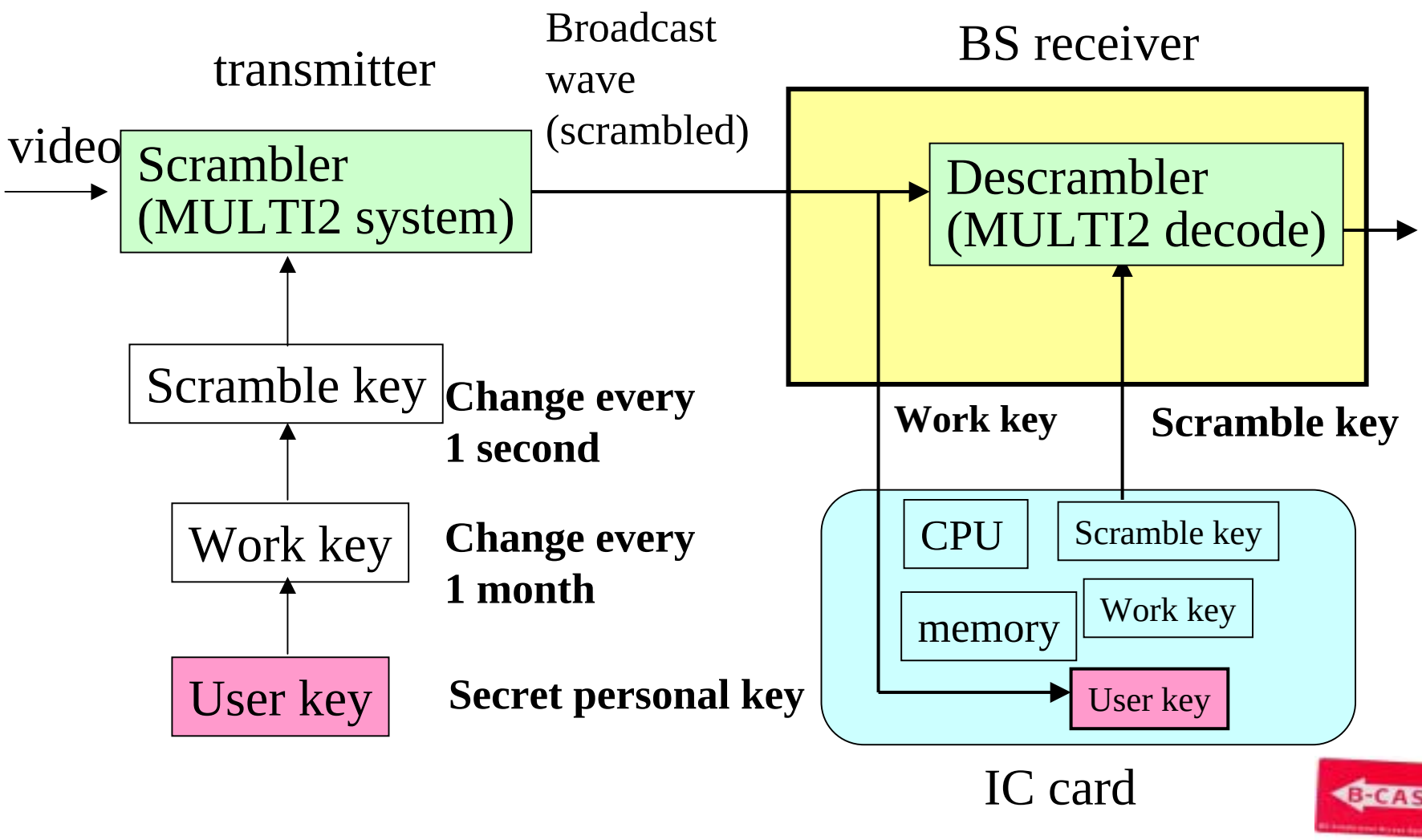
Copy control for DVD

format	CPRM	DVD-RAM	DVD-RW	DVD-R
Video format	invalid	-	OK	OK
Video recording (VR) format	valid	OK	OK	-

