eXtended Global Platform(XGP) Major Technology Abstract

1 Overview

XGP is one of the future Broadband Wireless access systems (BWA), which will realize the high-speed data communication and large capacity with mobile communication network. Major features of XGP are as follows.

- OFDMA/TDMA-TDD is adopted to realize high throughput communication
- High capacity radio network based on micro cell system
- Communication possible at movement of up to 300 km/h
- Cell planning unnecessary because of Dynamic Channel Assignment
- Micro cell / macro cell coexistence

2 Target for XGP development

XGP will support all the services that general mobile system supplies. It is also making effort to provide subscribers with a wider rang of other services, which will be required in future. The major expanded features of XGP system are described as follows:

- ***Higher data transfer throughput***

  In order to process the visual data or streaming data, average throughput of more than 1Mbps is necessary. Therefore, this superior data speed is one of the major features of XGP.

- ***Higher capacity to cope with traffic density***

  The more the users accessing the system with higher speed data service, the more the system capacity with network system including BS will be needed. By adopting a new method of radio interface, XGP made it possible for data traffic processed by 1 base station (BS) to grow evolutionally. In addition, XGP system has better efficiency in using frequency than other radio system due to its feature of micro cell basis. Also by building the network majorly on microcell, it provides a higher capacity than other mobile system based on 3G technology.

- ***Flexibility for cell mapping regarding the usage of various cell type***s

  One of the major features of XGP system is the flexibility of BS location design. In other system, to enable a frequency resource to exert its best efficiency, the cell mapping should be carefully designed and cell construction by adding the BS should be strictly observed. In addition, by

adopting autonomous decentralized control function, XGP system can be construction with more flexibility. It could adopt various types of cells, such as Macro Cell, Nano Cell and Femto Cell in time of need, in order to cover one area more efficiently.

- ***Higher capability for mobility service***

  The demerit of a micro cell system is that hand-over might be happened more frequently than the case in macro cell system. This demerit limits the mobility of terminals in micro cell system. Since each BS in micro cell system has a smaller radio zone, when a mobile station (MS) moves into these BS zones, radio connection of MSes with BS has to switch, whenever it moves from one BS area to another. That means terminal has to overcome the frequent hand-over without temporary silence in case of voice terminals and packet loss in case of data terminals. XGP has suited itself to high-speed movement by adopting seamless handover technology.

3 Major Technical Advantage

3.1 OFDMA/TDMA structure

One of the major techniques, which are applied for link access in XGP, is the OFDMA (Orthogonal Frequency Division Multiple Access).

OFDM (Orthogonal Frequency Division Multiplexing) is an FDM technique that divides a communications channel into a small number of equally spaced frequency bands, each of which carries a portion of the radio signal in parallel. These sub-carriers are then transmitted simultaneously at different frequencies to the receiver. OFDMA is a multiple access scheme for OFDM systems. The access method is also combined to TDMA, hence the general access method for the XGP is OFDMA/TDMA-TDD.

TDD is adopted as duplex method on time axis. The transmission and reception structure of 4 symmetrical slots for uplink and downlink each is described below. Each time slot has 625usec duration for time axis, therefore TDMA frame will be 5 ms.

OFDMA is adopted as multiplex method for plural uses on t the frequency axis. Hence, it is able to assign multi frequency for each link connection with wider frequency band.

