

Project: IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)

Submission Title: [Introduction of vertically connected wireless system]

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Abstract: [Millimeter-wave vertically connected wireless system]

Purpose: [Contribution to millimeter-wave interest group at January 2004 meeting]

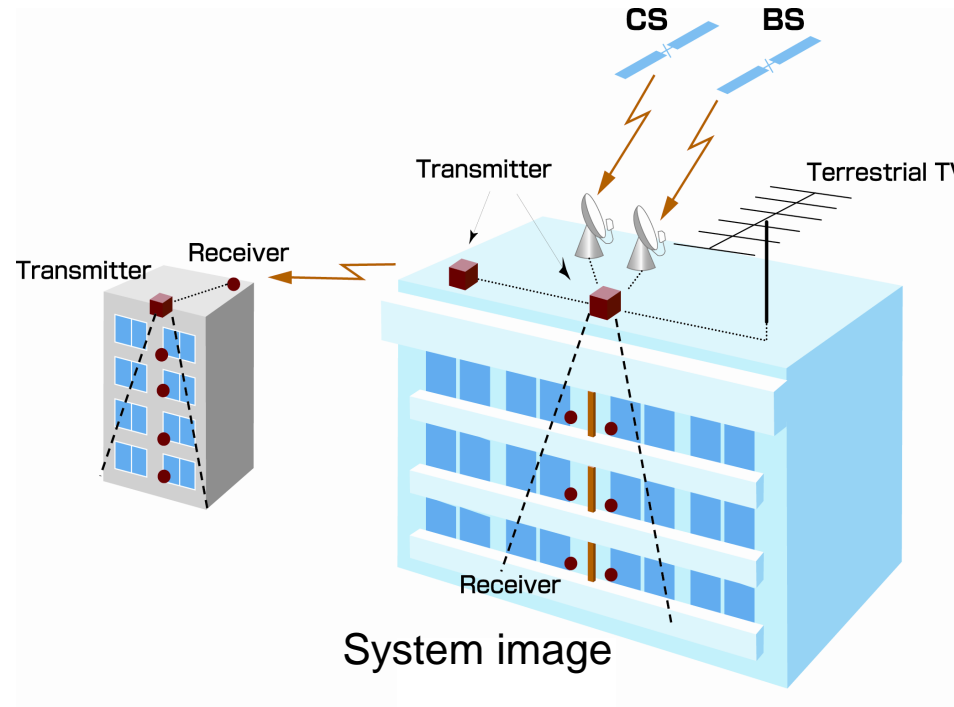
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60GHz band Application

-Millimeter-wave vertically connected wireless link -

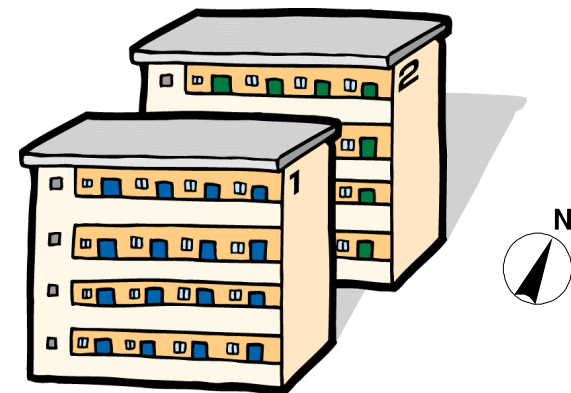
Expectation of wireless link for broadcasting



Problems of receiving satellite broadcasting signals

Satellite broadcasting (BS, CS) provides high-quality services. However some apartment buildings can not receive signals,

Because of
obstacles for satellite direction,
no balconies for satellite direction,
etc.



Demands for wireless re-broadcasting system

- Wide band transmission.
- Flexible extension of contents.
- Easy set up.
- Low cost.
- Un-license system.