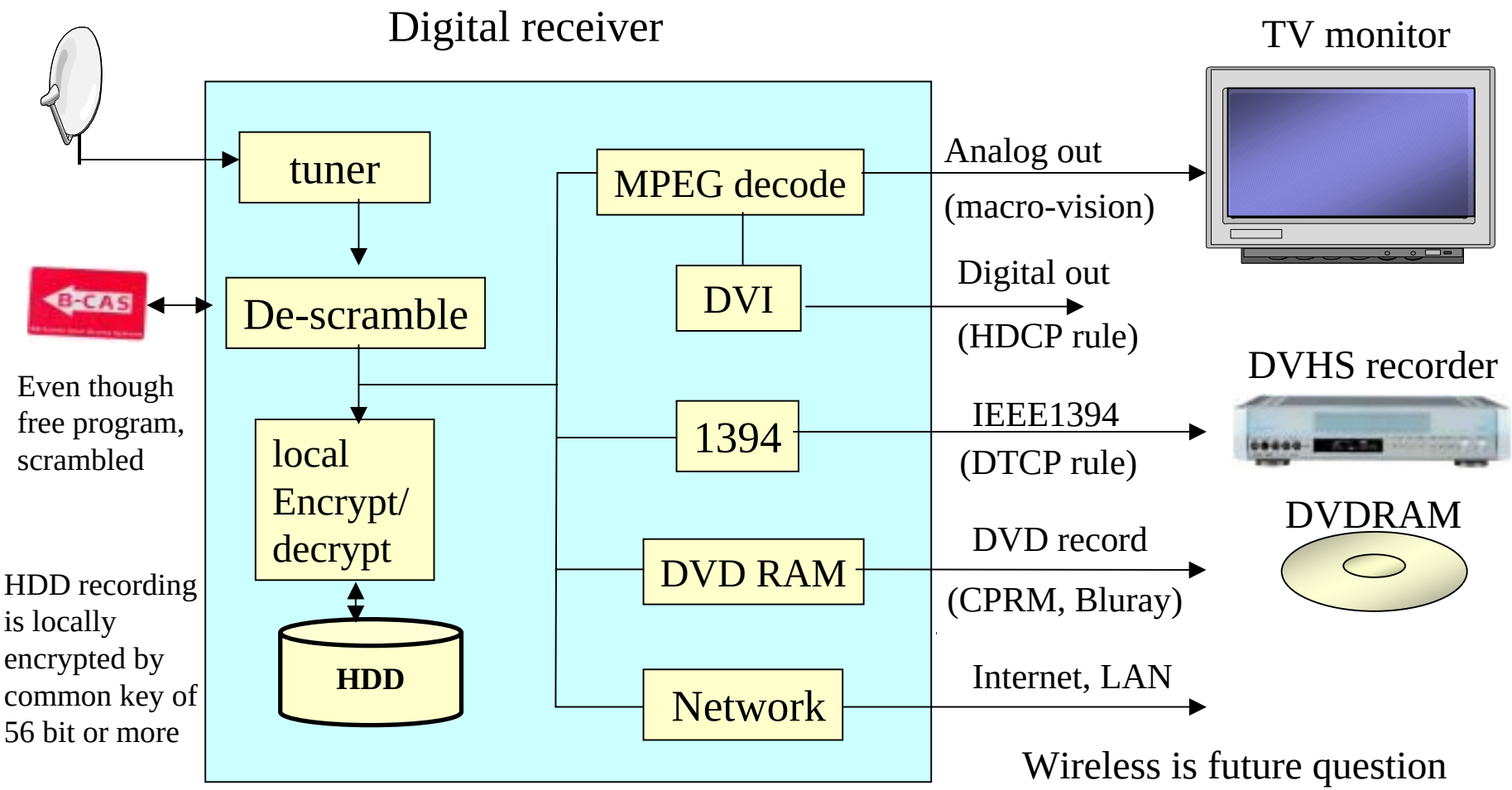
CPRM; Copy Protection for Recordable Media

