DAFTAR PUSTAKA

[1] Massive MIMO in 5G Network, 2018, Long Zao, Hui Zao, Springer SpringerBriefs in Electrical and Computer Engineering

[2] Antenna Selection in Massive MIMO Using Non-Central Principal Component Analysis, 2016   
M. T. A. Rana 26th International Telecommunication Networks and Applications Conference (ITNAC)

[3] Energy and Spectral Efficiency of Very Large Multiuser MIMO Systems, Hien Quoc Ngo, Thomas L. Marzetta, IEEE TRANSACTIONS ON COMMUNICATIONS, VOL. 61, NO. 4, APRIL 2013

[4] Fundamentals of massive MIMO

[5] M. Sadeghi, C. Yuen, and Y. H. Chew, “Sum rate maximization for uplink distributed massive MIMO

systems with limited backhaul capacity,” inProc. IEEE Global Telecommun. Conf. (GLOBECOM), Austin,

TX, Dec. 2014.

[6] E. Bj¨ ornson, J. Hoydis, M. Kountouris, and M. Debbah, “Hardware impairments in large-scale MISO systems: Energy efciency, estimation, and capacity limits, ” in Proc. Signal Processing and Optimization for Green Energy and Green Communications (DSP'13), Santorini, Greece, 201

[7] Performance of Conjugate and Zero-Forcing, Beamforming in Large-Scale Antenna Systems, Hong Yang, Thomas L. Marzetta

[8] Massive MU-MIMO Downlink TDD Systems with Linear Precoding and Downlink Pilots, Hien Quoc Ngo, Thomas L. Marzetta , 2013

[9] Stutzman W. L. dan Gary A. Thiele, Antenna Theory and Design, New York: John Wiley & Sons, 2013.

Membangun sistem

Analisa sistem Massive MIMO

Studi latar belakang

penelitian

Membangun sistem pemancar

Analisa pengaruh estimasi CSI terhadap kinerja sistem

Menentukan kanal yang digunakan

Perkembangan Teknologi 5G

Studi literatur

Analisa pengaruh pengaruh penambahan jumlah antena terhadap kinerja sistem

*Massive MIMO* dapat mendukung perkembangan 5G

Membangun sistem penerima

Analisa efisiensi spektrum pada sistem *Massive MIMO*

Penambahan jumlah elemen *array* dapat meningkatkan kapasitas

Menetukan parameter sistem

Analisa Efisiensi SpektrumSistem Multi User Massive MIMO Sel Tunggal Pada Kanal Rayleigh dan Random Line

of Sight

Penulisan laporan

Simulasi efisiensi spektrumsistem *Massive MIMO*

Studi literatur estimasi CSI

Pembuatan *draft paper*

Simulasi deteksi sinyal pada tiap user

Studi literatur teknik transmisi *downlink Massive MIMO*

Mengumpulkan data hasil simulasi dan Analisa hasil simulasi

Simulasi transmisi sinyal skema *downlink*

Studi literatur proses deteksi *Massive MIMO*

Simulasi *precoding* dengan *Zero Forcing*

Simulasi estimasi CSI dengan *uplink training* pilot

Proses publikasi

Simulasi sistem Massive MIMO

**Estimasi CSI**

**BTS**

**User**

**Transmisi**

Channel Estimation

Channel Estimation

Sinyal pilot diterima

Orthogonal pilot

**User**

**BTS**

**W**

**H**

**Kanal**

Data

stream

Decoding

Modulasi QAM

Decoding

OFDM

Precoding

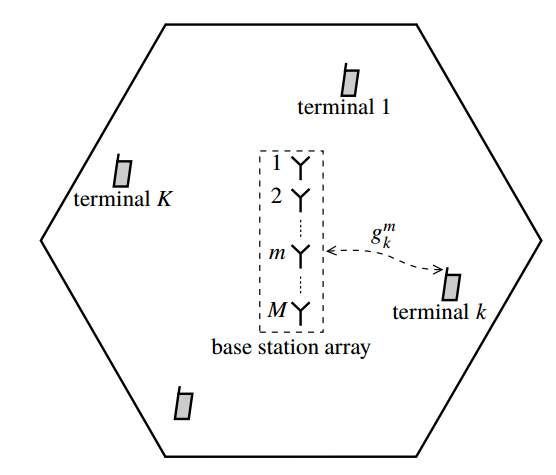
|  |  |  |  |
| --- | --- | --- | --- |
| Uplink data | Uplink pilot | Downlink pilot | Downlink data |