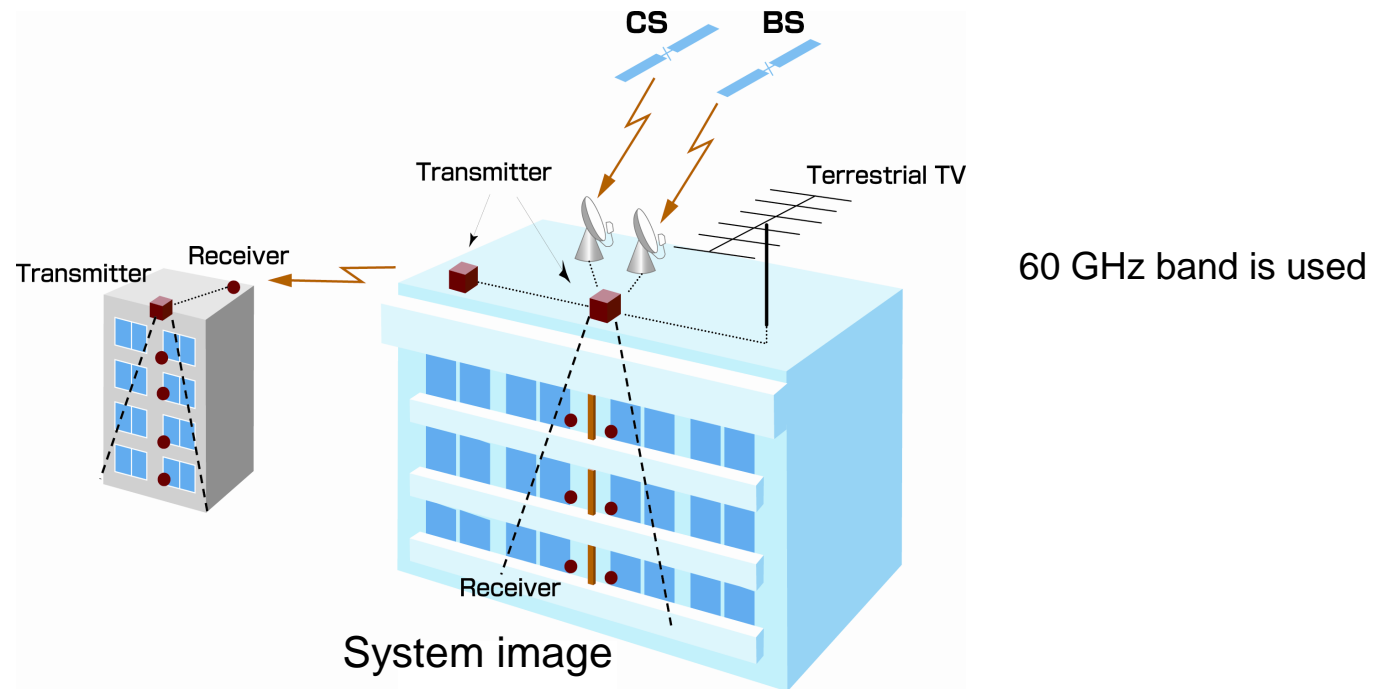
60GHz band

Wide band transmission.

Small sized devices.

Un-license band.

Vertically connected wireless link



Re-broadcasting system between the rooftop satellite antenna with individual receivers at balconies

