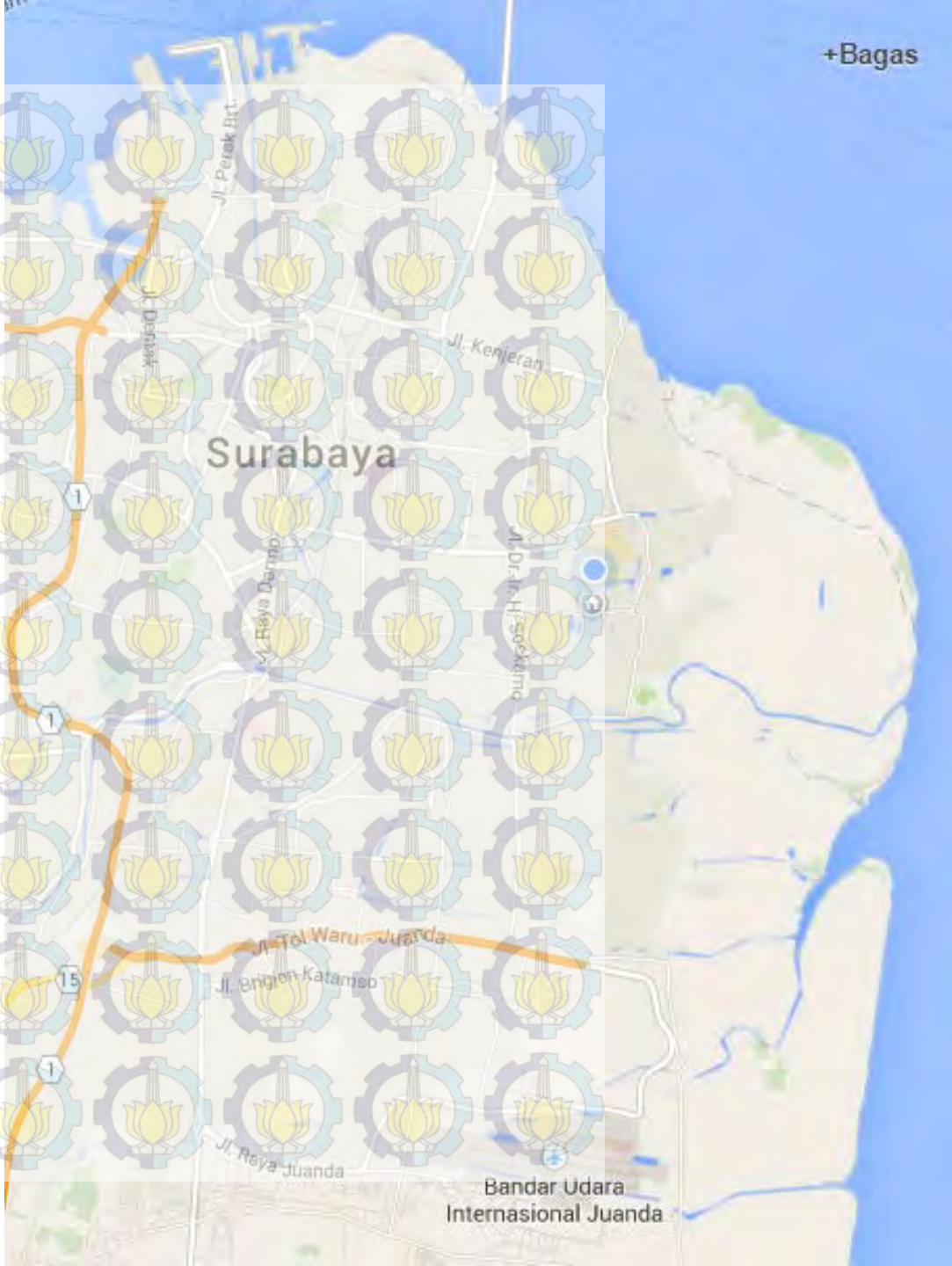
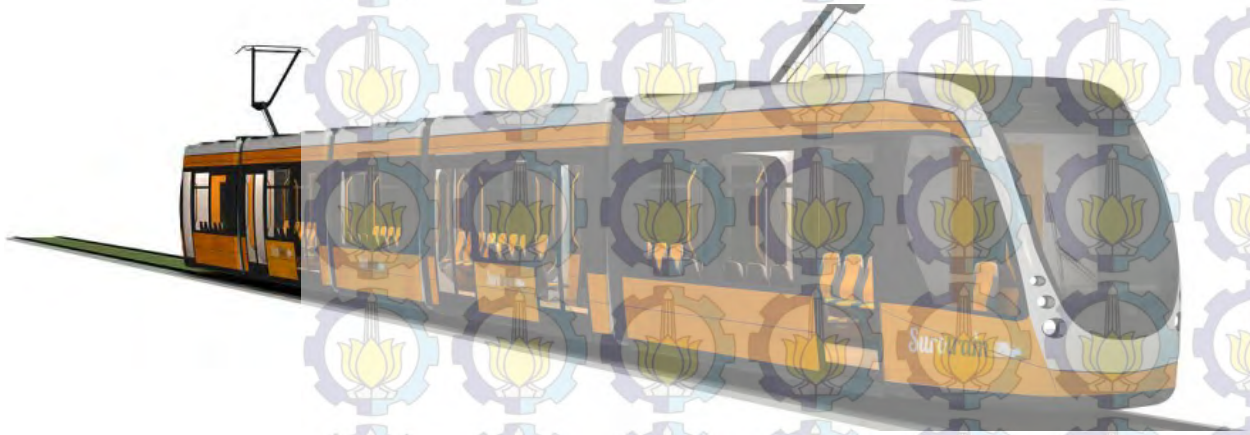
ANALISA PERANCANGAN BTS HOTEL PADA *MASS RAPID TRANSIT* DI SURABAYA

BAGAS **PRASETYA** PUTRA 2210100018

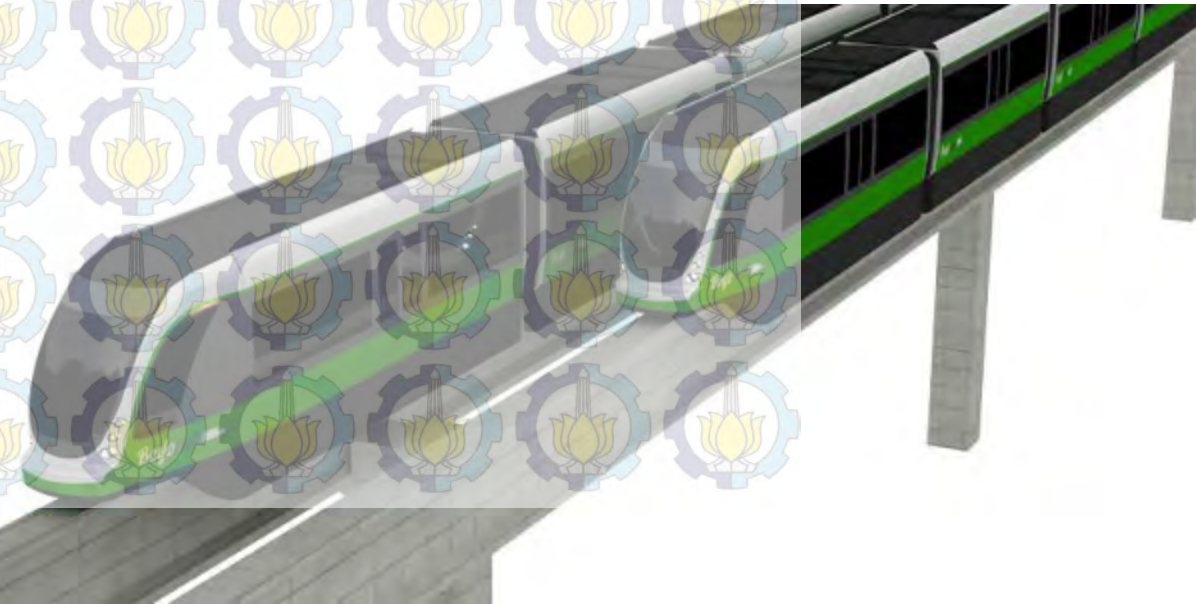
Dosen Pembimbing:
Dr. Istas Pratomo, ST., MT.
Ir. Gatot Kusrahardjo, MT.