6-4 charge system by scramble for BS

BCAS（Conditional Access System)



6-4 Composition of RMP in receiver



Card id not provided to unauthorized receiver (enforcement)

7. New type display

7-1 Liquid crystal display

7-2 plasma display TV (PDP)

7-3 FED(Field Emission Device)

7-4 Feature of each display

7-5 Projection TV

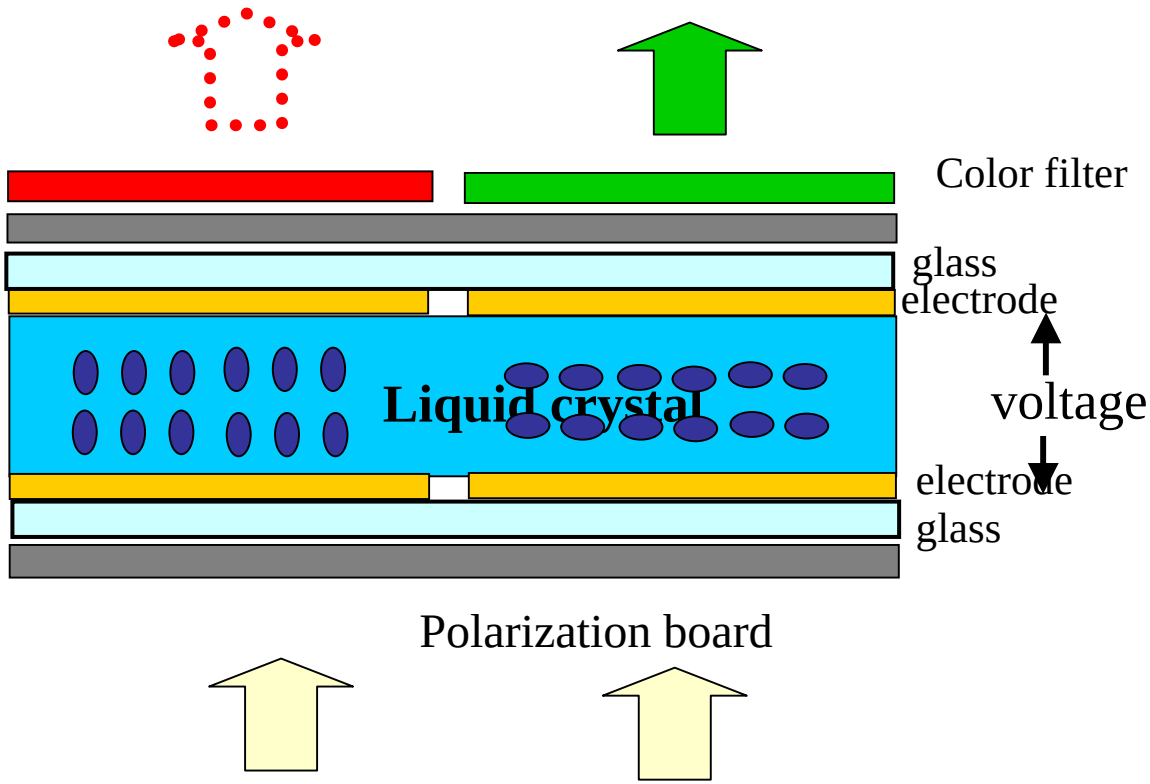
In this section, wide screen and high definition flat displays are introduced, this device is indispensable for HDTV.