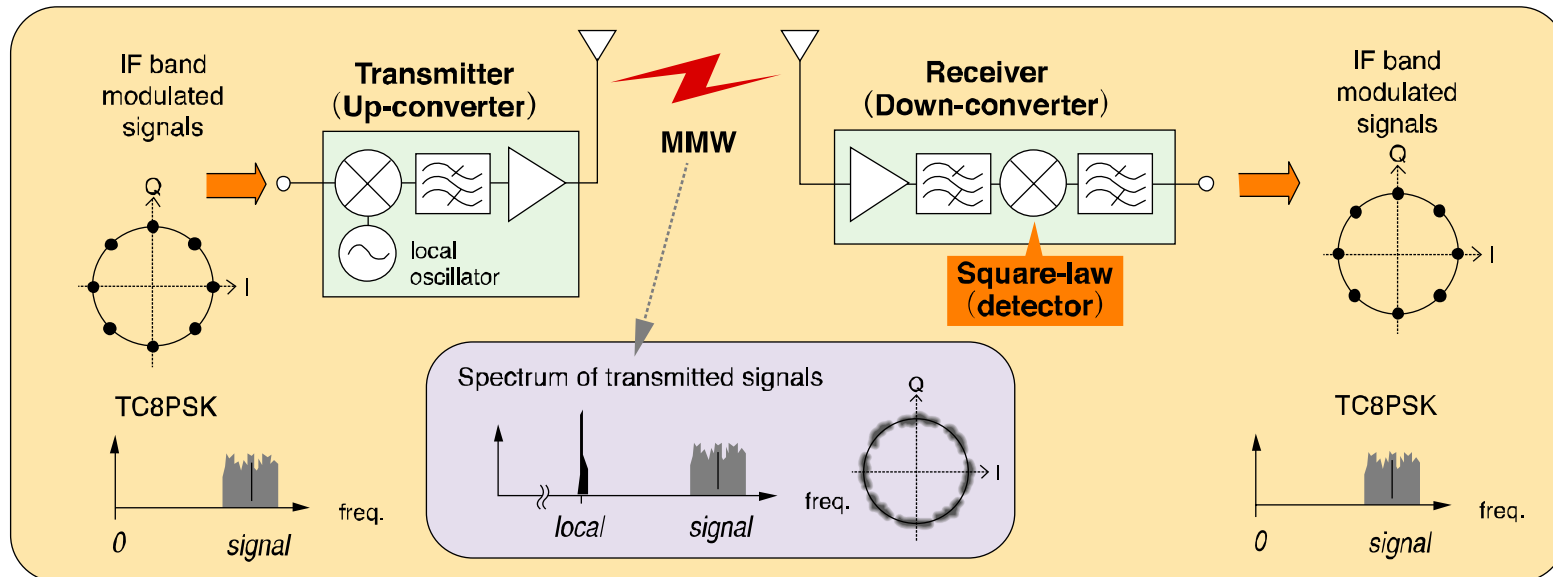
Special features:

flexible wireless link / easy set-up / easy extension / low cost

Current Standards for un-license band (Japan)

Unlicensed band	59-66 GHz
Output power	≤ 10 mW (+50 %, -70 %)
Antenna gain	≤ 47 dBi
Frequency stability	Max. ± 500 ppm
Bandwidth	≤ 2.5 GHz

Self heterodyne scheme



- Tx transmits modulated signals with local signal.
- Rx obtains BS-IF signals by using the received local signal.

Special features:

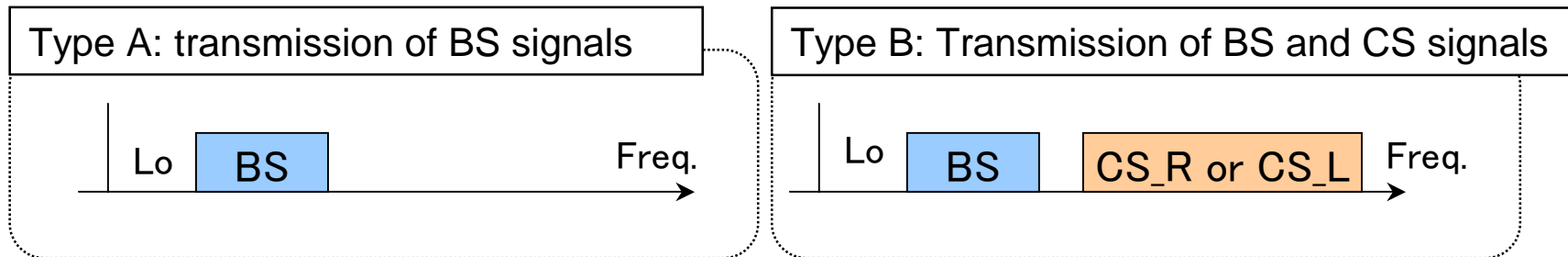
- Rx can cancel the phase noise problem.
- Tx can use low cost local oscillator. / Rx does not need local oscillator.

Definitions for Link Budget Calculation

Parameter	Value	Comment
Transmission power	10 mW	
Antenna Gain (Tx, Rx)	23 dBi	
Transmission distance	33 m	10 F building is assumed
Loss	98.4 dB	
k	$1.38e-23$ JK	
T	300 K	
NF	6 dB	
C/N for BS	26 dB	at BS satellite antenna
C/N for CS	19 dB	at CS satellite antenna

Link Budget

Two examples of transmission media are shown here.