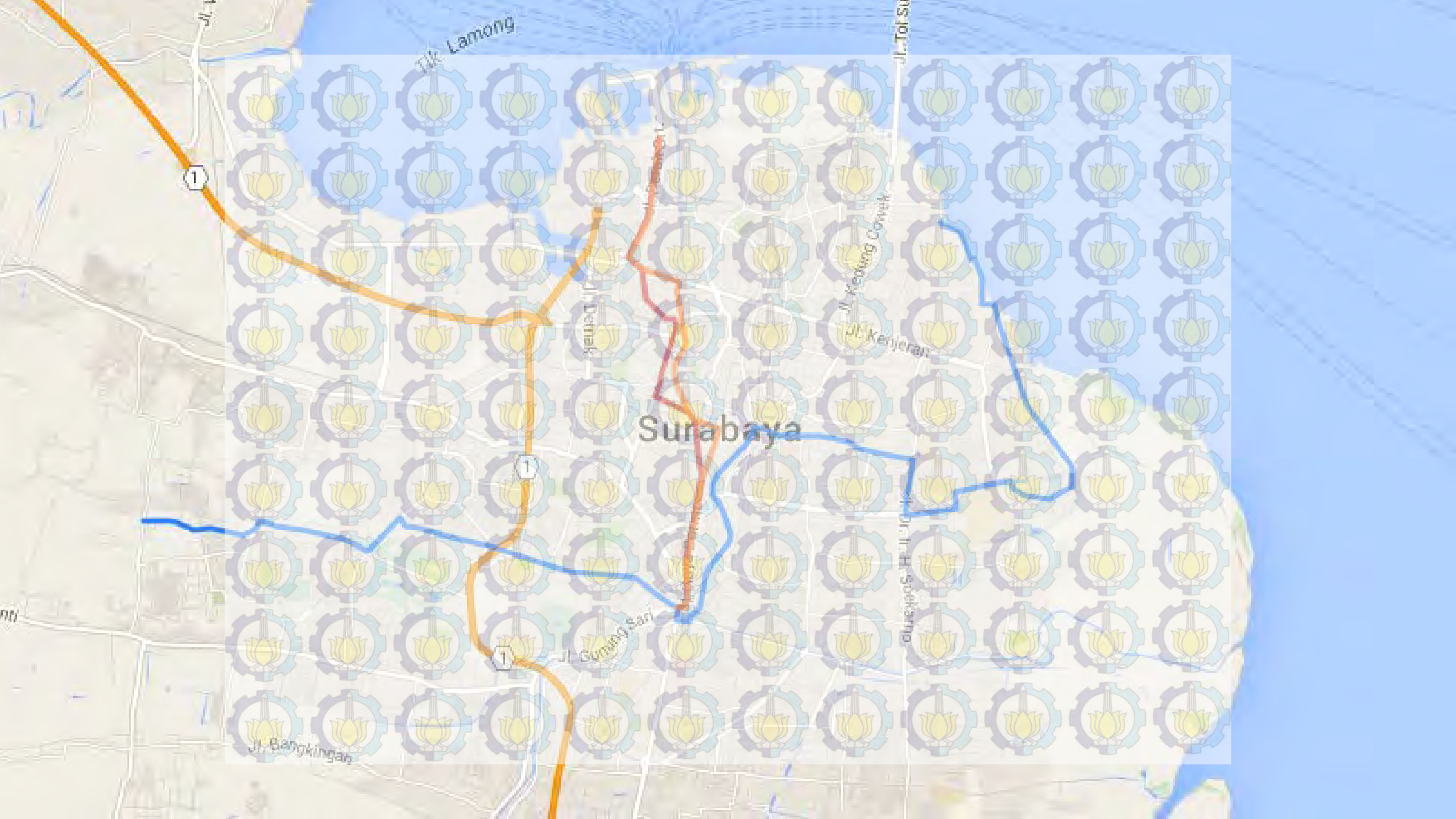




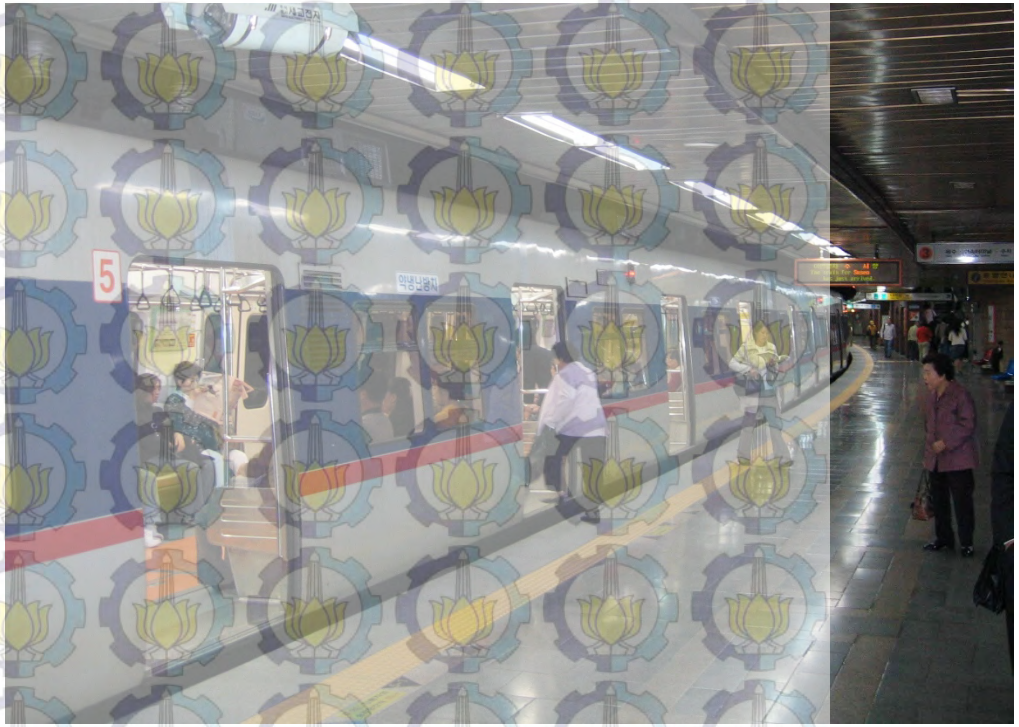
Surotrain

Boyorail

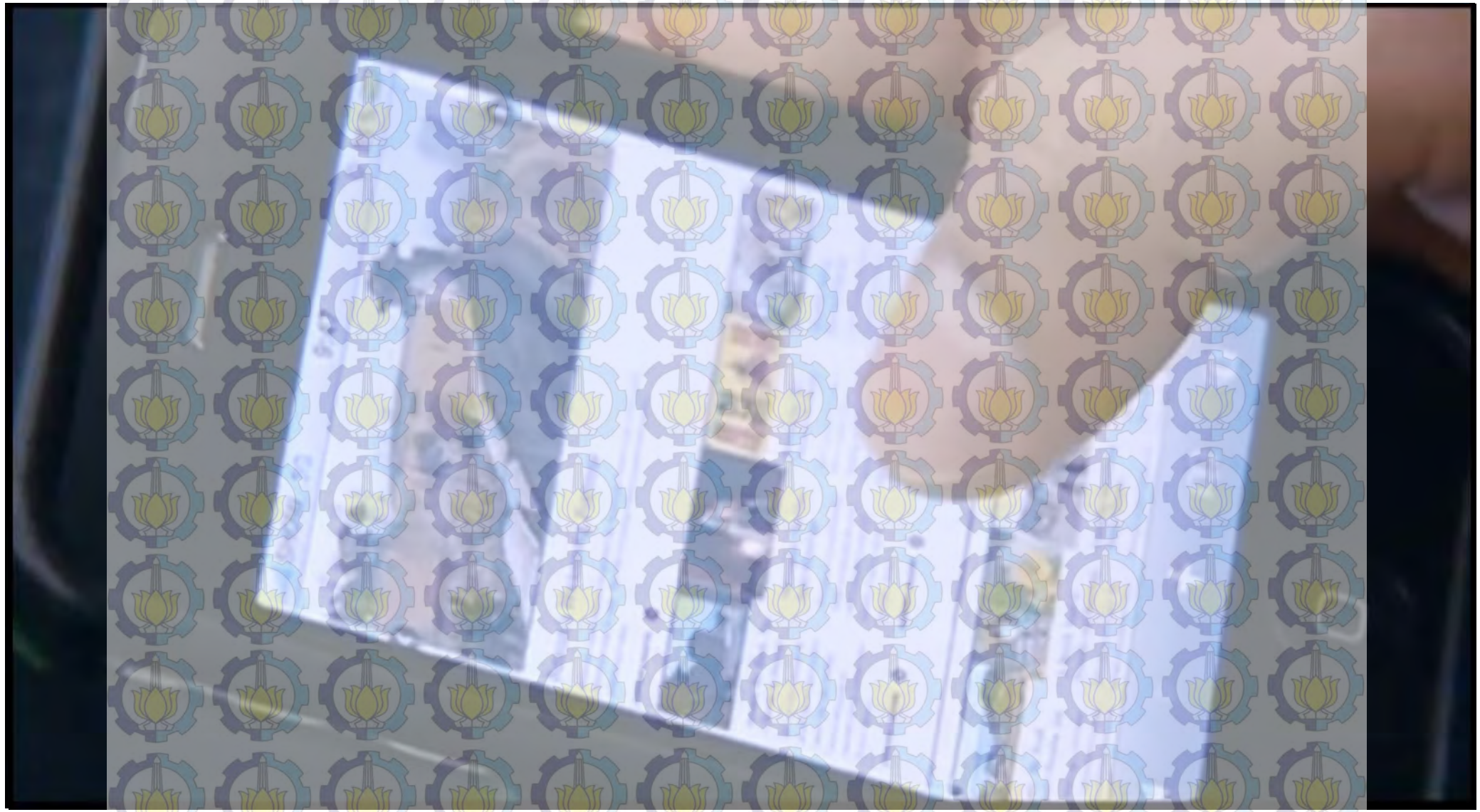


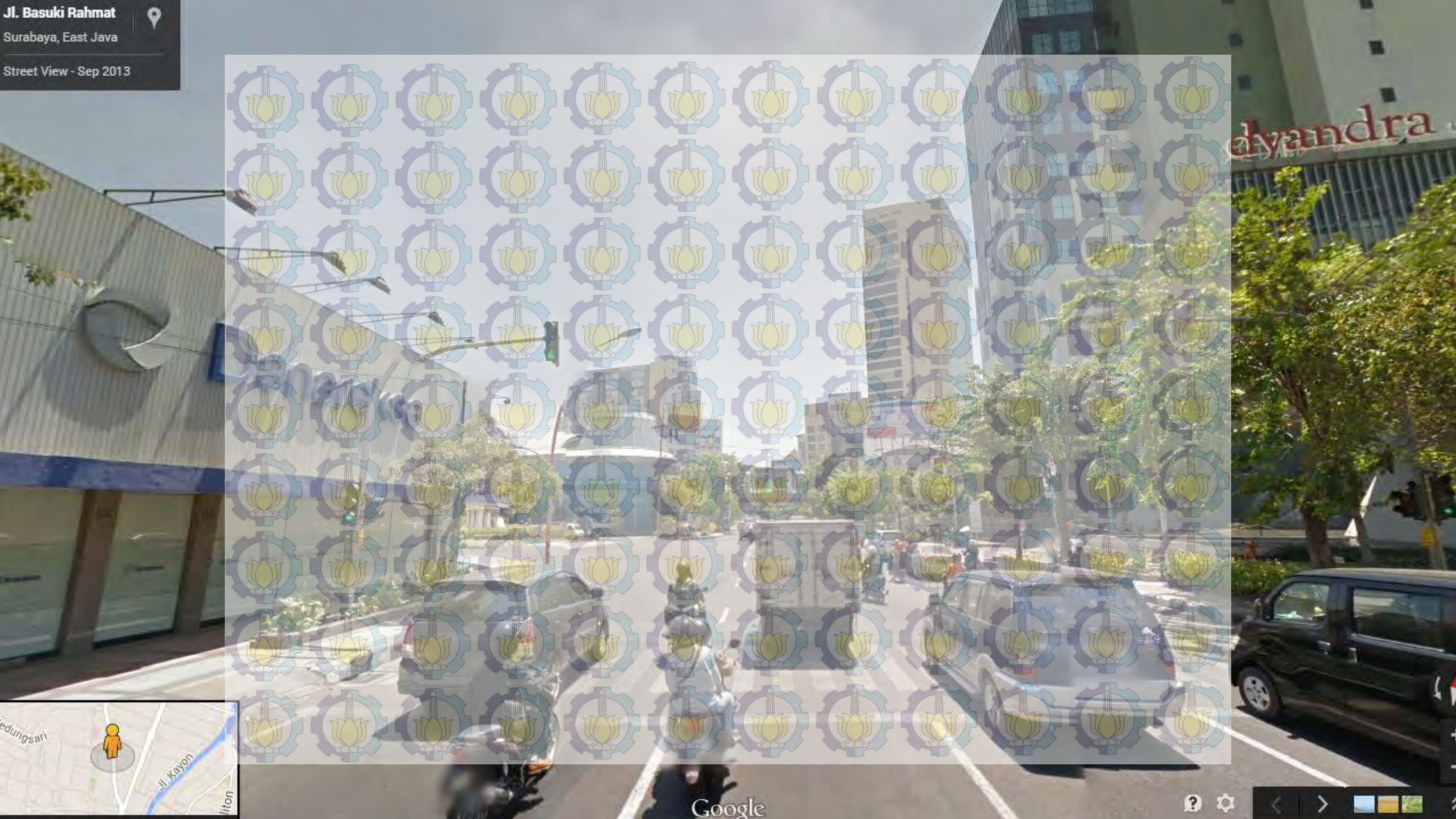

Jl. Lamong
Jl. Tol Surabaya
Jl. Kedung Cowek
Jl. Kenjeran
Jl. Jemursari
Jl. Gunung Sari
Jl. Bangkingan
Surabaya
1
1
1

Light Rapid Transit
Singapore



Seoul Subway
Korea Selatan




Jl. Basuki Rahmat
Surabaya, East Java
Street View - Sep 2013
dyandra
Jl. Kayon
Google

Tabel 1

Data Menara Telekomunikasi di Surabaya

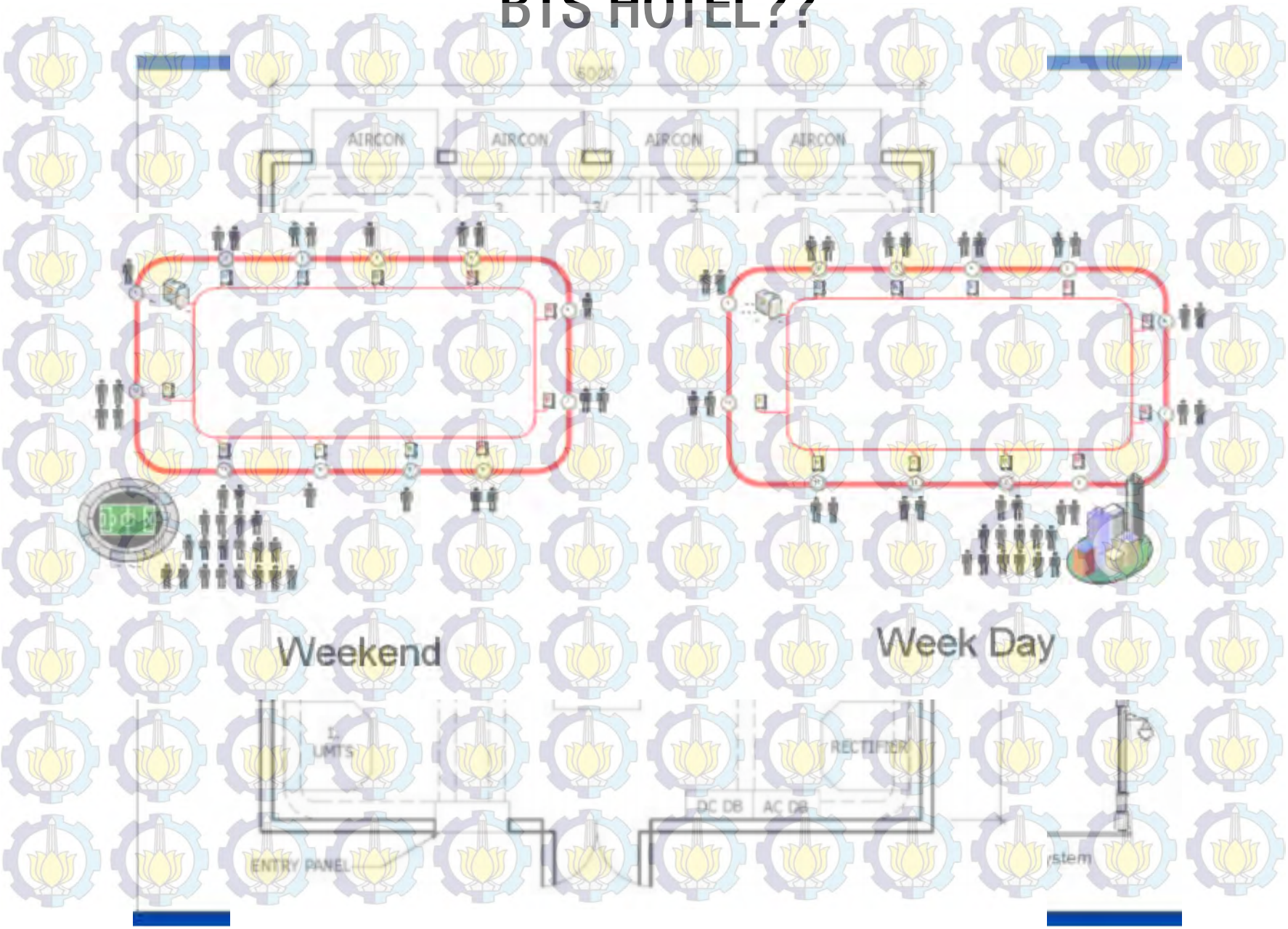
No	Type Menara	Jumlah
1.	Menara Green Field	455
2.	Menara Roof Top	398
3.	Menara Combat	4
	T O T A L	**857**

Tabel 2

Jumlah BTS yang Dimiliki Telco Operator

No.	Operator Telekomunikasi	Nama Singkat	Jumlah
1.	PT. Telekomunikasi Selular	Tsel	171
2.	PT. Indonesia Satelit Corporation	Isat	148
3.	PT. XL Axiata	XL	143
4.	PT. Hutchinson C.P Telecommunication	HCPT	136
5.	PT. Mobile-8 Telecom	Mob-8	34
6.	PT. Bakrie Telecom	Esia	141
7.	PT. Natrindo telepon Selular	NTS	161
8.	PT. Smart Telecom	Smart	68
9.	PT. Sampoerna Telekomunikasi Indonesia	STI	5
10.	PT. Telekomunikasi Indonesia	Flexi	189
11.	Noname		11
	T O T A L		**1207**

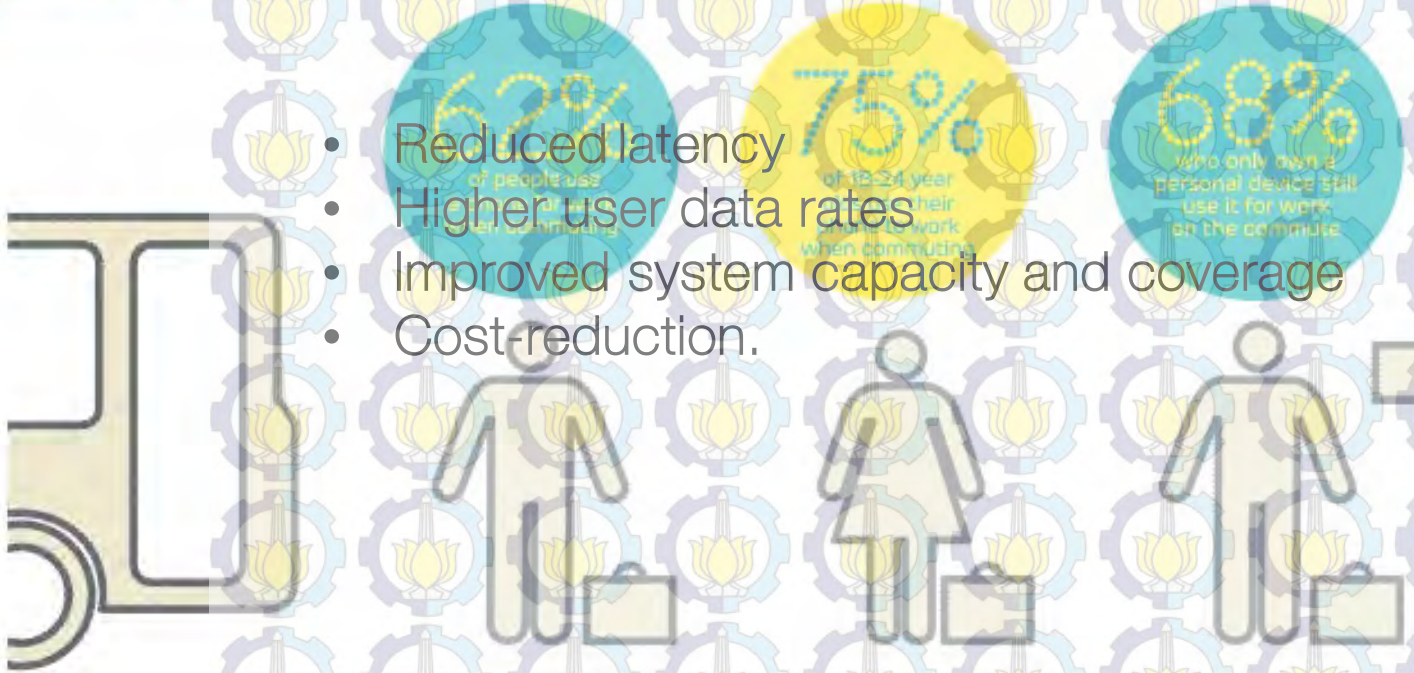
BTS HOTEL??