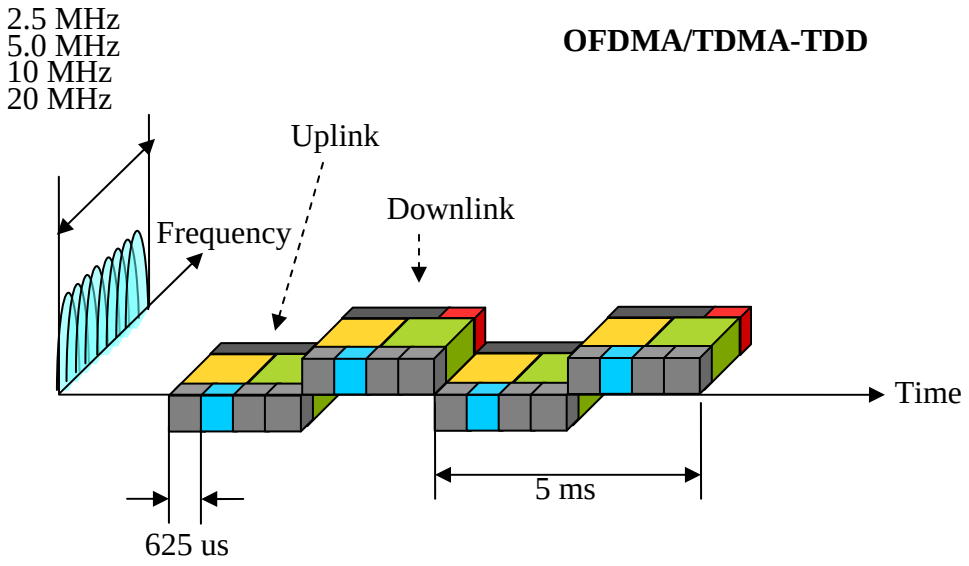


Figure 1 OFDM/TDMA-TDD structures

Table 1 Radio access methods

Radio access method	OFDMA/TDMA-TDD
Number of TDMA multiplexed circuits	4
Number of OFDMA multiplexed circuits	Depend on Channel Band width
Channel Band width	5MHz, 10MHz, 20MHz
Data modulation method	BPSK, QPSK, 16QAM, 64QAM, 256QAM

The Structure of OFDM and parameters are shown in Figure 2. The OFDM frame parameters for XGP are shown in Table 2.

Subchannels are formed with the combination of plural sub-carriers. The Sub-carrier interval refers to the interval between the sub-carriers. The smaller the interval is, the bigger the influence of interference between sub-carriers becomes, yet the better the data transfer efficiency would be. The system bandwidth refers to the total bandwidth occupied by a system. FFT, which stands for Fast Fourier Transform, shows the maximum number of sub-carriers in system bandwidth.

The Effective channel band is the frequency band, which is actually used by the system in communication.

Guard band is needed to avoid the interference with other link, which is used by neighboring channel band. To maintain the high quality of communication, DC carriers should be inserted into these sub carriers. And their deployment should be considered as XGP frame format.