Type	A	B
Bandwidth	300 MHz	780 MHz
NF deterioration	9 dB	9 dB
CNR cut off (BS)	14 dB	14 dB
CNR cut off (CS)	-	8 dB
Margin for BS	11 dB	9.7 dB
Margin for CS	-	9.8 dB

From link budget, 33 m (= 10F building) transmission is possible.

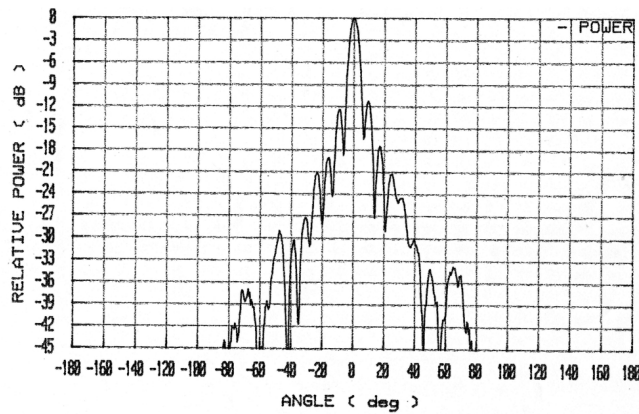
Developed Prototype



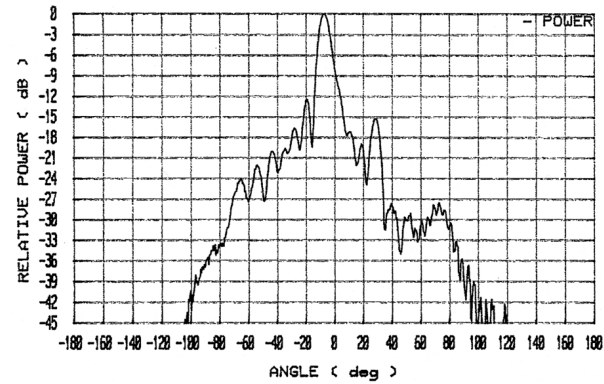
For BS signal transmission

RF frequency (RF)	59.01-60.345 GHz
Local tone (Lo)	59.01 GHz
IF frequency	1032.23-1335.25 MHz
Total power	10 mW
Antenna gain	23 dBi (Tx , Rx)
Diameter	11 cm
Weight	600 g (include the metal fittings)