AIRCON
AIRCON
AIRCON
AIRCON
Weekend
Week Day
UMTS
RECTIFIER
DC DB
AC DB
ENTRY PANEL

THE FIRST COMMERCIAL MOBILE 4G LTE IN INDONESIA

TELKOMSEL 4G LTE

Consumers are using their personal phones to work while commuting



- Reduced latency
- Higher user data rates
- Improved system capacity and coverage
- Cost-reduction.

4G LTE

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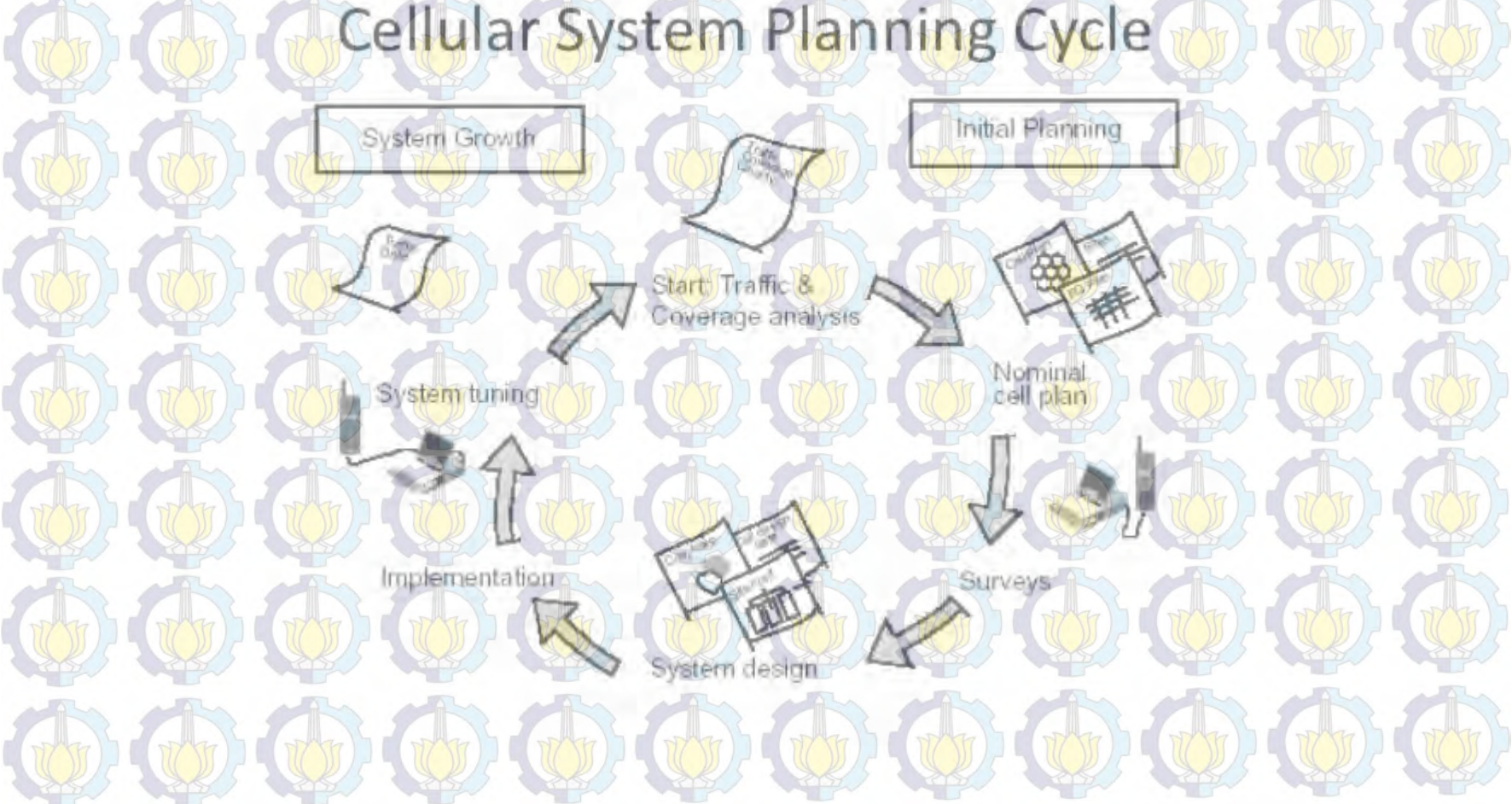
Cellular System Planning Cycle
System Growth
Initial Planning
Start: Traffic & Coverage analysis
Nominal cell plan
System tuning
Surveys
Implementation
System design

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Batasan Masalah

Cellular Planning

- Dimensioning
- Traffic Forecasting
- Capacity Planning
- Coverage Planning
- Link Budget

LTE 900 MHz dan 1800 MHz

- BTS Hotel
- Jaringan Fiber Optik

Deployment Planning

- Design Criteria
- Technology Considerations
- Frequency Bands
- Core Design
- RF Design – RAN
- Backhaul Considerations
- Bandwidth Efficiency
- Investment/Pricing Models
- Businesses Consideration
- Ecosystem Deployment

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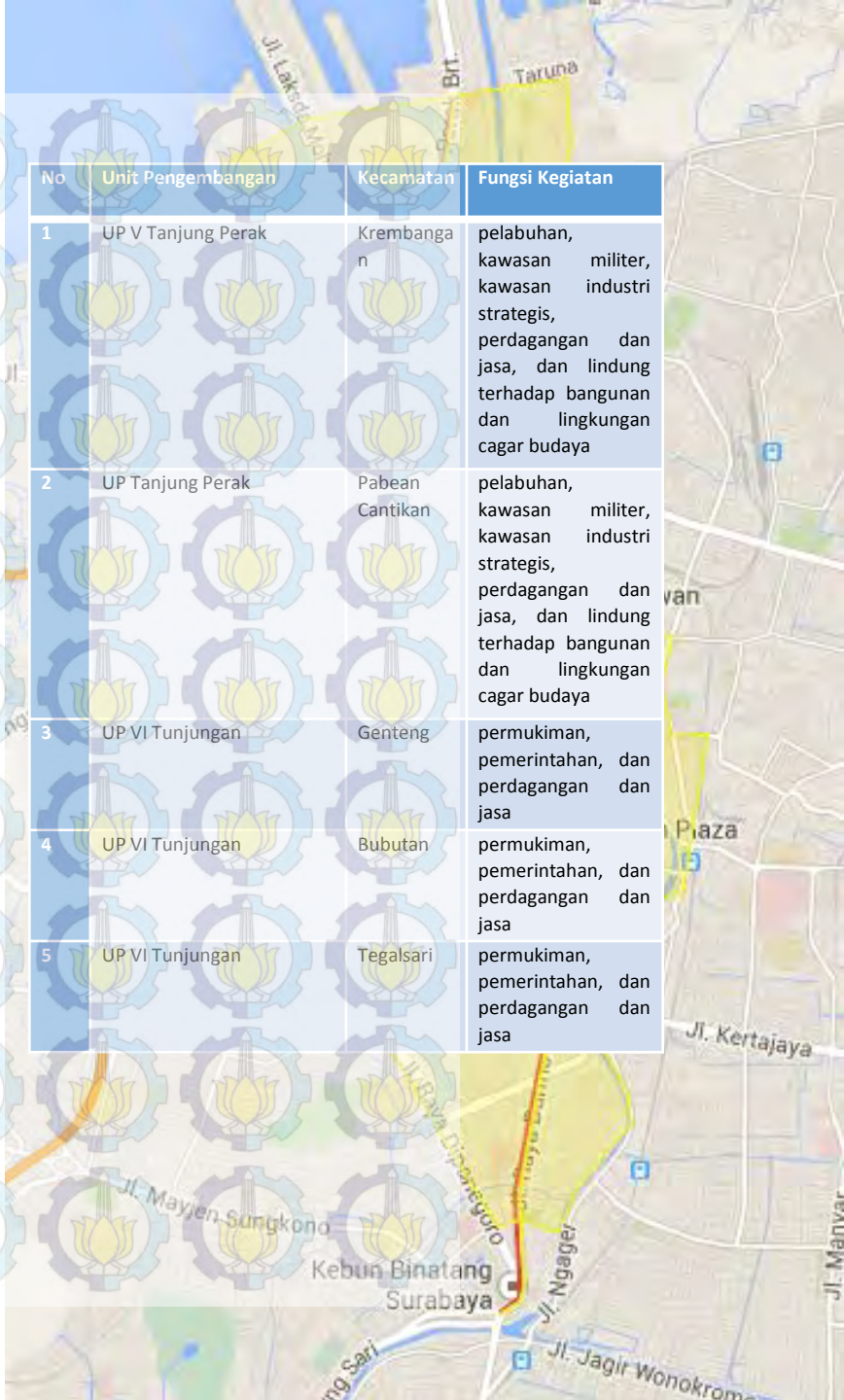
Jalur Tram

- Gerbangkertosusila, kawasan metropolitan yang mencakup 7 wilayah administrasi
- Kawasan Strategis Ekonomi
- Pusat Perdagangan Jasa
- Kawasan Transportasi Terpadu

RTRW Kota Surabaya 2029

- Pemerintahan
- Kawasan Militer
- Perdagangan dan Jasa
- Kawasan industri strategis
- Bangunan dan Lingkungan Cagar Budaya
- Pemukiman

No	Unit Pengembangan	Kecamatan	Fungsi Kegiatan
1	UP V Tanjung Perak	Krembangan	pelabuhan, kawasan militer, kawasan industri strategis, perdagangan dan jasa, dan lindung terhadap bangunan dan lingkungan cagar budaya
2	UP Tanjung Perak	Pabean Cantikan	pelabuhan, kawasan militer, kawasan industri strategis, perdagangan dan jasa, dan lindung terhadap bangunan dan lingkungan cagar budaya
3	UP VI Tunjungan	Genteng	permukiman, pemerintahan, dan perdagangan dan jasa
4	UP VI Tunjungan	Bubutan	permukiman, pemerintahan, dan perdagangan dan jasa
5	UP VI Tunjungan	Tegalsari	permukiman, pemerintahan, dan perdagangan dan jasa



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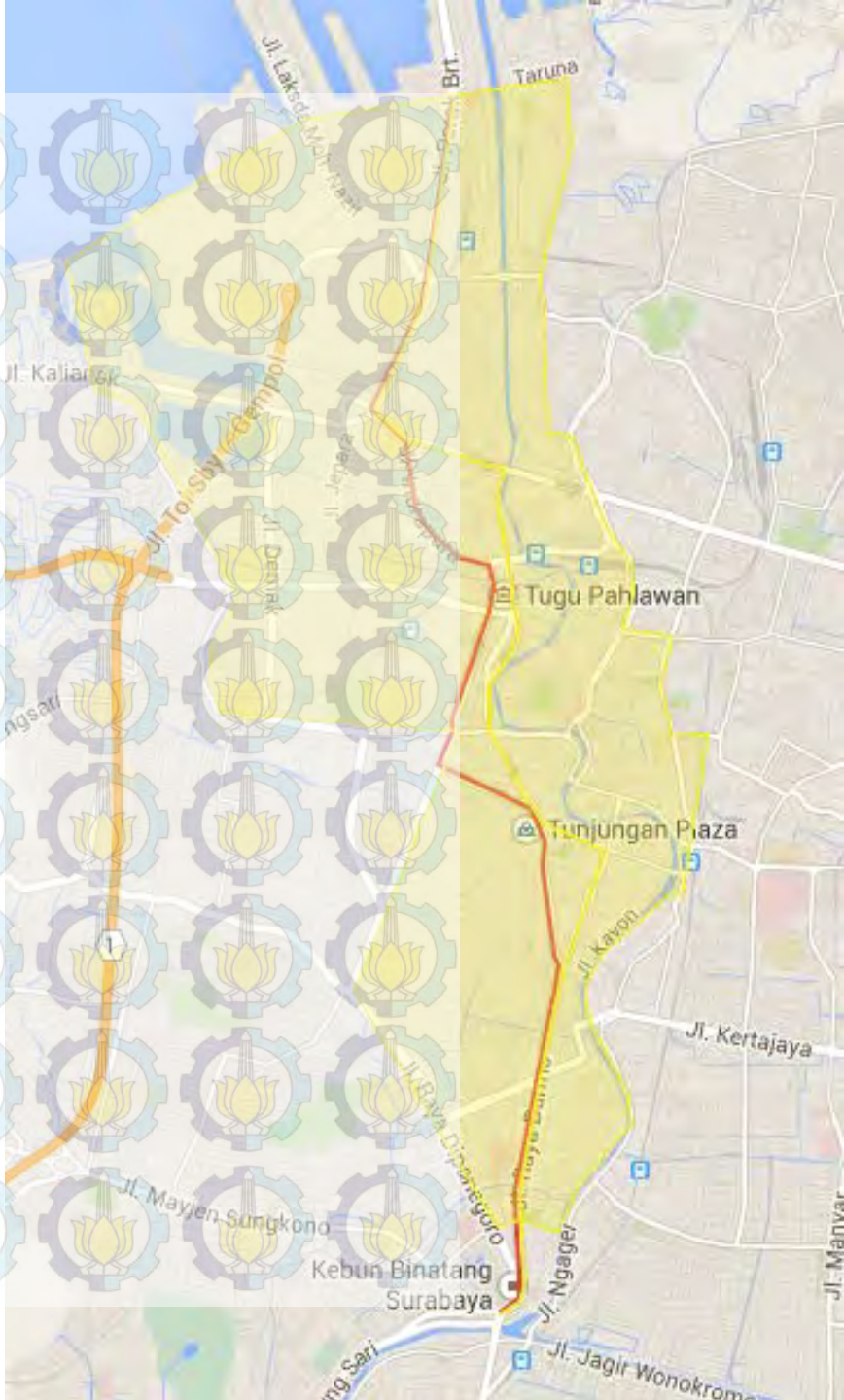
Traffic Forecasting