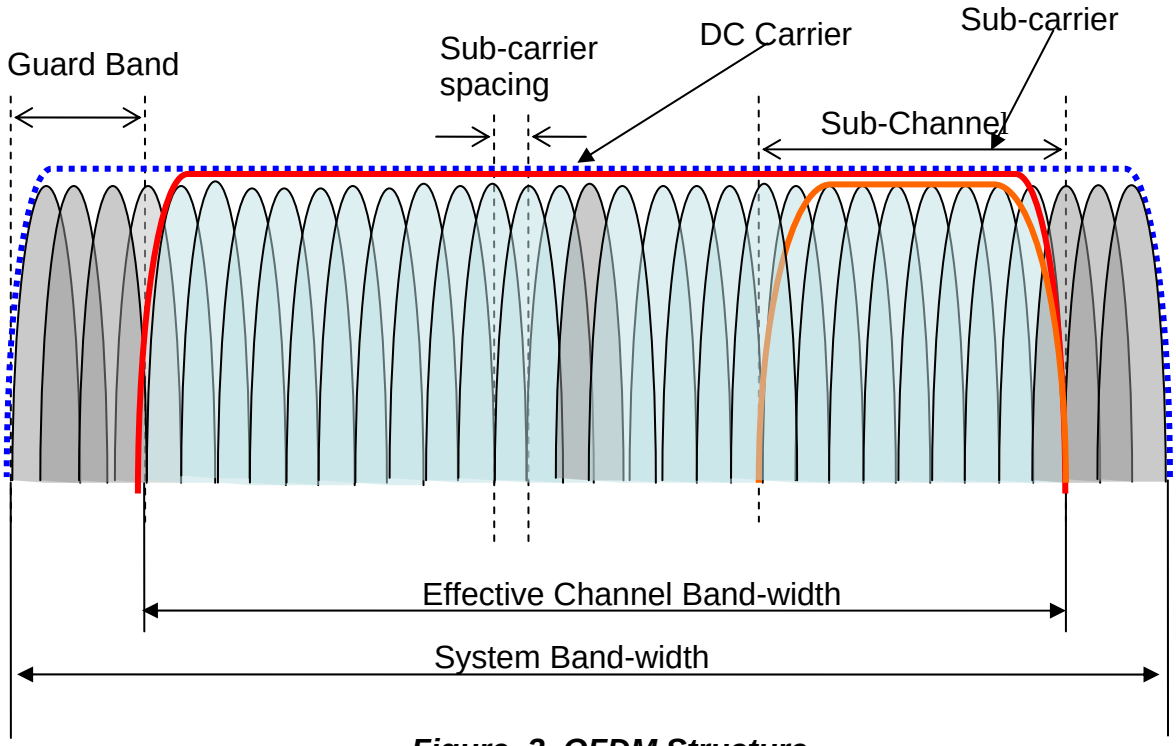


Figure 2 OFDM Structure

Table 2 OFDM parameters

Parameter	Type 1	Type 2	Type 3	Type 4	Type 5	Type 6	Type 7
System Bandwidth [MHz]	2.5	5	10	10	20	20	20
Effective Channel Bandwidth [MHz]	1.8	3.6	8.1	9.0	16.2	17.1	18.0
Sub carrier Spacing [kHz]	37.5						
SCH Bandwidth [kHz]	900						
Guard Interval length [us]	6.66 (S1), 3.33 (S2 – S19)						
OFDM Data Length [us]	26.67						
OFDM Symbol Length [us]	33.33 (S1), 30 (S2 – S19)						
Guard Interval Ratio	1/4 (S1), 1/8 (S2 – S19)						
Total Guard Time [us]	51.67 (21.67 + 30)						
OFDM Symbol Number per Subcarrier	19						

3.2 Data Frame Structure and High Data Speed

Figue.3 shows the frame structure of XGP. It has 4 slots for uplink and 4 slots for downlink symmetrically. The frame length is 5ms and each time slot has the length of 625usec. Plural OFDM symbols are allotted in each slot. Each symbol has its OFDM data part and GI part.