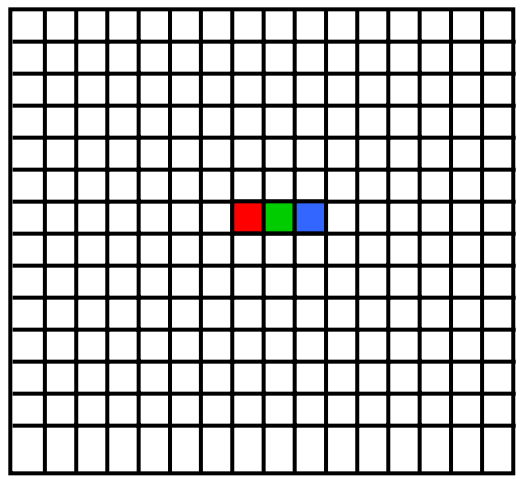
7. New type display

Plasma display TV

Liquid crystal display TV

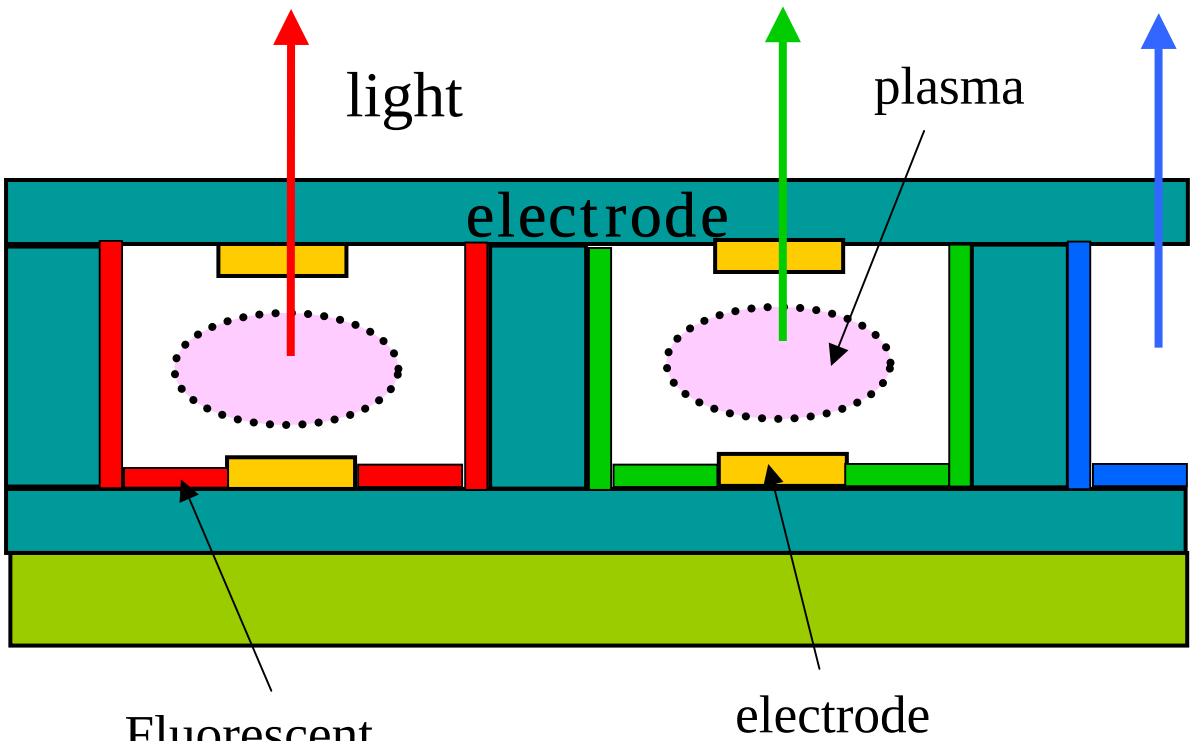