Kecamatan	Luas Kecamatan (km^2)	Kepadatan Penduduk (Jiwa/km^2)	Jumlah Penduduk (Jiwa)
Tegalsari	4,29	21.787	93.465
Genteng	4,04	13.491	50.505
Bubutan	3,86	22.768	87.882
Krembangan	8,34	13.730	114.506
Pabean Cantikan	6,8	10.698	72.744
Total Luas	27,33	Total Penduduk	419.102

a. Laju pertumbuhan penduduk kota Surabaya : 0,63 %
b. Presentase penduduk produktif (15 – 64 tahun) : 72,11 %
c. Asumsi Penetrasi Seluler : 70 %
d. Asumsi Penetrasi Pengguna Operator A : 40 %
e. Asumsi Penetrasi Pengguna Operator A LTE : 30 %
f. Asumsi pertumbuhan penduduk hingga tahun 2020

$$Un = Uo\,(1 + fp)^n$$



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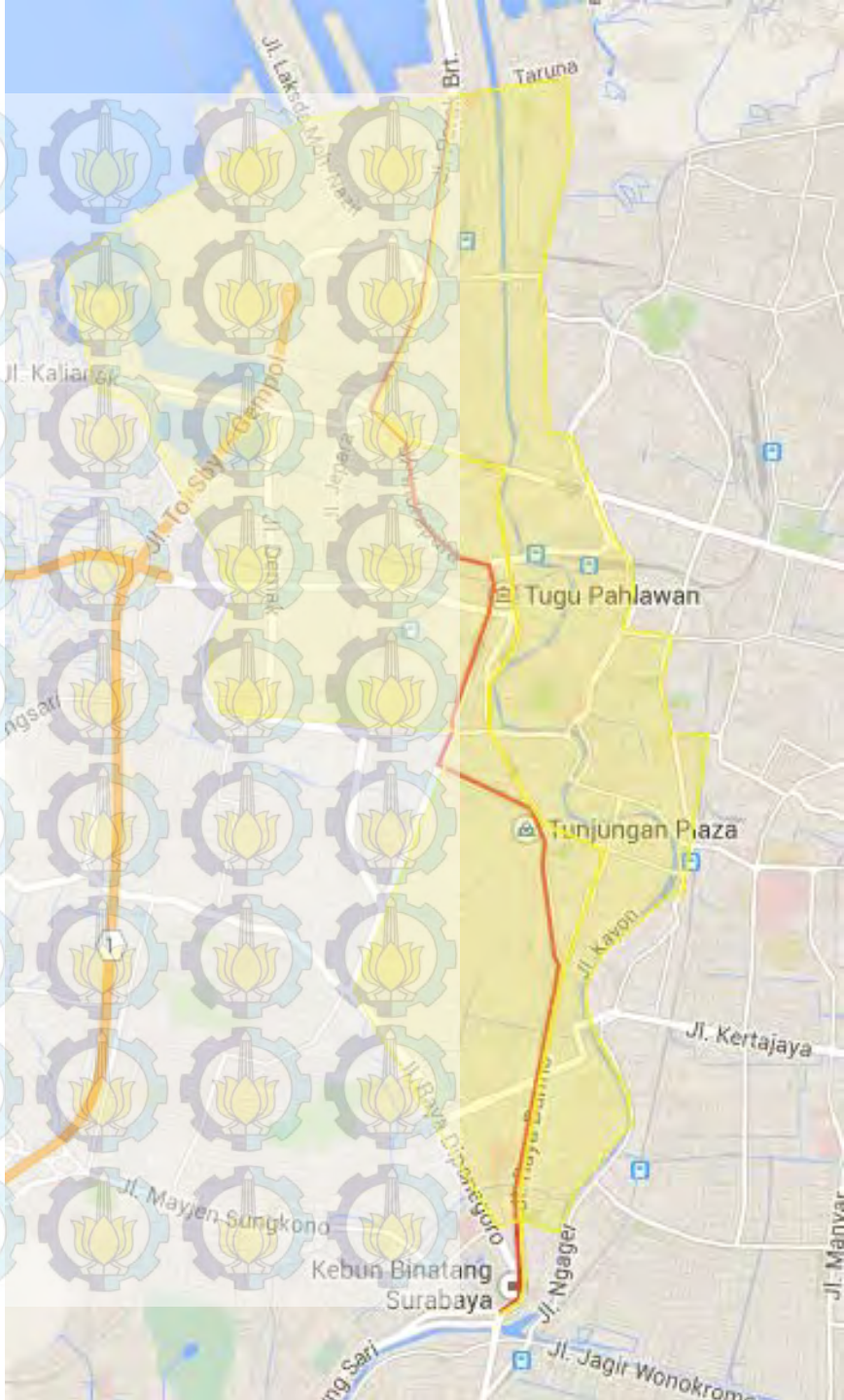
Traffic Forecasting

Kecamatan	Penduduk Produktif	Pengguna Operator A	Pengguna Operator A LTE	Kepadatan Pengguna (Jiwa/km^2)
Tegalsari	69985.70503	22395.42561	6718.627683	1566.113679
Genteng	37817.66471	12101.65271	3630.495813	898.6375774
Bubutan	65805.20761	21057.66644	6317.299931	1636.6062
Krembangan	85741.00615	27437.12197	8231.136591	986.9468334
Pabean Cantikan	54470.01687	17430.4054	5229.12162	768.9884735
			Total	1061.565584



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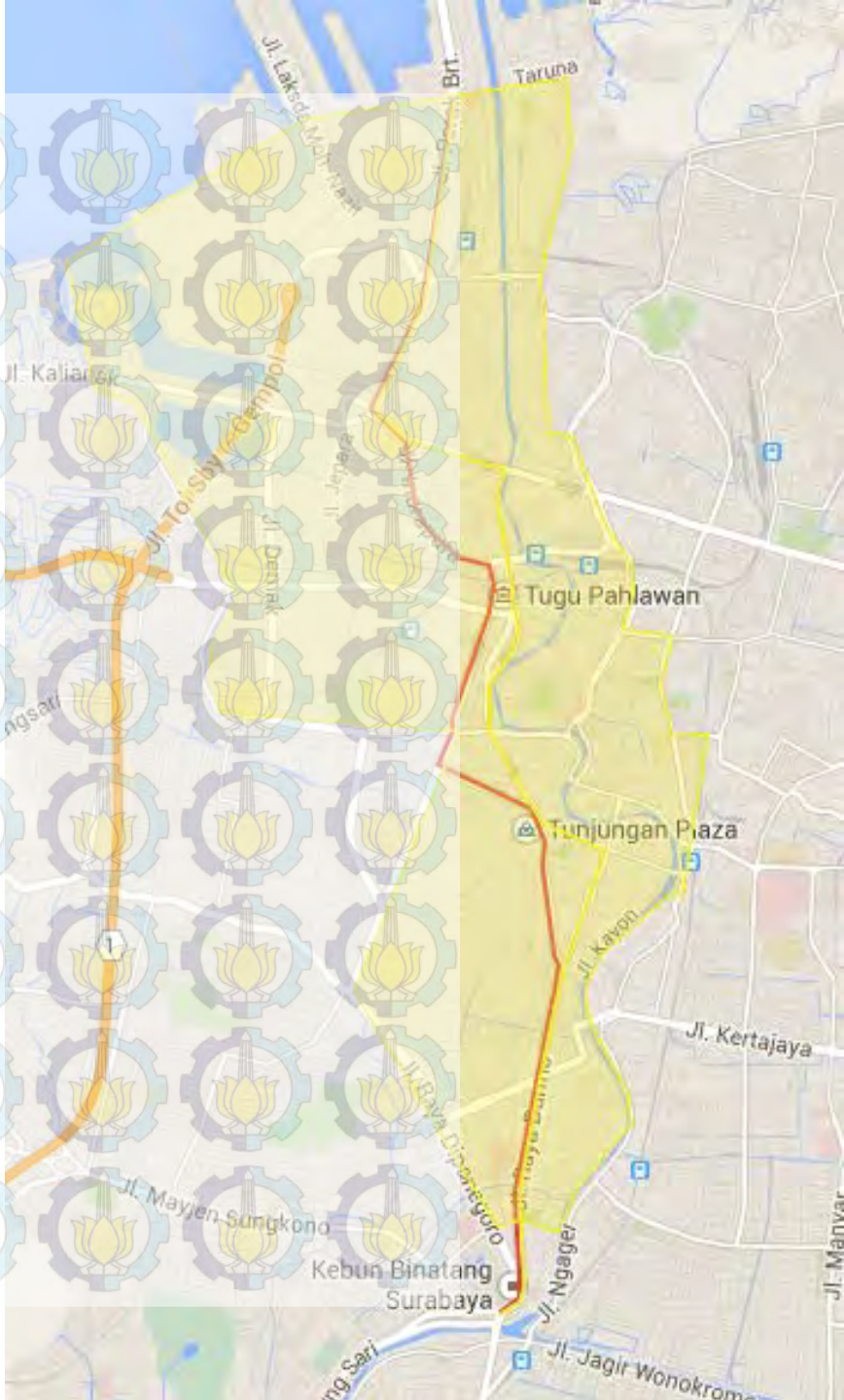
Capacity Planning - OBQ

	OBQ		
Service Type	Building	Pedestrian	Vehicular
S	386.2564671	343.3390819	171.6695409
SM	3.08652428	1.54326214	1.028841427
SD	79.48534909	79.48534909	79.48534909
MM	1225.791071	980.6328571	19.61265714
HMM	7344.274292	2937.709717	391.6946289
HIMM	176.372816	88.18640801	141.0982528
Total OBQ	14450.75247 Kbps / Km^2		

Total OBQ =	14450.75247	Kbps/Km^2
=	14.45	Mbps/Km^2



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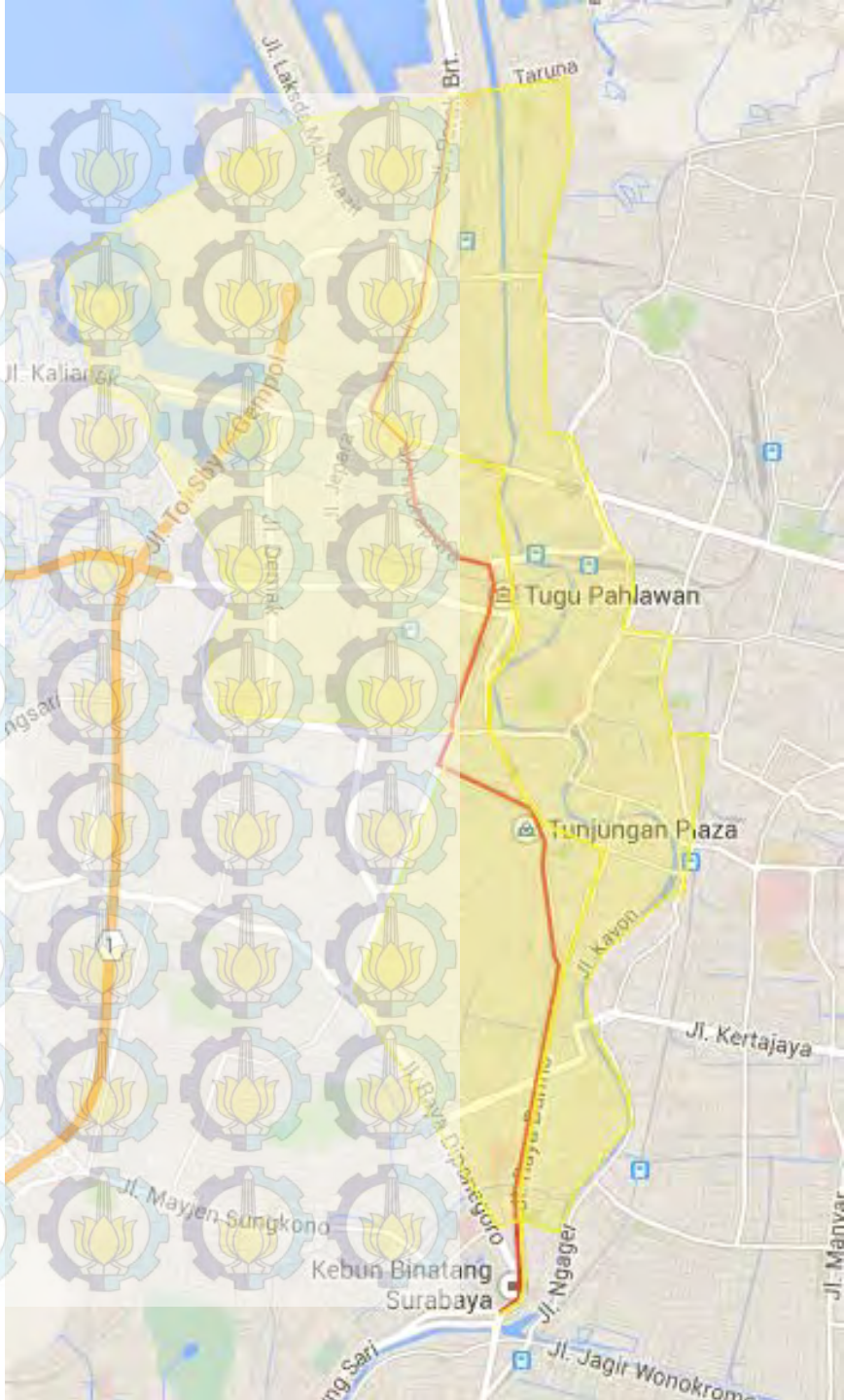
Capacity Planning – Kapasitas Sel