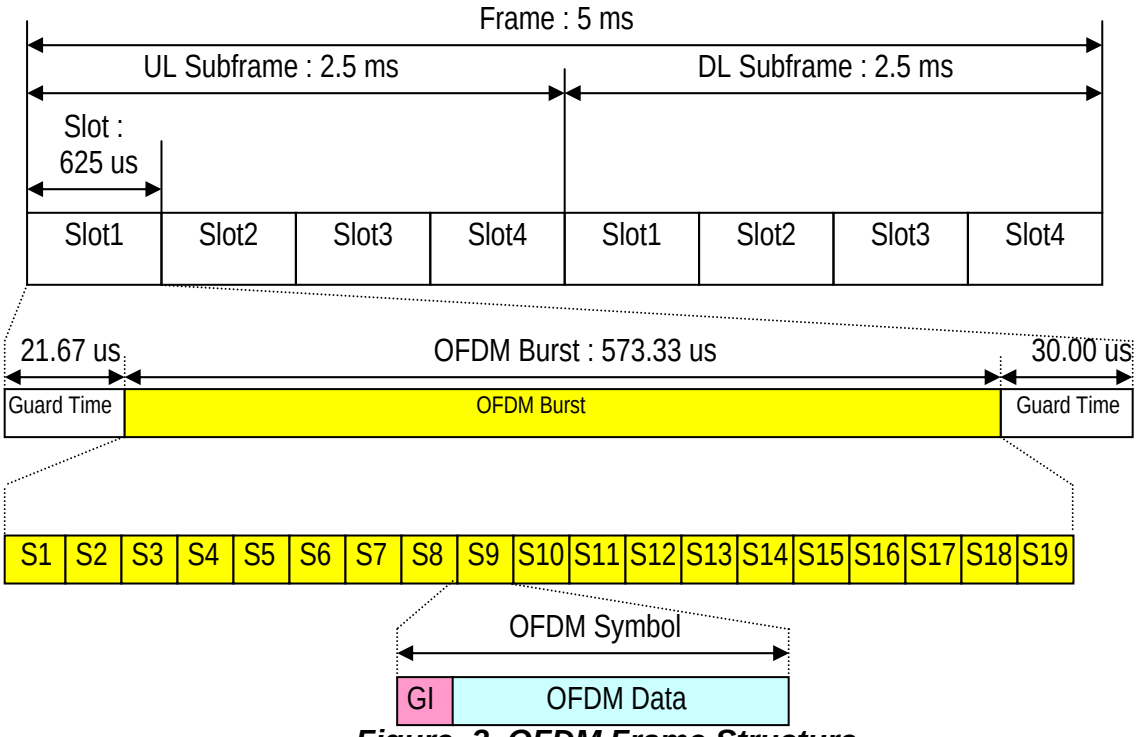
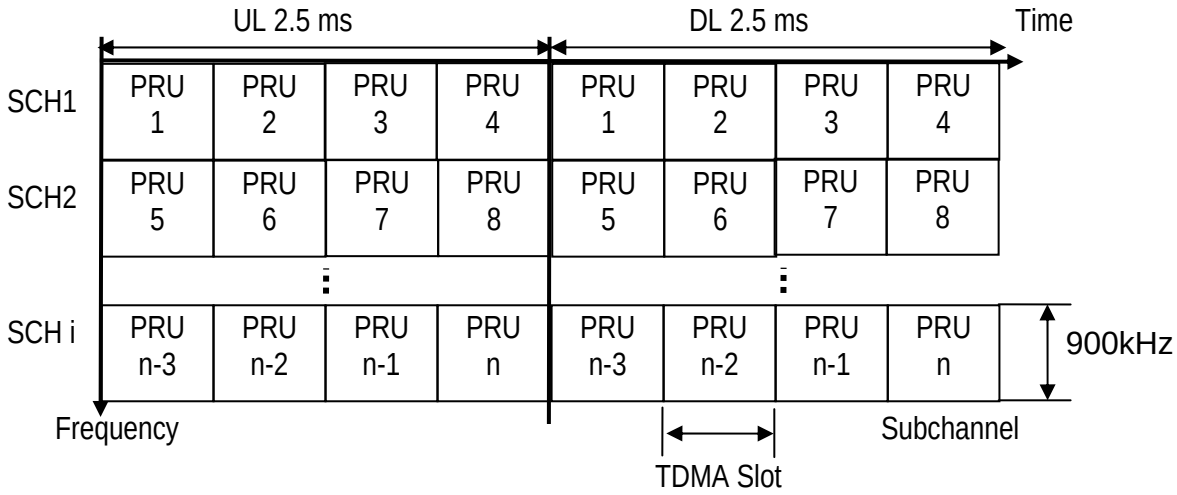


Figure 3 OFDM Frame Structure

Figure.4 shows the PRU (Physical Resource Unit). The word PRU defined in XGP stands for a block divided by the time axis unit (TDMA slot 625usec) and the frequency axis unit (OFDM subchannel 900 kHz). This figure also shows the correspondence between subchannel number and PRU number.



SCH i : Subchannel Number (i = 1~m m=1,2,4,9,10,18,19,20)
PRU n : PRU number (n = 4*m)

Figure 4 PRU Structure

Table 3 shows the PRU configuration for each bandwidth.

Table 3 PRU Configuration

Parameter	Type 1	Type 2	Type 3	Type 4	Type 5	Type 6	Type 7
System Bandwidth [MHz]	2.5	5	10	10	20	20	20
Number of Subchannel	2	4	9	10	18	19	20
Total Number of PRU	8	16	36	40	72	76	80

For bandwidth of 10MHz and 20MHz, numbers of subchannels are selected as 9MHz and 18MHz, considering the existence of the guard band for the system.

In these OFDM symbols, data is modulated with following rates shown in Table 4 for the channel coding in downlink.