7-1 Liquid crystal display



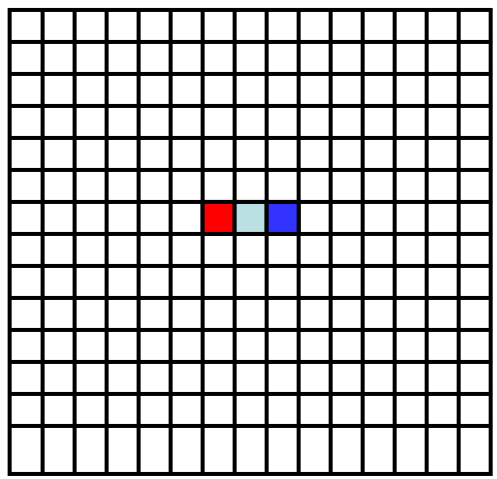


300 thousand pixel

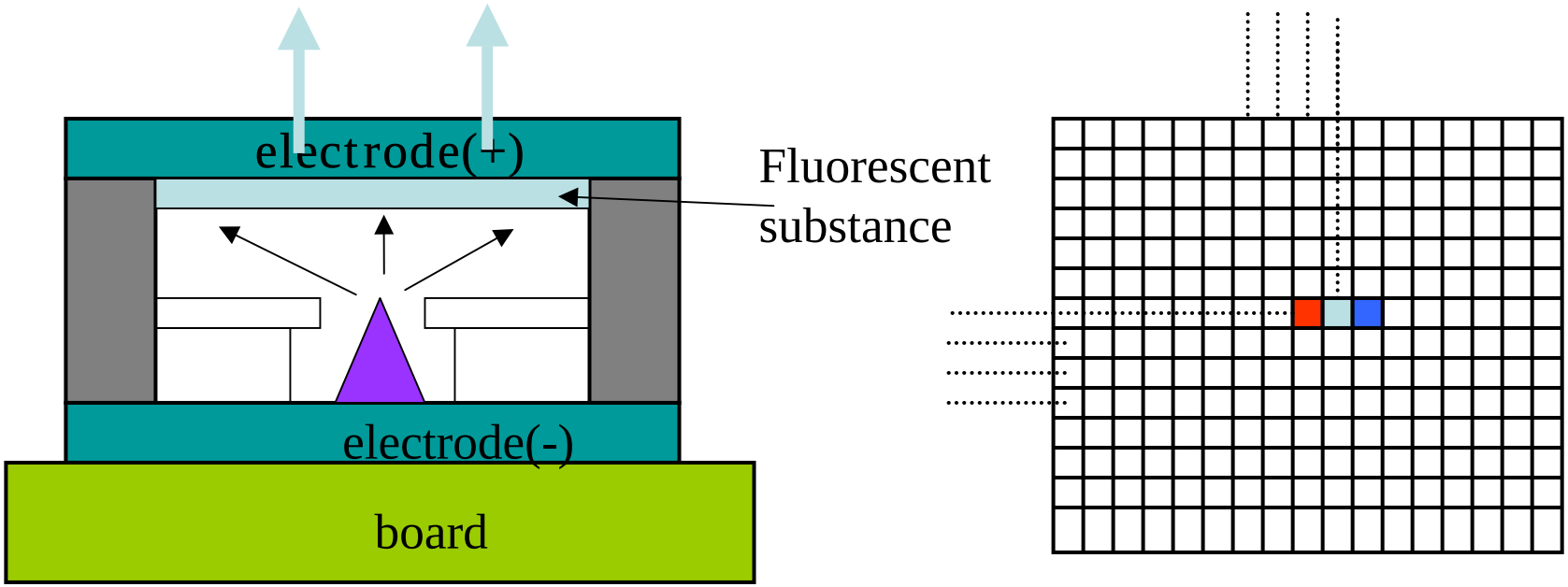
7-2 plasma display TV (PDP)