Antenna pattern



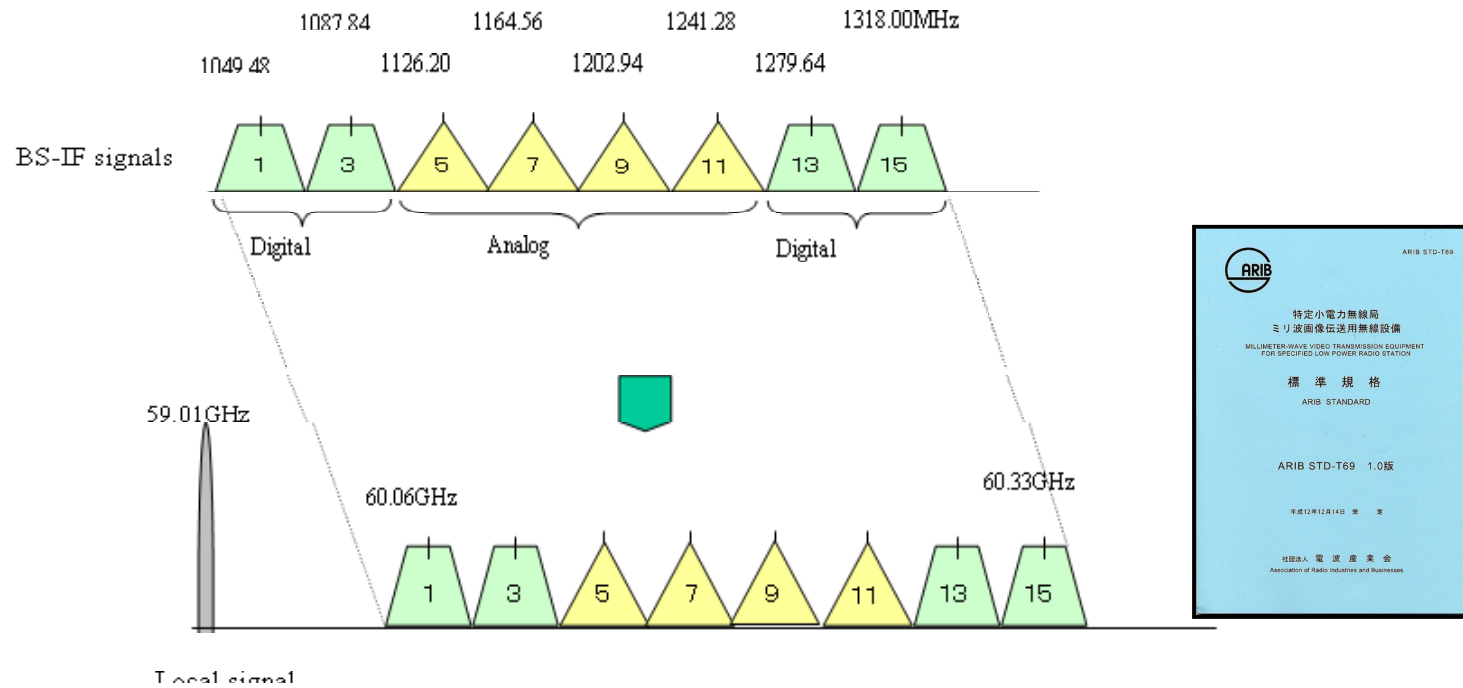
E-Plane



H-Plane

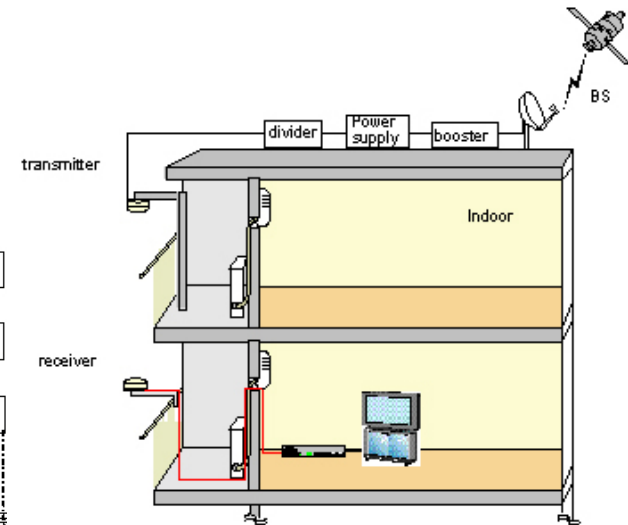
23 dBi antenna (beam width is about 5 degrees)