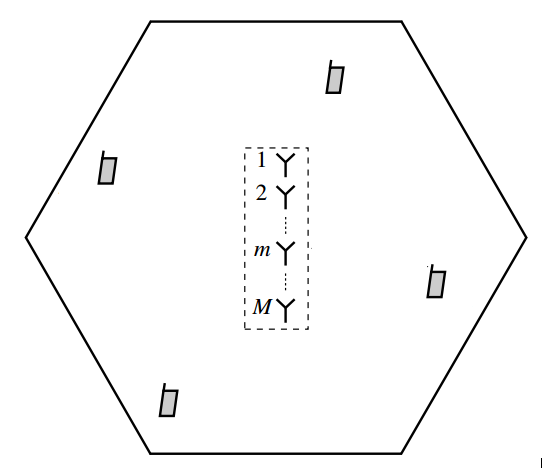
1. Dengan downlink pilot

|  |  |  |
| --- | --- | --- |
| Uplink data | Uplink pilot | Downlink data |

1. Tanpa downlink pilot

asa





**User K**

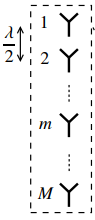
**User 3**

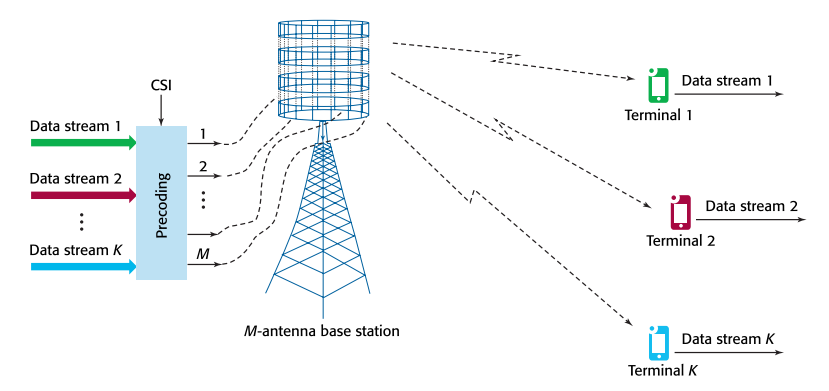
**User 2**

**User 1**

**BTS**







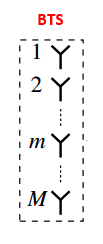
BTS dengan M-antena

User 3

User 2

User 1

**Orthogonal** **pilot**



Estimasi Kanal

*Mean Square Error* (MSE)

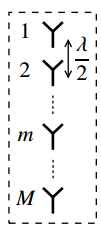
Sinyal pilot diterima



|  |  |
| --- | --- |
| Parameter | Urban |
| Frekuensi Carrier | 30GHz |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |







**BTS Arr**

User 1



User k

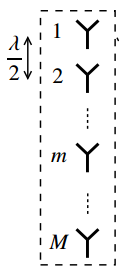




User K



**User 1**



**BTS Array**

**User k**



**User K**

|  |  |
| --- | --- |
| Parameter | Suburban area |
| Frekuensi carrier | 30GHz |
| Spectral bandwidth | 20MHz |
| Jumlah Antena BTS | 100 antena |
| Jumlah user | 5 user |
| Gain antenna BTS | 0dBi |
| Gain antenna terminal | 0dBi |
| Noise figure BTS | 9dB |
| Noise figure perangkat user | 9dB |
| Temperatur perangkat user | 300K |
| Kecepatan mobitilas user | 284km/ha |
| Daya radias BTS | 1W |
| Daya radiasi perangkat user | 200Mw |

|  |  |
| --- | --- |
|  | **Subcarrier ke-Ns** |
|  | **……………** |
| **Cyclic prefix** |  |
|  |  |
|  |  |
|  |  |
|  | **……………** |
|  | **Subcarrier ke-2** |
|  | **Subcarrier ke-1** |