	Channel Bandwidth	1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz
Normal Cyclic Prefix	Resource Blocks in the frequency domain	6	15	25	50	75	100
	OFDMA symbols per 1 ms	7					
	Modulation symbol rate (Msps)	1.0	2.5	4.2	8.4	12.6	16.8
	QPSK Bit Rate (Mbps)	2.0	5.0	8.4	16.8	25.2	33.6
	16QAM Bit Rate (Mbps)	4.0	10.1	16.8	33.6	50.4	67.2
	64QAM Bit Rate (Mbps)	6.1	15.1	25.2	50.4	75.6	100.8
	2×2 MIMO 64QAM Bit Rate (Mbps)	12.1	30.2	50.4	100.8	151.2	201.6
	4×4 MIMO 64QAM Bit Rate (Mbps)	24.2	60.5	100.8	201.6	302.4	403.2

$$C = B * \log_2 (1 + SNR)$$

Kapasitas Sel =	17782085.764	bps
=	17,78	Mbps



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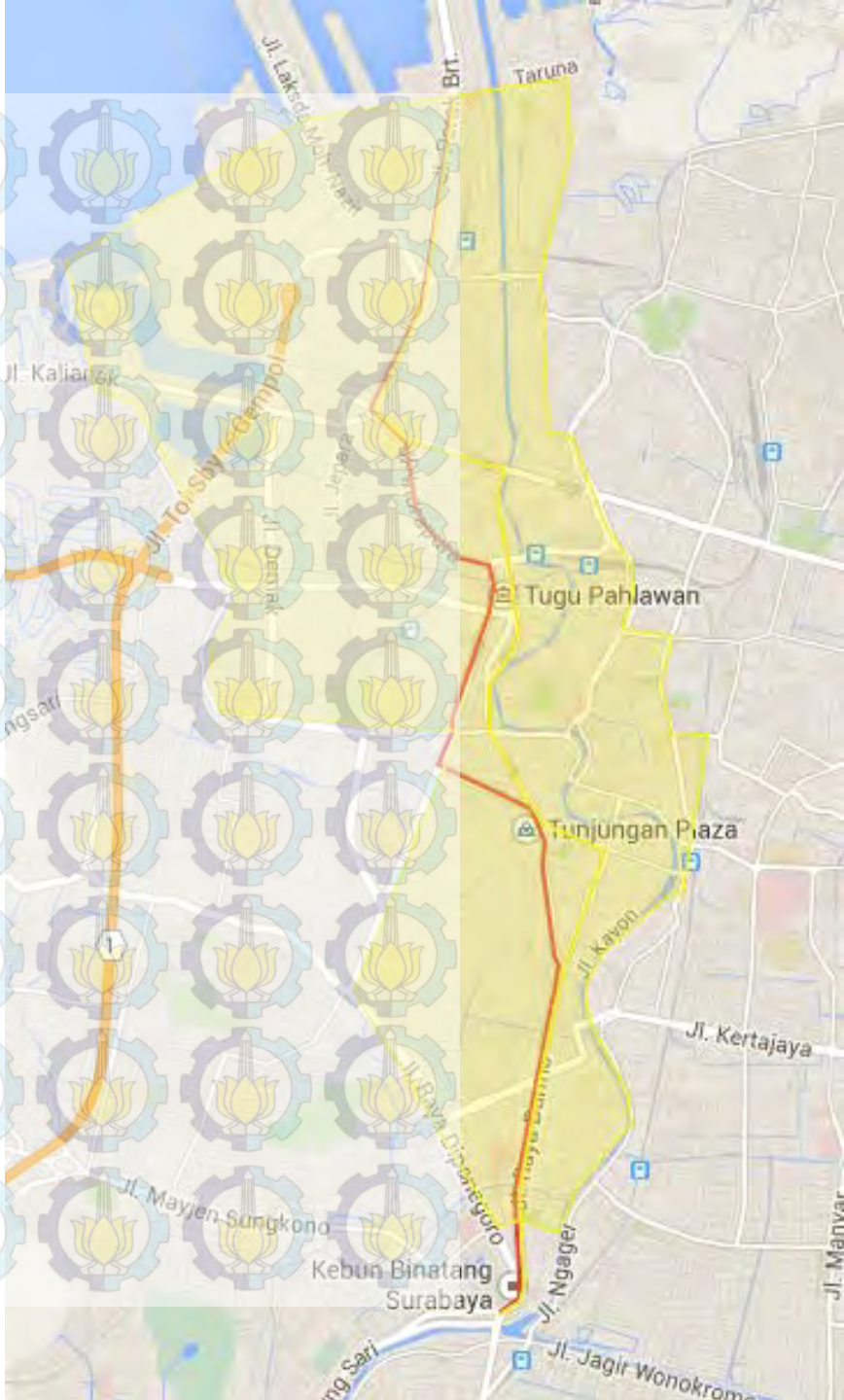
Capacity Planning – Luas Cakupan Sel

L = kapasitas sel / OBQtotal

Luas Cakupan Sel =	1.162569218	Km^2/sel



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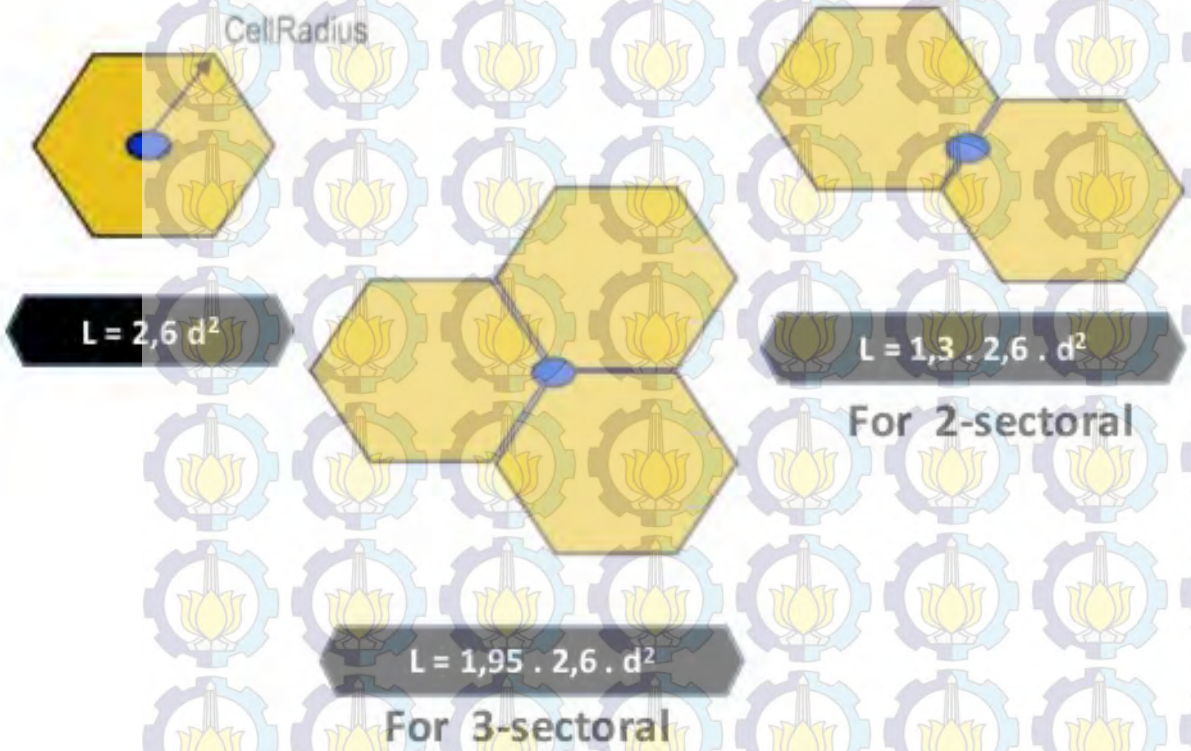
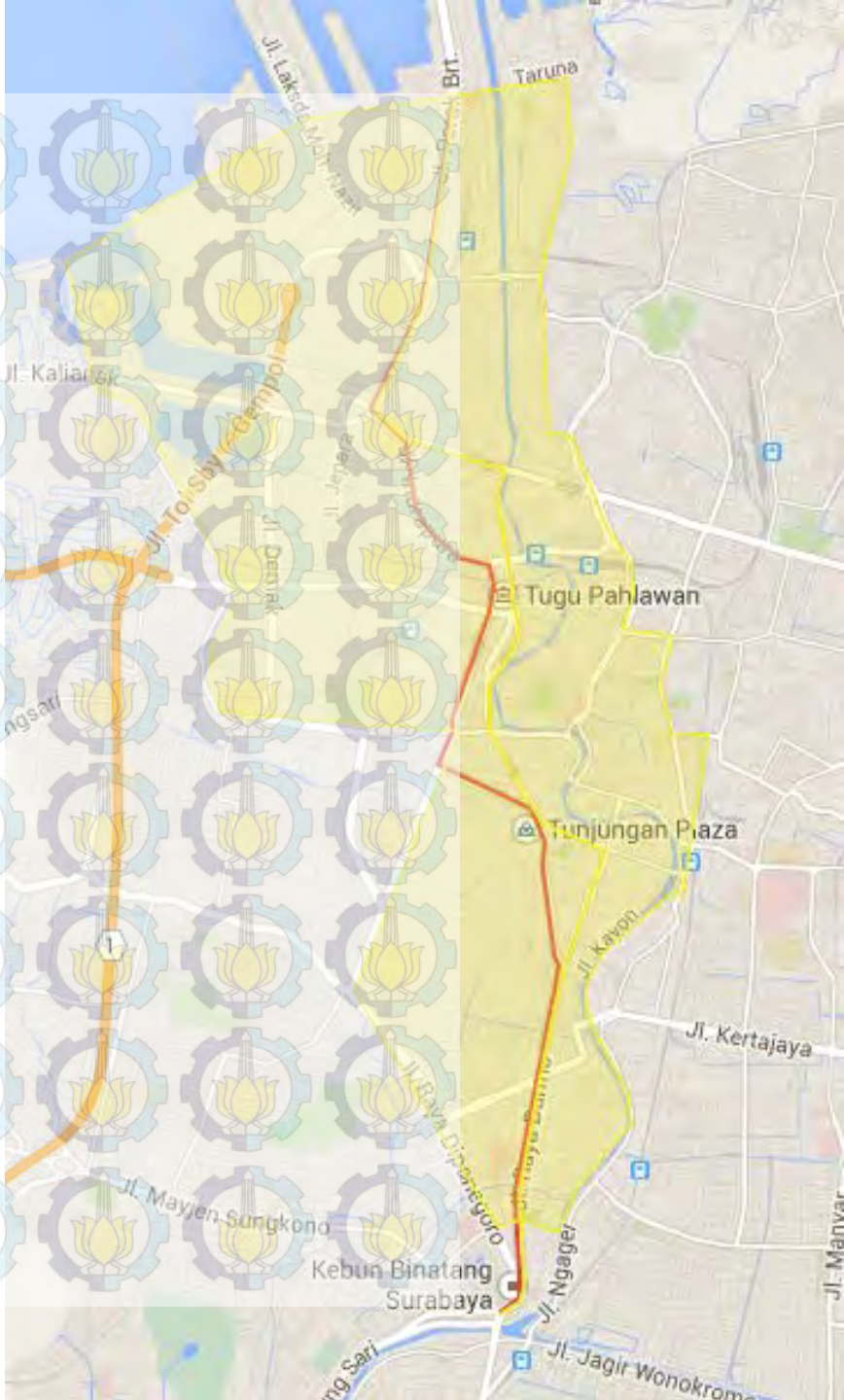
Capacity Planning – Radius Sel





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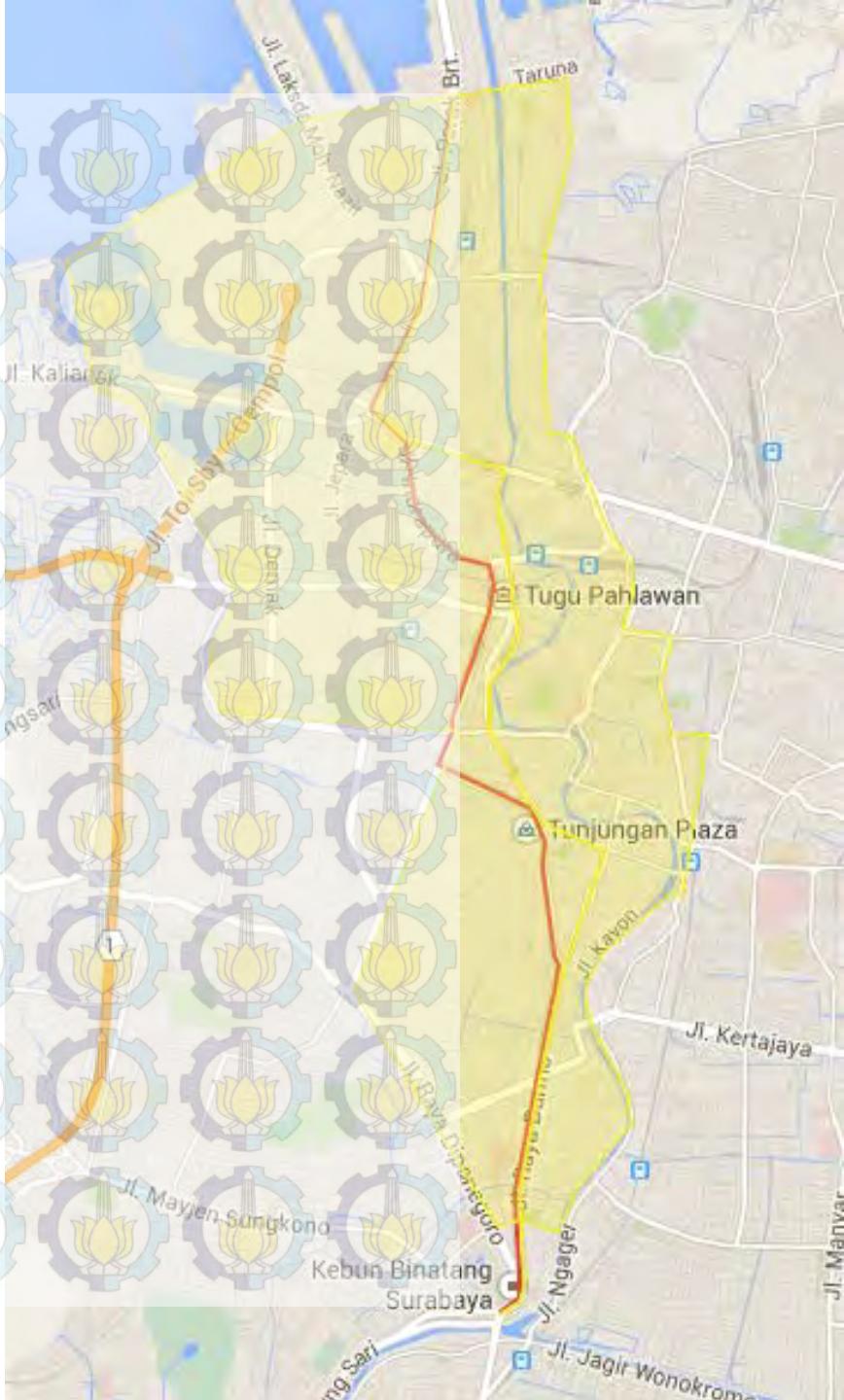
Capacity Planning – Radius Sel

$$\text{Radius} = \sqrt{\frac{Luas\ cakupan\ sel}{2{,}6}}$$ (1-sectoral, omnidirectional)