Frequency Arrangement



ARIB STD-T69

Measurement in an apartment building



Measurement condition



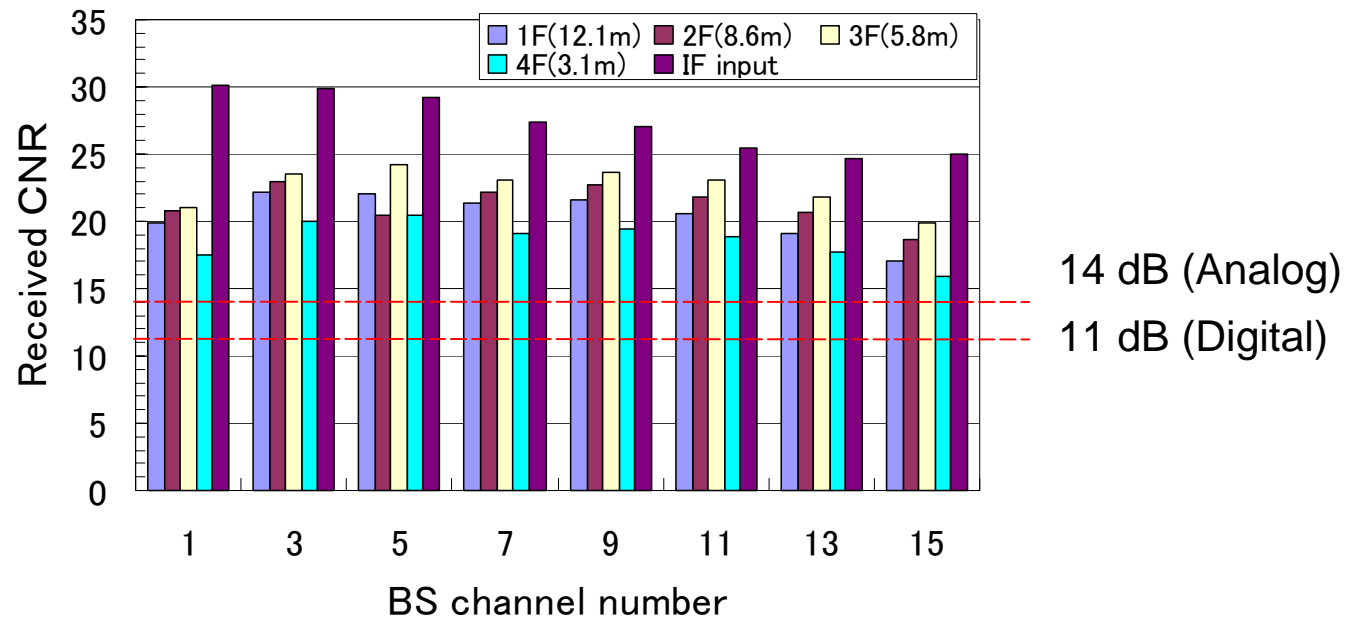
Transmitter



Receiver

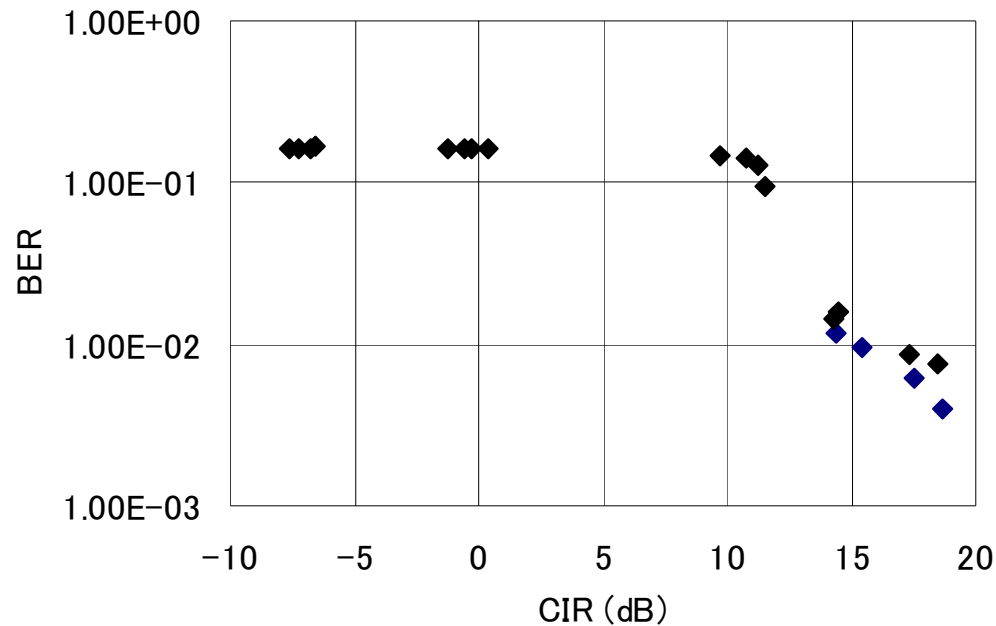


CIR characteristics



Enough quality signals were received for all floors.

CIR characteristic



Condition: two transmitters are set.

CIR >12 dB is required when plural transmitters are set in the apartment.

Conclusion

Vertically connected wireless link is introduced.

- CRL developed prototypes for BS transmission.
- Link Budget is calculated.

In the measurements, we confirmed that

- BS-signal transmission with high quality in 5F apartment
- CIR > 12 dB is required when multiple transmitters are set.