SDTV; 300,000
HDTV: 1,000,000



7-3 FED(Field Emission Device)



same principle of cathode ray tube

7-4 feature of each display

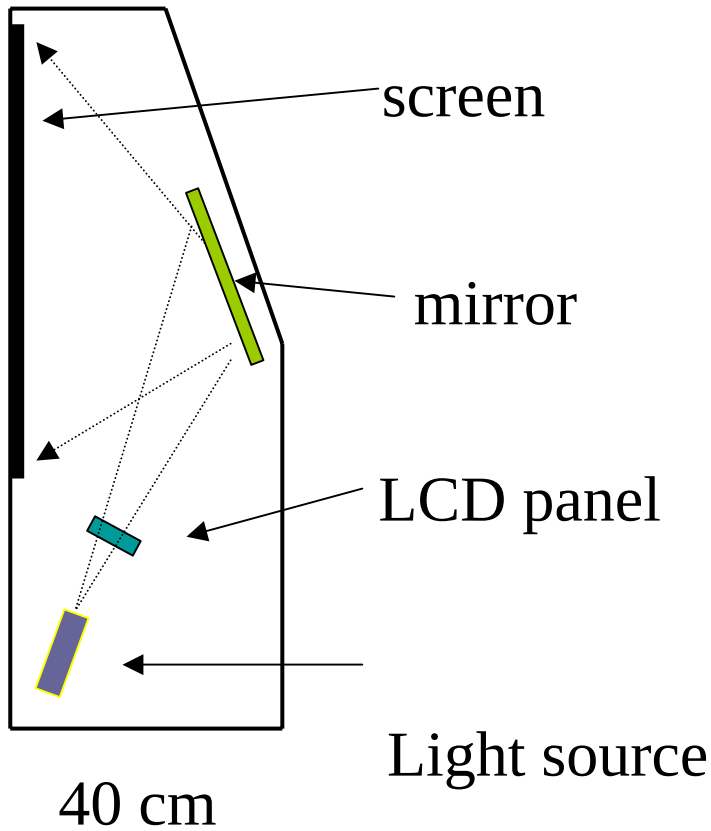
item	**LCD**	**PDP**	**FED**	remarks
Average blightness	1	2	1	To save power consumption, PDP is not so good
Power consumption	2	3	1	
Motion picture performance	3	2	1	
contrast	Dark position ; 1 Blight position; 4	2	1	
Visual angle	3	1	1	Self lightning system is better