Table.4 OFDM DL Channel Coding downlink

Modulation	Coding rate R	Efficiency
BPSK	1 / 2	0.5
	2 / 3	0.67
QPSK	1 / 2	1
	3 / 4	1.5
16QAM	1 / 2	2
	3 / 4	3
64QAM	4 / 6	4
	5 / 6	5
256QAM	6 / 8	6
	7 / 8	7

Figure 5 shows the downlink data channel of OFDM frame structure in one PRU.

They are consisted to contain 456 symbols. The composition of these symbols for data frame, which is used to convey the data, is shown in Table.5.

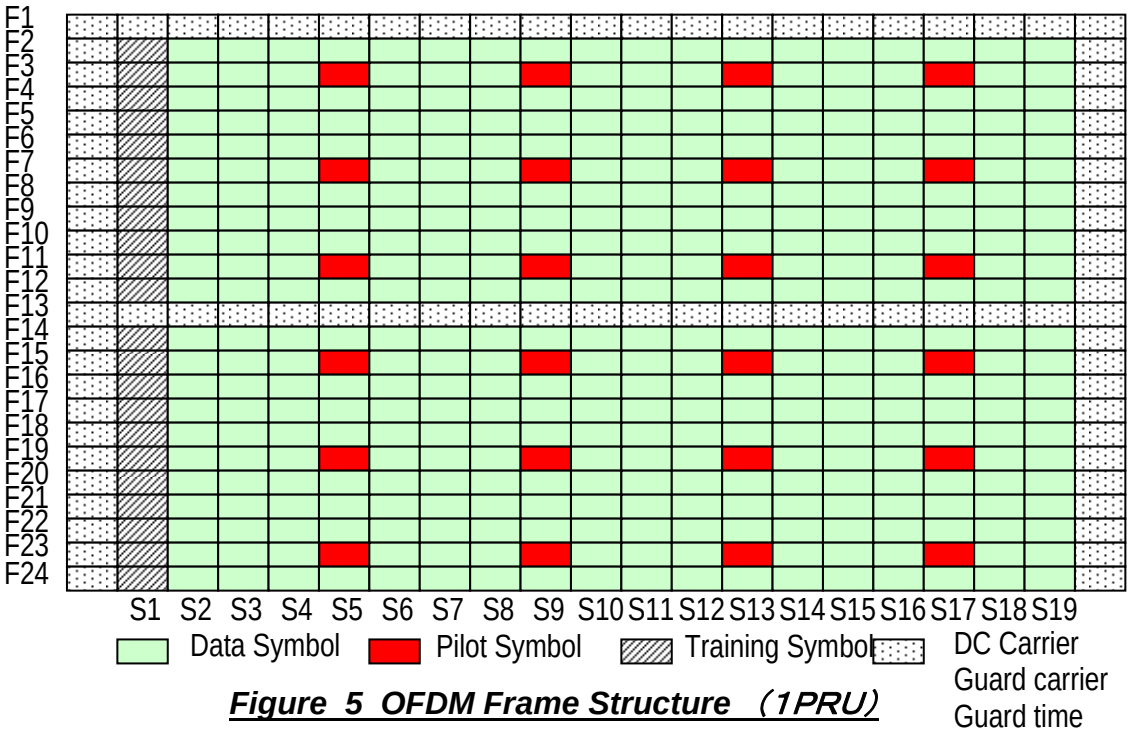


Figure 5 OFDM Frame Structure （1PRU）

Table 5 The Composition of Data Frame

Symbol Name	Number of Symbols
Data Symbol	372
Training Symbol	22
Pilot Symbol	24
Null Symbol (DC Carrier, Guard Carrier)	38

When PRU is formatted on the PHY frame, the data throughput is calculated as follows.