Radius Sel =	0.668686778	Km
≈	668	m



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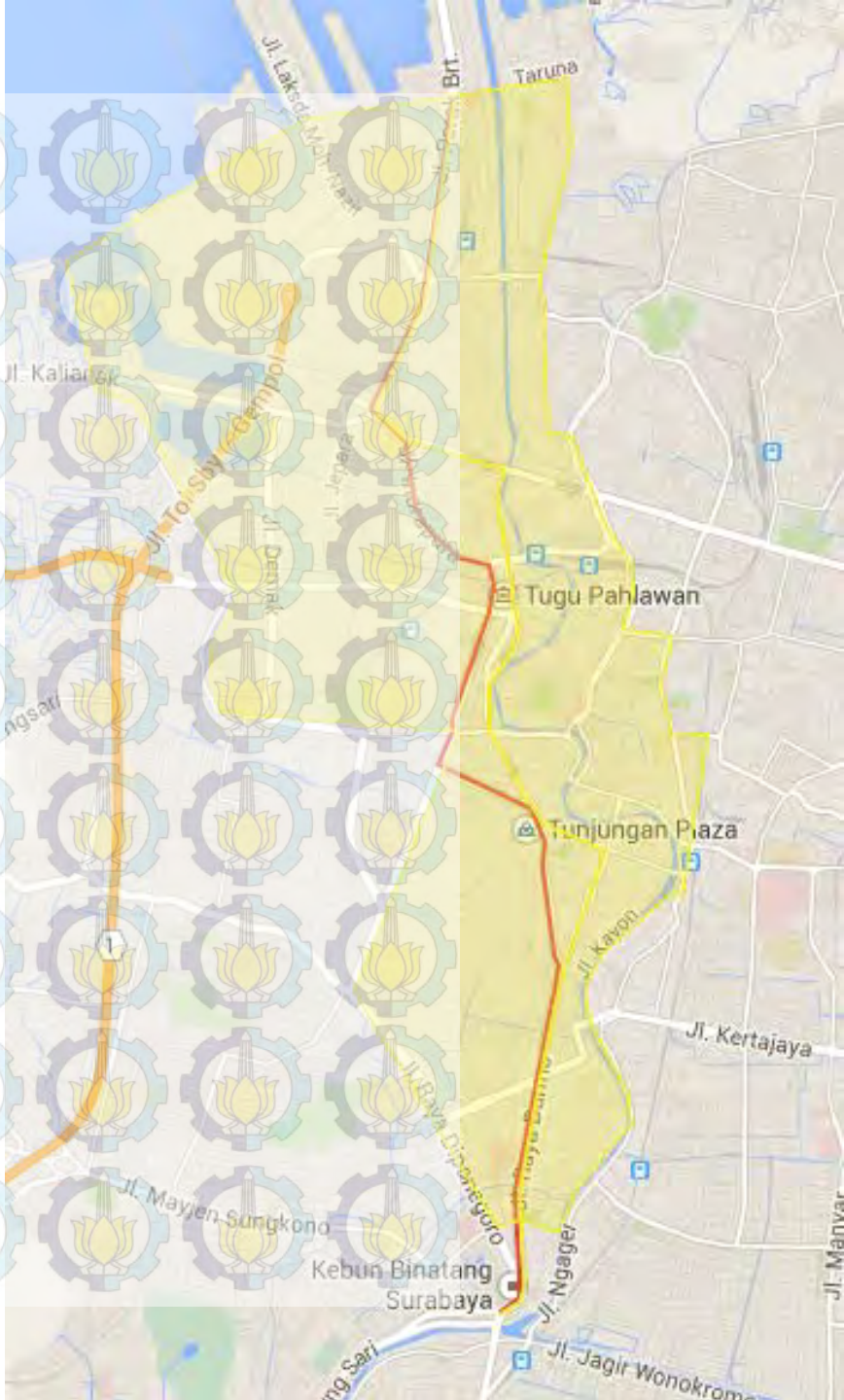
Coverage Planning - Link Budget (Uplink)

Uplink Link Budget		
Data rate (Kbps)	64	Kbps
Transmitter -UE		
Max Tx Power	23	dBm
Tx Antenna Gain	-5	dBi
Body Loss	0	dB
EIRP	18	dBm
Receiver - eNode B		
eNode B noise figure	2	dB
Thermal noise	-118,661496	dBm
Receiver noise	-116,661496	dBm
SINR	-7	dB
Receiver sensitivity	-123,661496	
Interference margin	2	dB
Cable loss	2	dB
Rx antenna gain	18	dBi
Fast fade margin	0	dB
Soft handover again	0	dB
Maximum path loss	155,661496	dB



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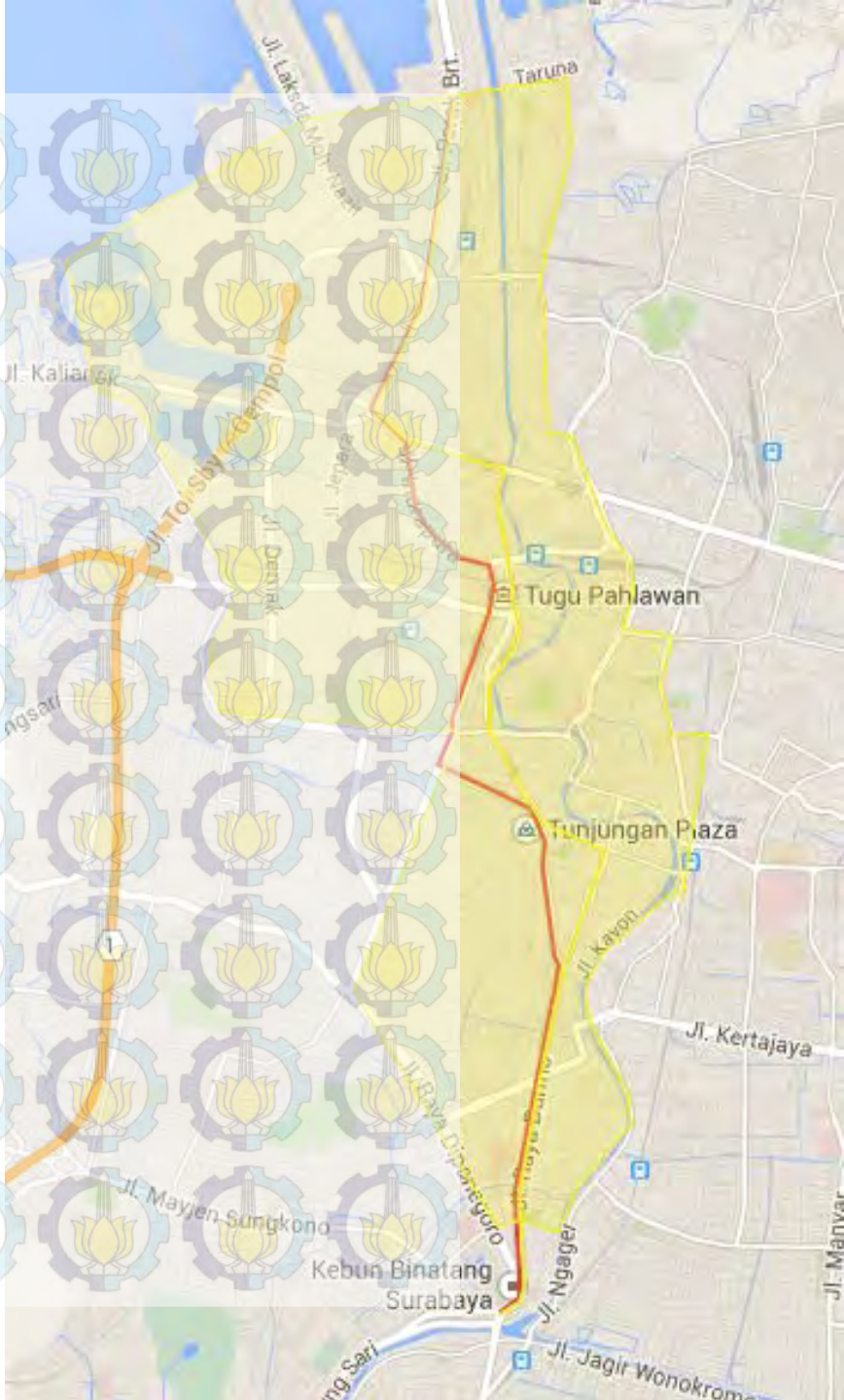
Coverage Planning - Link Budget (Downlink)

Downlink Link Budget			
Data rate (Kbps)		1024	Kbps
Transmitter - eNode B			
Tx Power		46	dBm
Tx antenna gain		18	dBi
Cable loss		2	dB
EIRP		62	dBm
Receiver - UE			
UE noise figure		7	dB
Thermal noise		-104,43	dB
Receiver noise floor		-97,4339	dBm
SINR		-9	dB
Receiver sensitivity		-94	dBm
Interference margin		4	dB
Control channel overhead		1	dB
Rx antenna gain		0	dBi
Body loss		0	dB
Maximum path loss		151	dB



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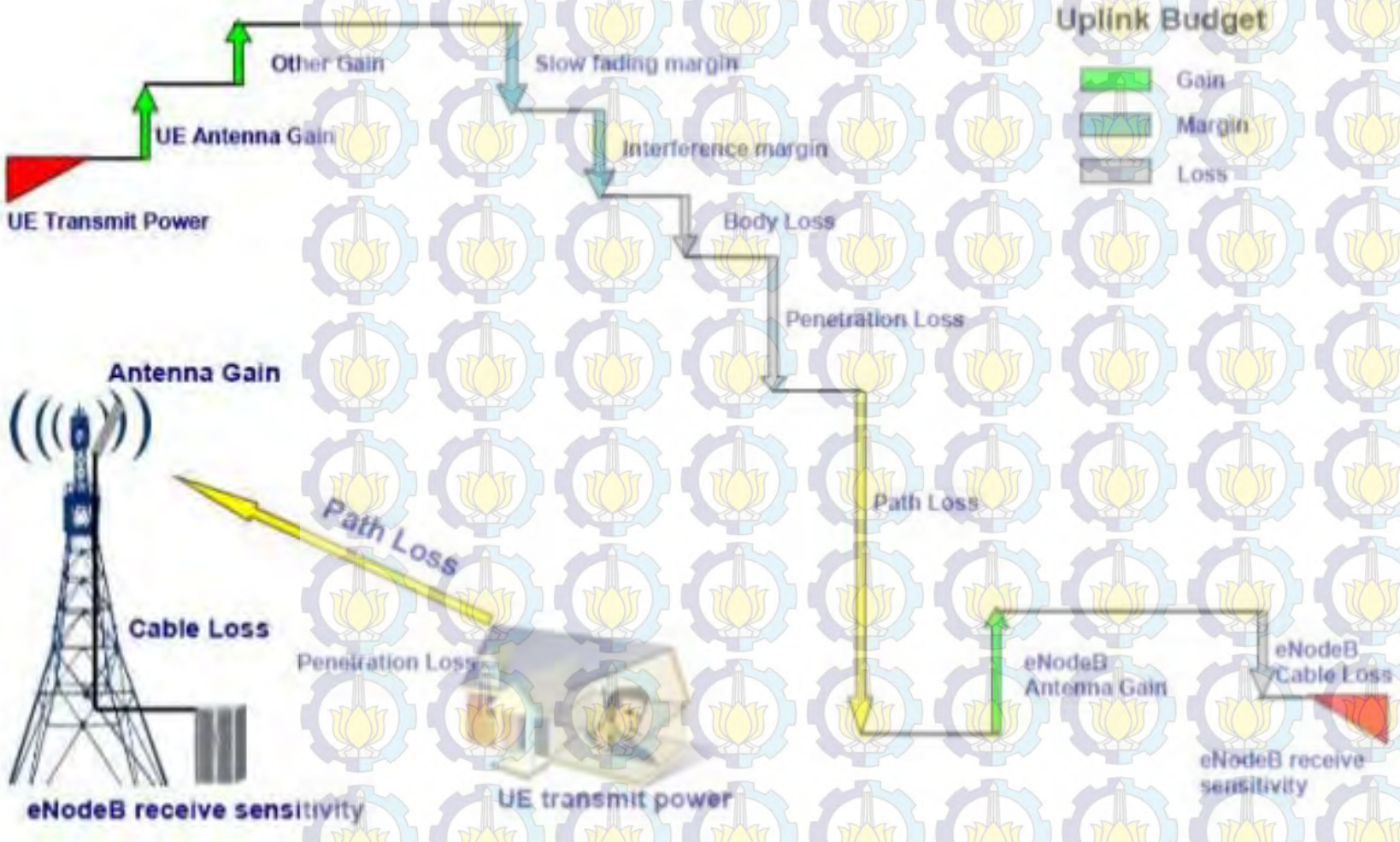
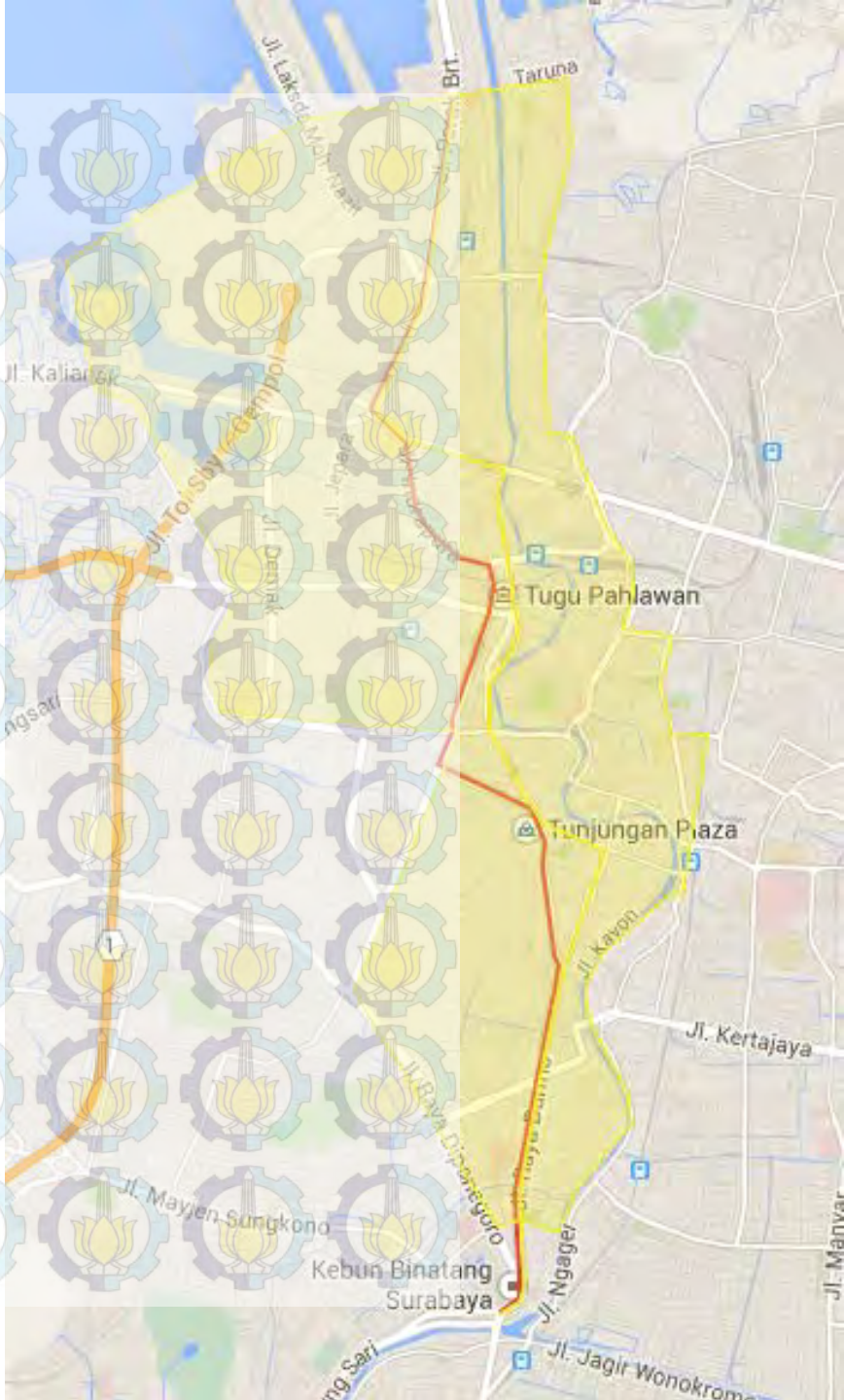
Model Propagasi