1; best, 2; better, 3; good , 4; not so good

7-5 Projection TV

40-60 inch

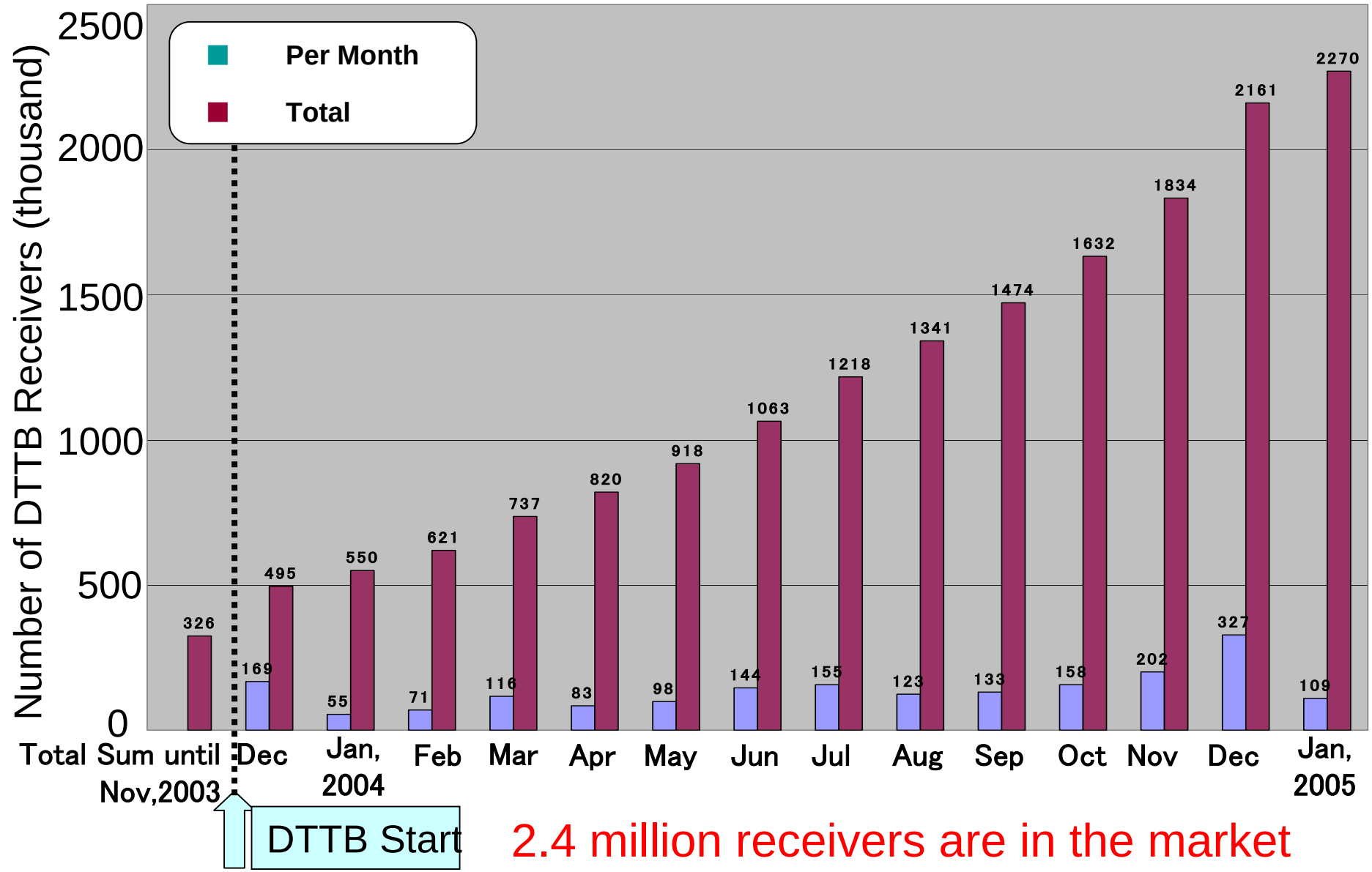
Projection TV



8.examples of products

In this section, mainly introduce the fixed reception type digital receiver. Mobile and handheld receiver will be introduced in seminar #9)

Rapid increase of DTTB Receiver Shipment



2.4 million receivers are in the market now

Digital TV Products

Plasma

PDP

HITACHI

SONY

Panasonic

Pioneer

Victor·JVC

SANYO

TOSHIBA

Digital TV Products

LCD

Panasonic

SONY

SHARP

TOSHIBA

Victor · JVC

SANYO

MITSUBISHI

HITACHI

Digital TV Products

CRT

Panasonic

SONY

MITSUBISHI

TOSHIBA

STB type

SONY

Panasonic

More manufactures are entering the market!