**Frequency**

**Bo = Ns BS**

**Ns subcarrier**

**Bs**

**Tcp**

**Tu**

**Time**

**Ts**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

**Jumlah sampel data (Ns)**

**Cyclic**

**prefix**

**Tu**

**Tg**

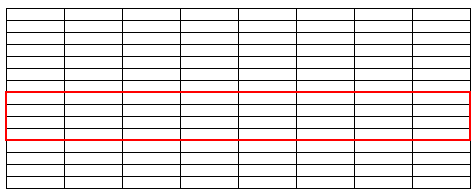
**Time**

**Nslot simbol OFDM**

**Coherence interval**

**Frekuensi**

**Nsmooth subcarriers**



**BC**

**Bs**

**Ts**

**Tslot**

**Waktu**

Studi literatur sistem komunikasi Massive MIMO

Membangun sistem Massive MIMO

Simulasi

Analisa

Publikasi dan laporan

**Kanal**

**Transmitter**

Data

stream

Modulasi QAM

Precoding

OFDM

(IFFT)

**Receiver**

Zero Forcing Detector

QAM

Demod

OFDM

(FFT)

Modulasi QAM

Add CP

Invers

FFT

Precoding

Remove CP

FFT

Detector

Demodulasi QAM

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No** | **Kegiatan** | **Semester 1** | | | | | | | | | **Semester 2** | | | | | | **Semester 3** | | | | | | |
| **1** | **2** | | **3** | **4** | **5** | **6** | | **1** | | **2** | **3** | **4** | **5** | **6** | | **1** | **2** | **3** | **4** | **5** | **6** |
| 1 | Studi Literatur |  |  | |  |  |  |  | |  | |  |  |  |  |  | |  |  |  |  |  |  |
| 2 | Membangun sistem pemancar |  |  | |  |  |  |  | |  | |  |  |  |  |  | |  |  |  |  |  |  |
| 3 | Membangun scenario model kanal |  |  | |  |  |  |  | |  | |  |  |  |  |  | |  |  |  |  |  |  |
| 4 | Membangun sistem penerima |  |  | |  |  |  |  | |  | |  |  |  |  |  | |  |  |  |  |  |  |
| 5 | Simulasi pembangkitan kanal |  |  | |  |  |  |  | |  | |  |  |  |  |  | |  |  |  |  |  |  |
| 6 | Simulasi estimasi CSI dengan jumlah user skala kecil |  |  | |  |  |  |  | |  | |  |  |  |  |  | |  |  |  |  |  |  |
| 7 | Simulasi transmisi dengan elemen array skala kecil |  |  | |  |  |  |  | |  | |  |  |  |  |  | |  |  |  |  |  |  |
| **U J I A N P R O P O S A L** | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | Simulasi estimasi CSI dengan jumlah elemen array massive |  | |  |  |  |  |  |  | | |  |  |  |  |  | |  |  |  |  |  |  |
| 7 | Simulasi pembangkitan data dan multiplexing OFDM |  | |  |  |  |  |  |  | | |  |  |  |  |  | |  |  |  |  |  |  |
| 8 | Simulasi transmisi dengan kanal Rayleigh |  | |  |  |  |  |  |  | | |  |  |  |  |  | |  |  |  |  |  |  |
| 9 | Simulasi transmisi dengan kanal random LOS |  | |  |  |  |  |  |  | | |  |  |  |  |  | |  |  |  |  |  |  |
| 10 | Simulasi proses decoding di receiver |  | |  |  |  |  |  |  | | |  |  |  |  |  | |  |  |  |  |  |  |
| 11 | Analisa |  | |  |  |  |  |  |  | | |  |  |  |  |  | |  |  |  |  |  |  |
| 12 | Penulisan paper |  | |  |  |  |  |  |  | | |  |  |  |  |  | |  |  |  |  |  |  |
| 13 | Penulisan thesis |  | |  |  |  |  |  |  | | |  |  |  |  |  | |  |  |  |  |  |  |
| **U J I A N T E S I S** | | | | | | | | | | | | | | | | | | | | | | | |

OFDM

User melakukan decoding

BTS mentransmisikan sinyal ke user

BTS membangkitkan data untuk masing-masing user

BTS membentuk precoding matrix

BTS mengestimasi kanal melalui sinyal pilot yang diterima

User mentransmisikan pilot ke BTS

**S**

**I**

**M**

**U**

**L**

**A**

**S**

**I**