Data Speed = (bit coding rate) * 372 * (Number of PRU) * (1/5ms)

In case of BPSK 1/2 in one PRU is as follows

1 * (1/2) * 372 * (1/5ms) = 37.2 kbps

In case of 256QAM 7/8 by 40 PRUs (10MHz) is as follows

8* (7/8) * 372 * 40 * (1/5ms) = 20.8 Mbps

In case of 256QAM 7/8 by 80 PRUs (20MHz) is as follows

8* (7/8) * 372 * 80 * (1/5ms) = 41.6 Mbps

Table 6. PHY frame data throughput (k b p s)

Modulation	Bit Symbol Efficiency		Type 1	Type 2	Type 3	Type 4	Type 5	Type 6	Type 7
		1 PRU	*8 PRU*	*16 PRU*	*36 PRU*	*40 PRU*	*72 PRU*	*76 PRU*	*80 PRU*
BPSK (1/2)	0.5	37.2	297	595	1339	1488	2678	2827	2976
QPSK (1/2)	1	74.4	595	1190	2678	2976	5356	5654	5952
QPSK (3/4)	1.5	111	892	1785	4017	4464	8035	8481	8928
16QAM (1/2)	2	148	1190	2380	5356	5952	10713	11308	11904
16QAM (3/4)	3	223	1785	3571	8035	8928	16070	16963	17856
64QAM (4/6)	4	297	2380	4761	10713	11904	21427	22617	23808
64QAM (5/6)	5	372	2976	5952	13392	14880	26784	28272	29760
256QAM (6/8)	6	446	3571	7142	16070	17856	32140	33926	35712
256QAM (7/8)	7	520	4166	8332	18748	20832	37497	39580	41664

3.3 High capacity for traffic density

XGP is mainly constructed as a micro cell system. The other mobile communication systems such as GSM, are constructed as macro cell system. The BS of macro cell system covers wider area, with traffic flow increase, the amount of terminals on each mobile station rises.. The more the users under one base station, the less frequency resource this base station can assign to each

user, which makes the speed of data transfer for each radio link deteriorate. On the other hand for the micro cell system, due to the relatively small coverage, the frequency resource, which is used in one BS can be re-used by the BS, which does not suffer the interference of this frequency. That enables the maintenance of high efficiency of frequency use and the maintenance of stable and high data speed for each user.

In addition, XGP has adopted adaptive antenna system and SDMA(space divided multiple access) to achieve higher spectrum efficiency. Further more, to provide the biggest possible capacity to deal with the high traffic in the wireless network, the IP network, which controlled by Optical access from BS, and high performance and high capacity GW for XGP are now developed.

3.4 Flexible Design and Location of Base Stations

XGP is based on micro cell system, and each base station assigns its own PRUs autonomously. This mechanism is called DCA, Dynamic Channel Assignment. As the BS continuously detects carrier sensing around and makes the candidate table for resource assignment, best PRU, which suffers least interference from surrounding BS, can be assigned by receiving a request for PRU from mobile station. This table is always refreshed and BS is always ready to automatically assign PRUs that can avoid interference. As far as BSis controlling such DCA system, the BS location planning is not necessary, which makes it more flexible on BS location design. After the location of a BS is fixed, to create circumstances for each BS best performance, its own setting design should be taken into consideration, such as its antenna setting, selection of antenna type, and etc.

3.5 Higher capability for mobility

Higher capability for mobility in XGP is achieved with the combination of several factors. One is the subcarrier spacing of OFDM parameter is selected as 37.5kHz , considering the signal interference at the movement of up to 300 km/h. The second is the directional and higher effective antenna system. When BS has to cover the railway or highway area, it has its radio area prolonged according to way of coverage. That makes less the frequent handover activities. The third is the seamless handover mechanism. A MS and BS in communication always continue to measure the connection quality by carrier sensing. When the condition of one PRU tends to deteriorate, the MS will request BS to hand over to another destination BS, while before the MS makes handover, radio connection information of source BS is transferred though network to destination BS. At this time, MS is connected with more than one links for continuous communication, communication data transferred simultaneously through plural BS. When hand-over is finished, the connection in network is switched to new connection, and data communications will be continued without any packet loss.

4 Other Major Techniques

1) Adaptive Antenna System

This is the technique to make adaptive beam forming from a BS to the MS by combining respective antenna power.

It is the technology that uses multiple antennas and combines received signals of each antenna adaptively to orient radio waves to desired directions to avoid influence of unnecessary radio waves and to send the most suitable radio waves to the specified terminal. With XGP that adopts the OFDMA/TDMA-TDD system, this technology can be effectively applied to both transmission and reception. It has the potential to increase XGP frequency efficiency and to make it possible to cover a wider area with lower cost. Figure 7 shows the image of coverage by Adaptive Antenna System.