All-in one DTTB Receiver

94% of DTTB receivers are all-in-one DTTB receivers

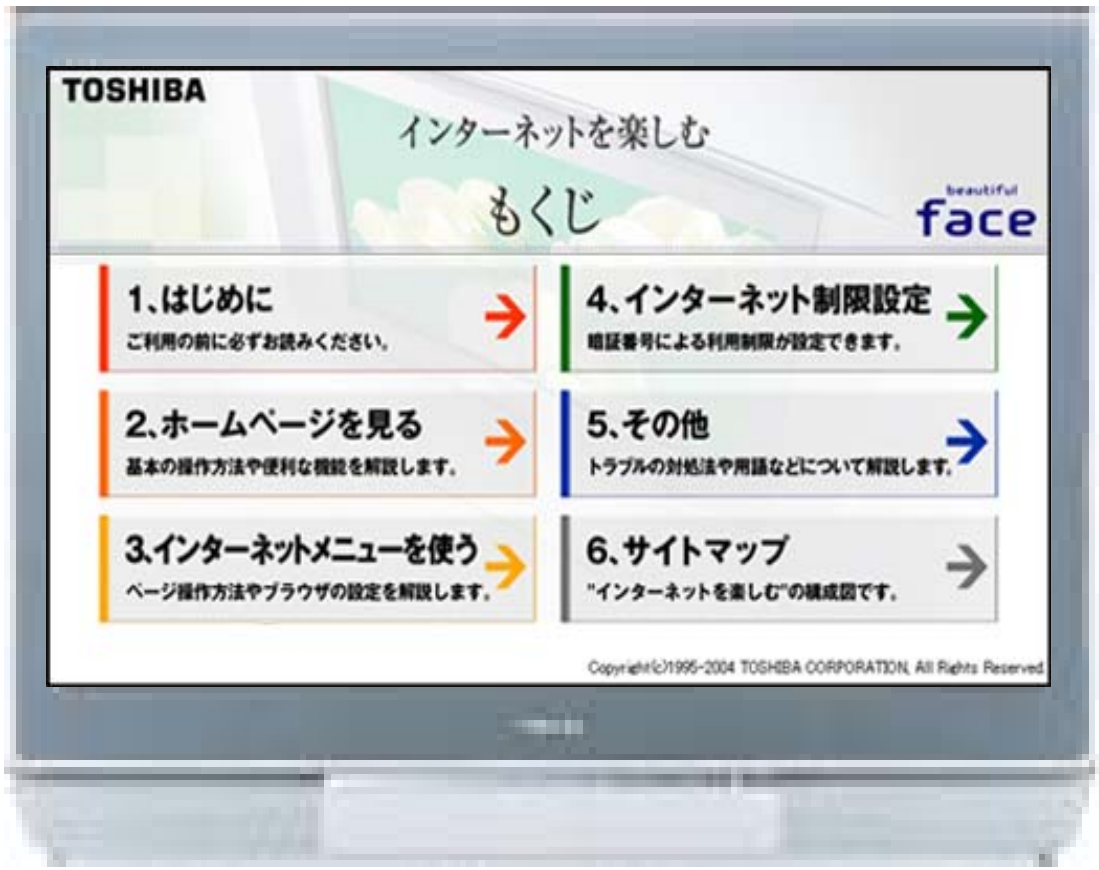
- **Equipped with digital terrestrial and satellite tuner**
- **Compatible with HDTV (1080i)**
- **Equipped with data broadcasting decoder**
- **Capability to connect network**

Many models have internet web browsing function

In addition, more than 3 million of HDTV ready TVs (HDTV display without DTTB tuner) have already shipped.

Example of Internet TV

Portal Site



Character Input Button

Internet Button

Operation Button

Access to Favorite Site

TOSHIBA

Example of Internet Function

Internet Screen

One Screen Mode

Internet Screen

TV Mode

Two (TV + Internet) Screen Mod

TOSHIBA

Example of Internet TV

EPG and T-navi Portal Site

T-navi: dedicated sites for TV internet viewers

Panasonic

Example of Internet TV

T-navi Menu List

NEWS

Travel

Shopping

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Example of Digital TV Product

1920x1080 full HDTV resolution LCD display

Digital HDTV recorder (HDD+DVD) with digital TV tuner

SHARP

Example of Digital TV PC Product

EPG enables to record TV program to PC

NEC

PC with DTTB tuner card

Example of Product (CATV Digital STB)

DTTB is broadcasted via CATV with 64QAM transmodulation.

1.0 million CATV digital STB are in the market (Dec.2004)

Panasonic

END of seminar #7