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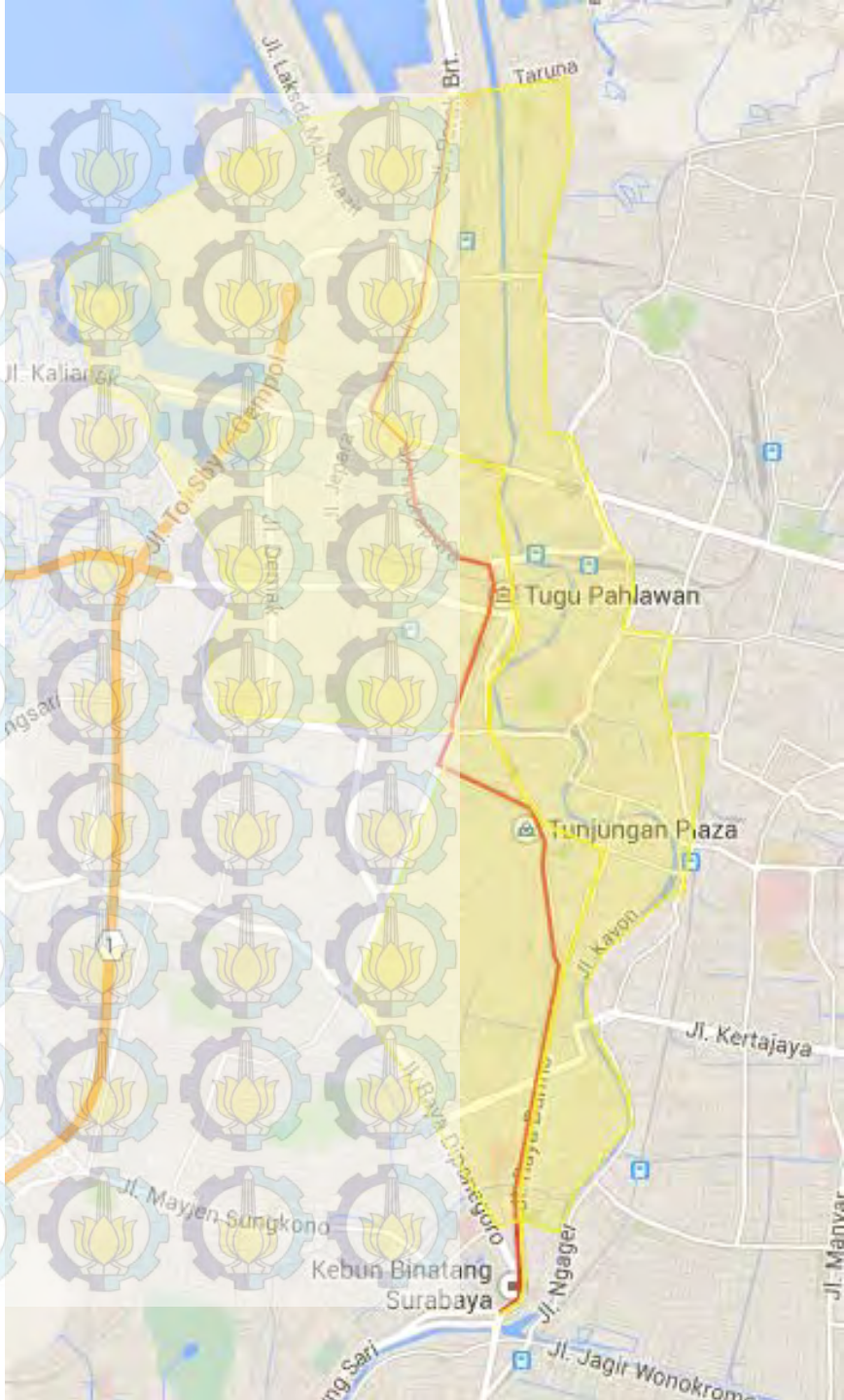
Model Propagasi

Parameter	Notasi	Nilai	
Frekuensi Pembawa	fc1	900	MHz
	fc2	1800	MHz
Tinggi antena BTS	hb	15	m
Tinggi antena MS	hm	1,5	m
Jarak BTS dengan MS	d	0.668686778	Km
Jarak antar gedung	b	30	m
Lebar jalan raya	w	15	m
Sudut ϕ	ϕ	90^0	
Rata-rata tinggi gedung termasuk atap	hroof	20	m

1. Model Propagasi Okumura-Hata
2. Model Propagasi COST-231 Walfish-Ikegami



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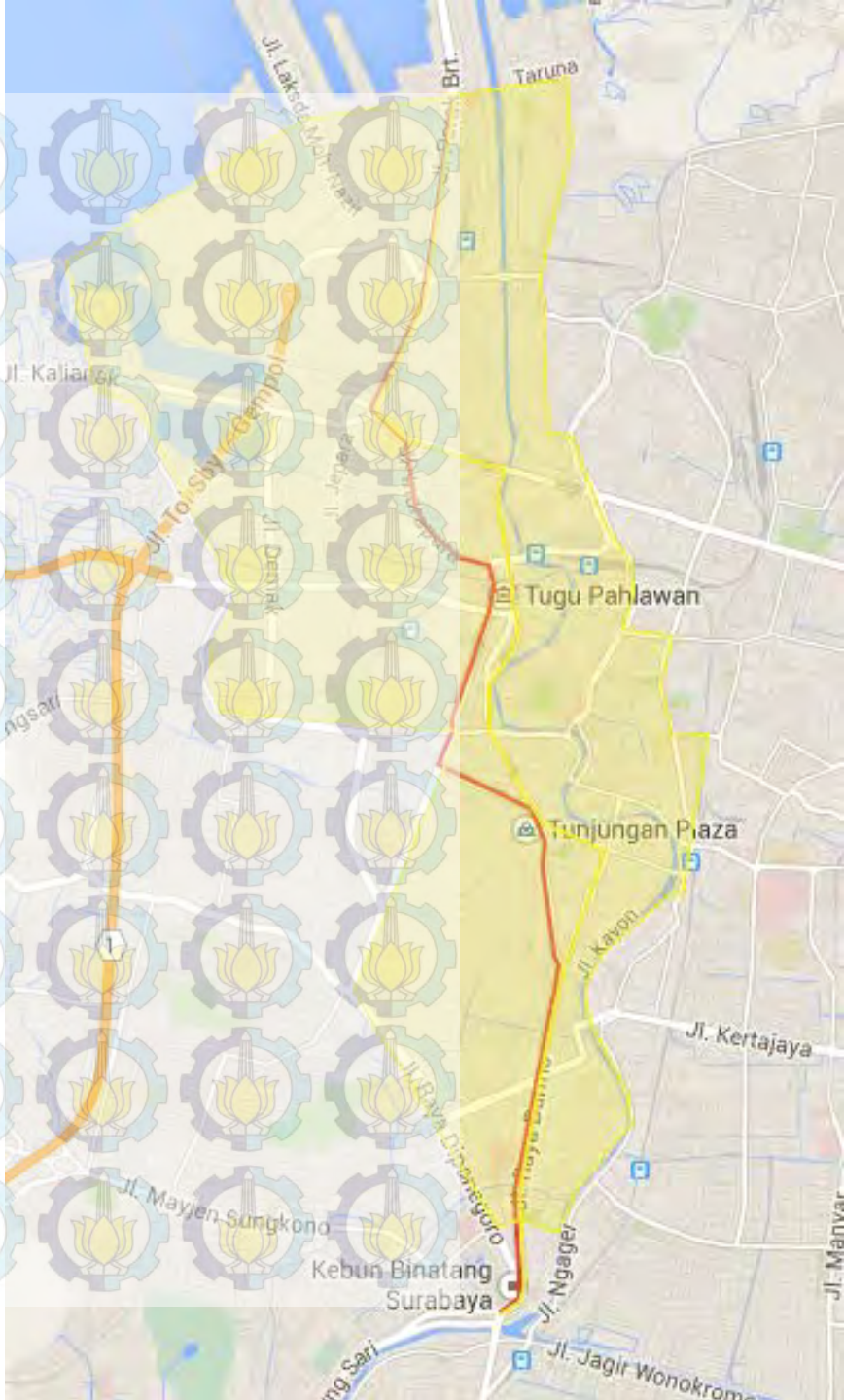
Model Propagasi

1. Model Propagasi Okumura-Hata

Path Loss	(900 MHz) =	124.0670	dB
Path Loss	(1800 MHz) =	131.9419	dB

2. Model Propagasi COST-231 Walfish-Ikegami

Path Loss	(900 MHz) =	138.6007	dB
Path Loss	(1800 MHz) =	154.0316	dB



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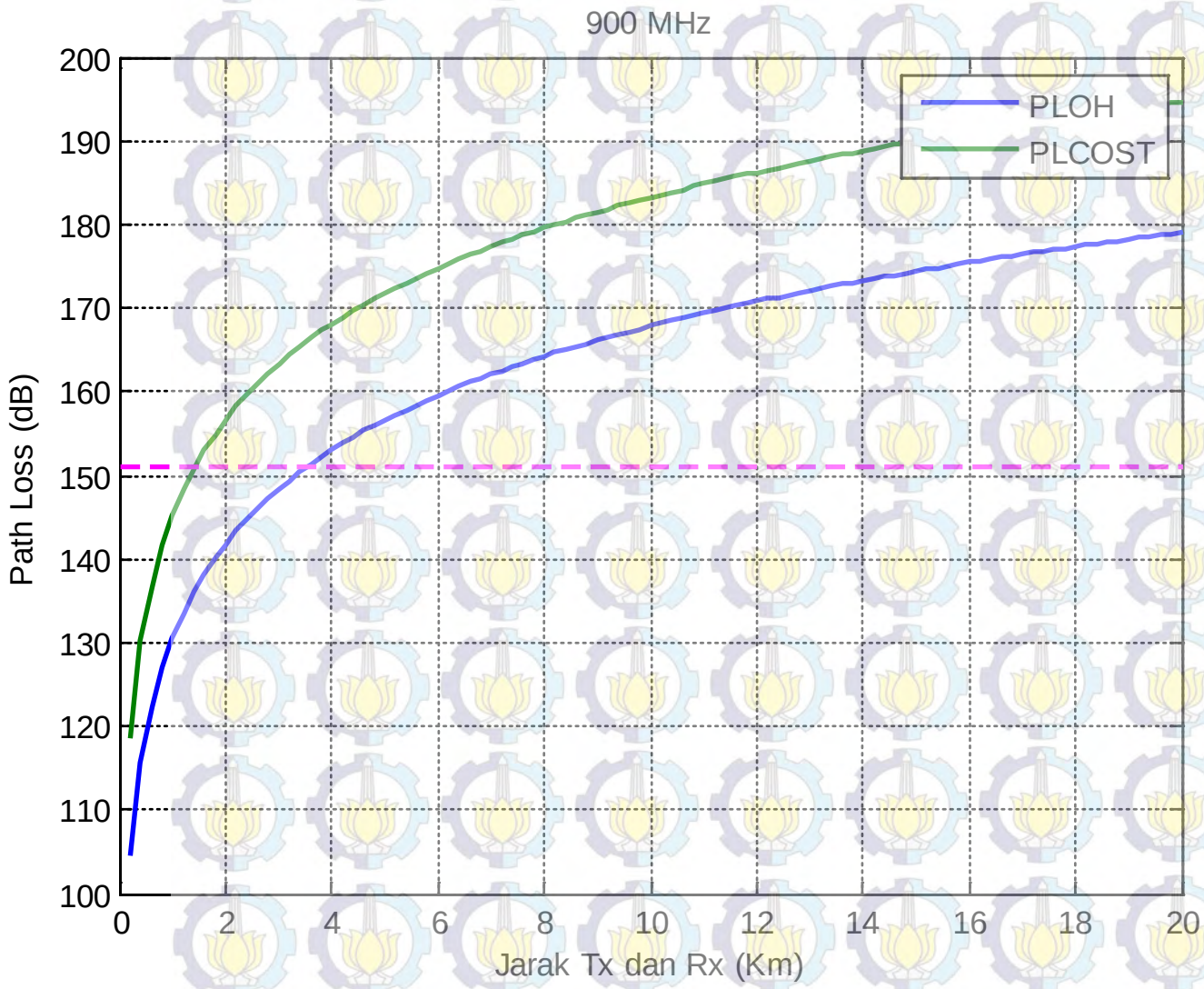
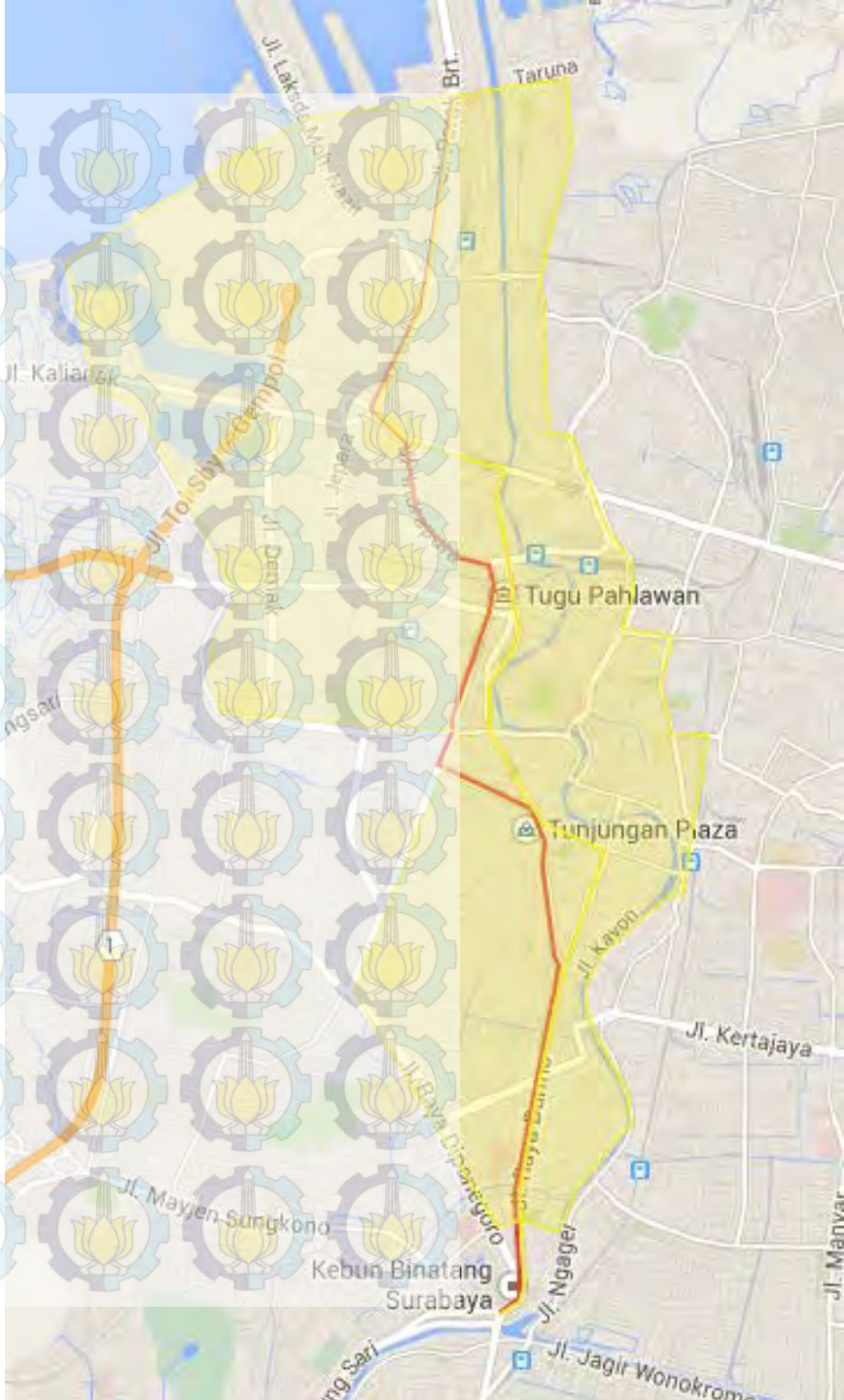
Model Propagasi