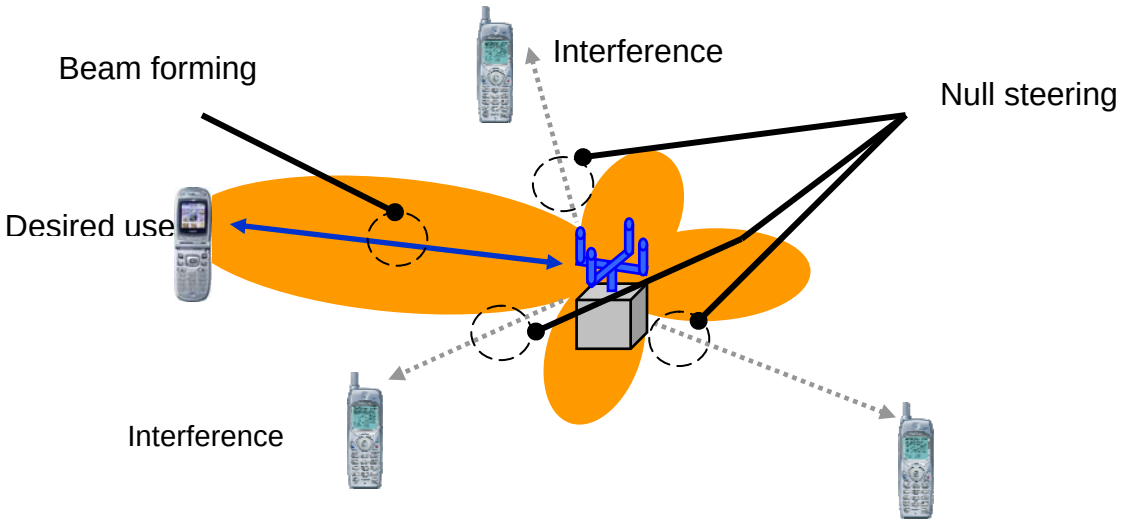


Figure 7 Adaptive Antenna System Control

2) MIMO

MIMO (Multiple Output and Multiple Input) is the system using several radio connections, such as multiple antennas to convey the data in parallel to make the data speed faster while avoid interference efficiently. This technique helps realize a faster data speed and more effective usage of frequency. According to the number of antenna, the development of 2 by 2 MIMO and 4 by 4 MIMO technique is planed .

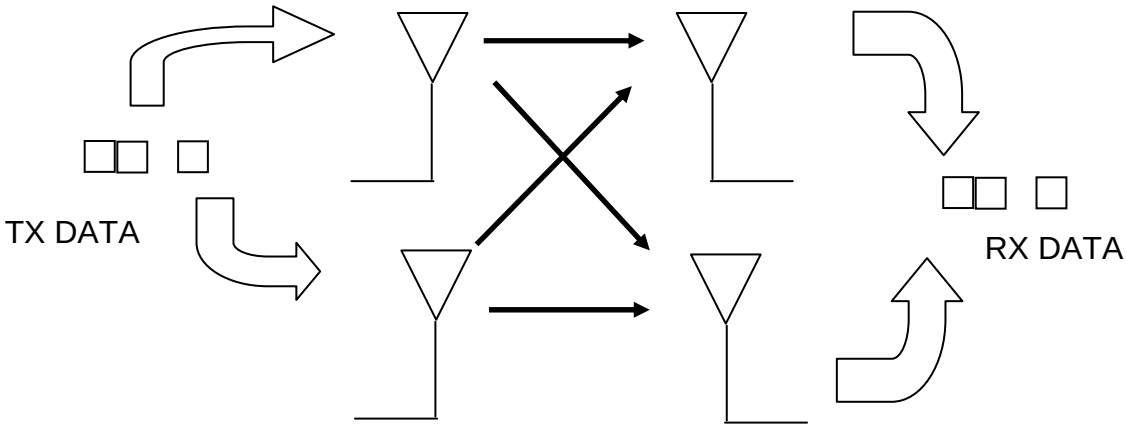


Figure 8 MIMO Control