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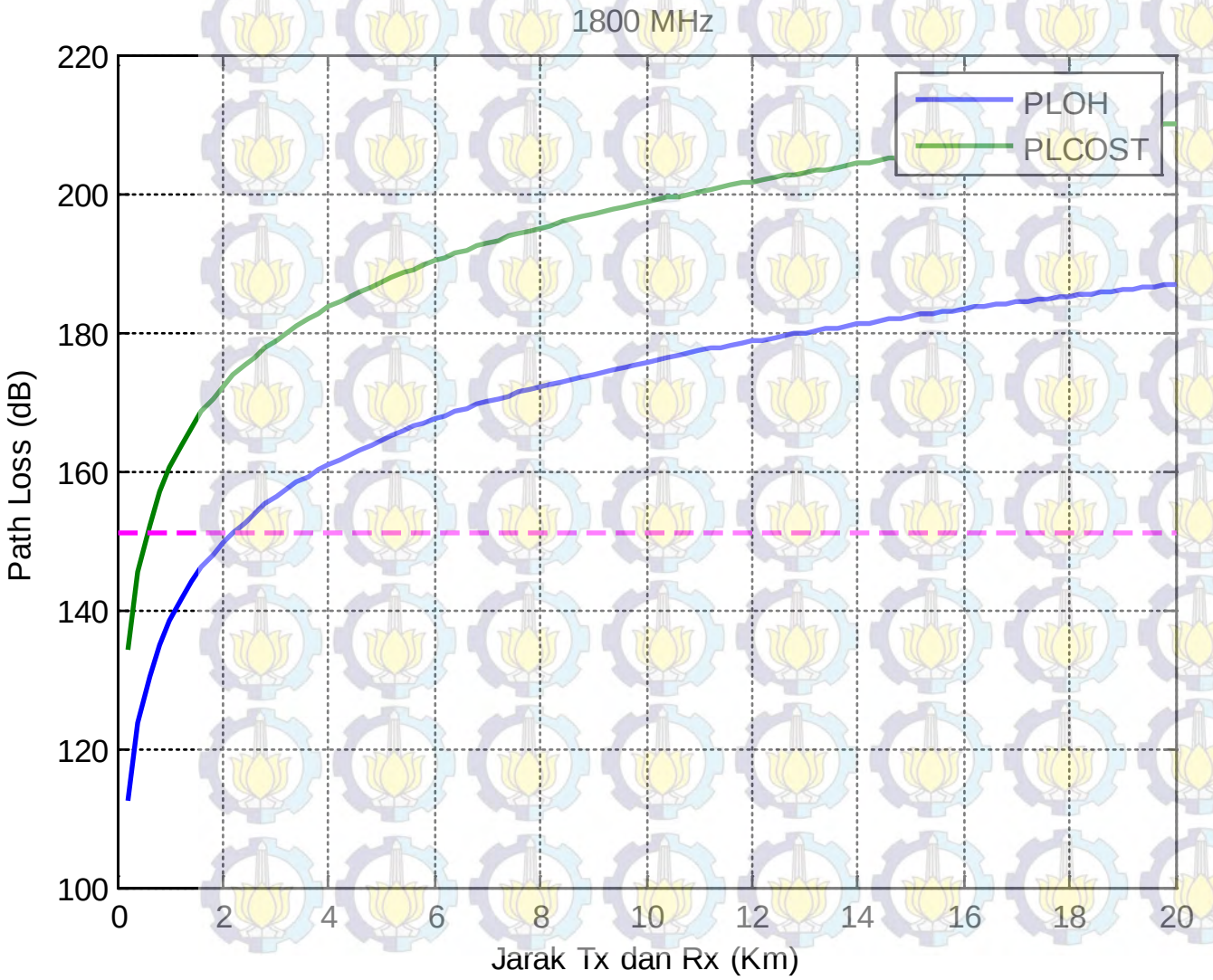
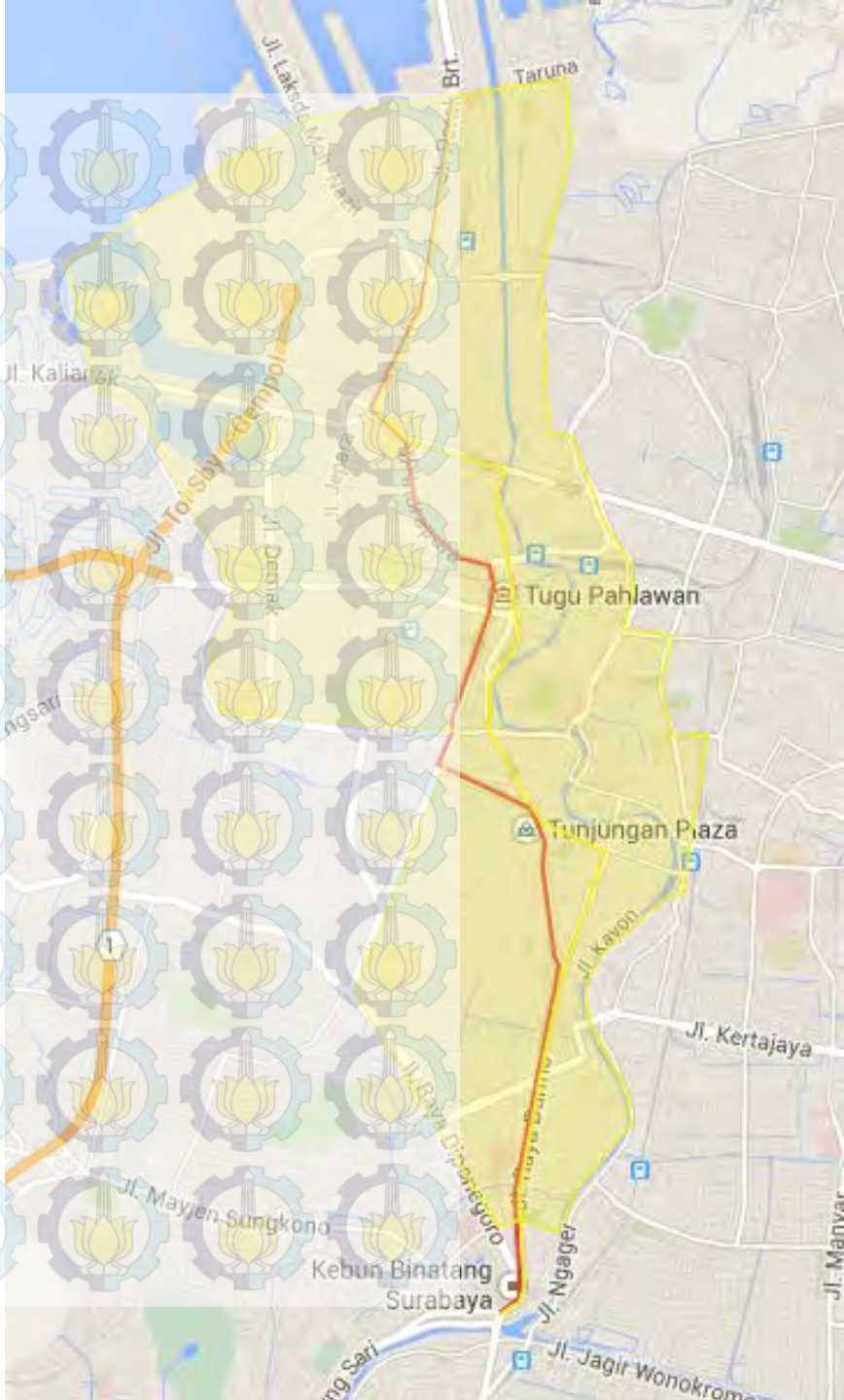
Model Propagasi





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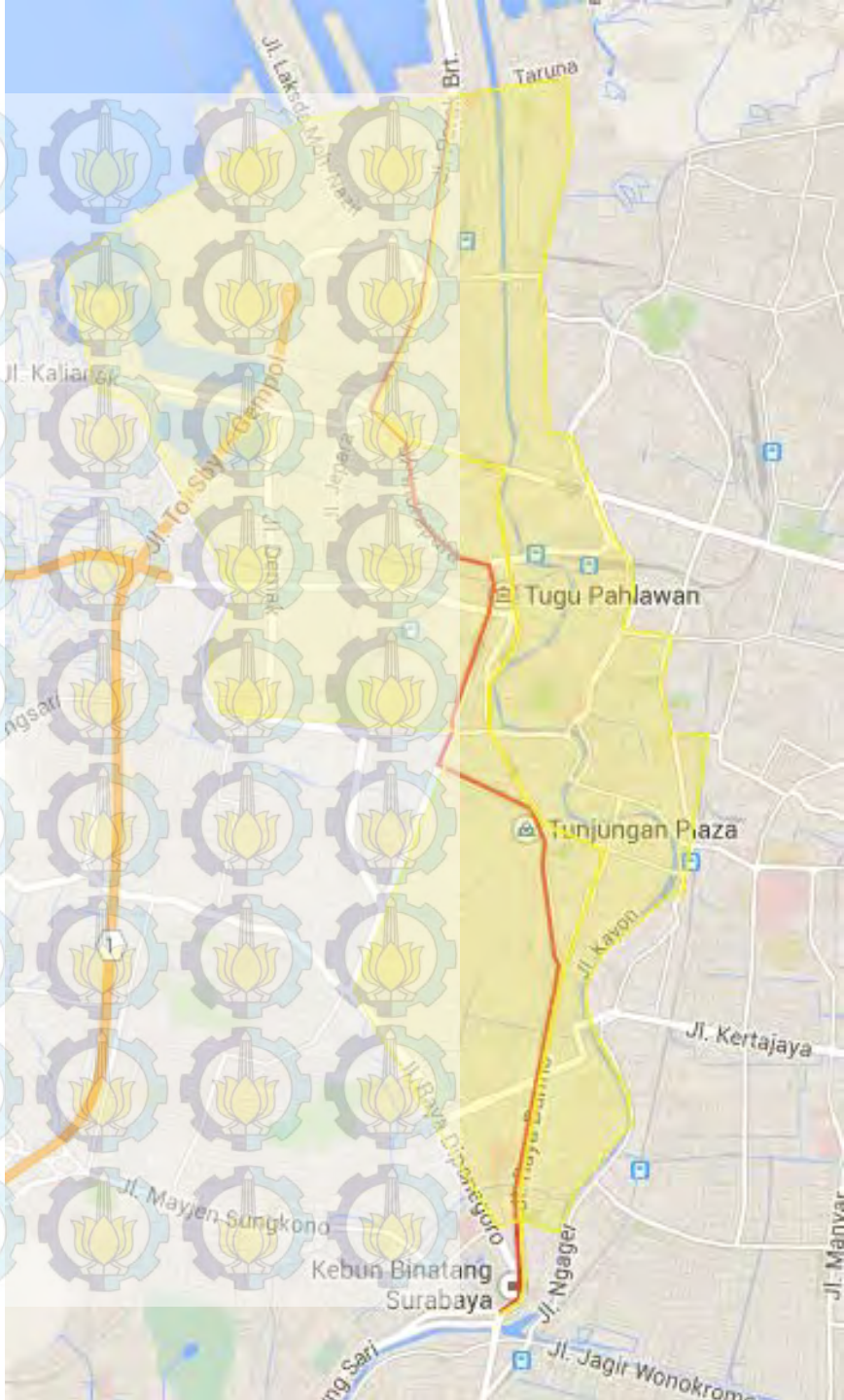
Model Propagasi

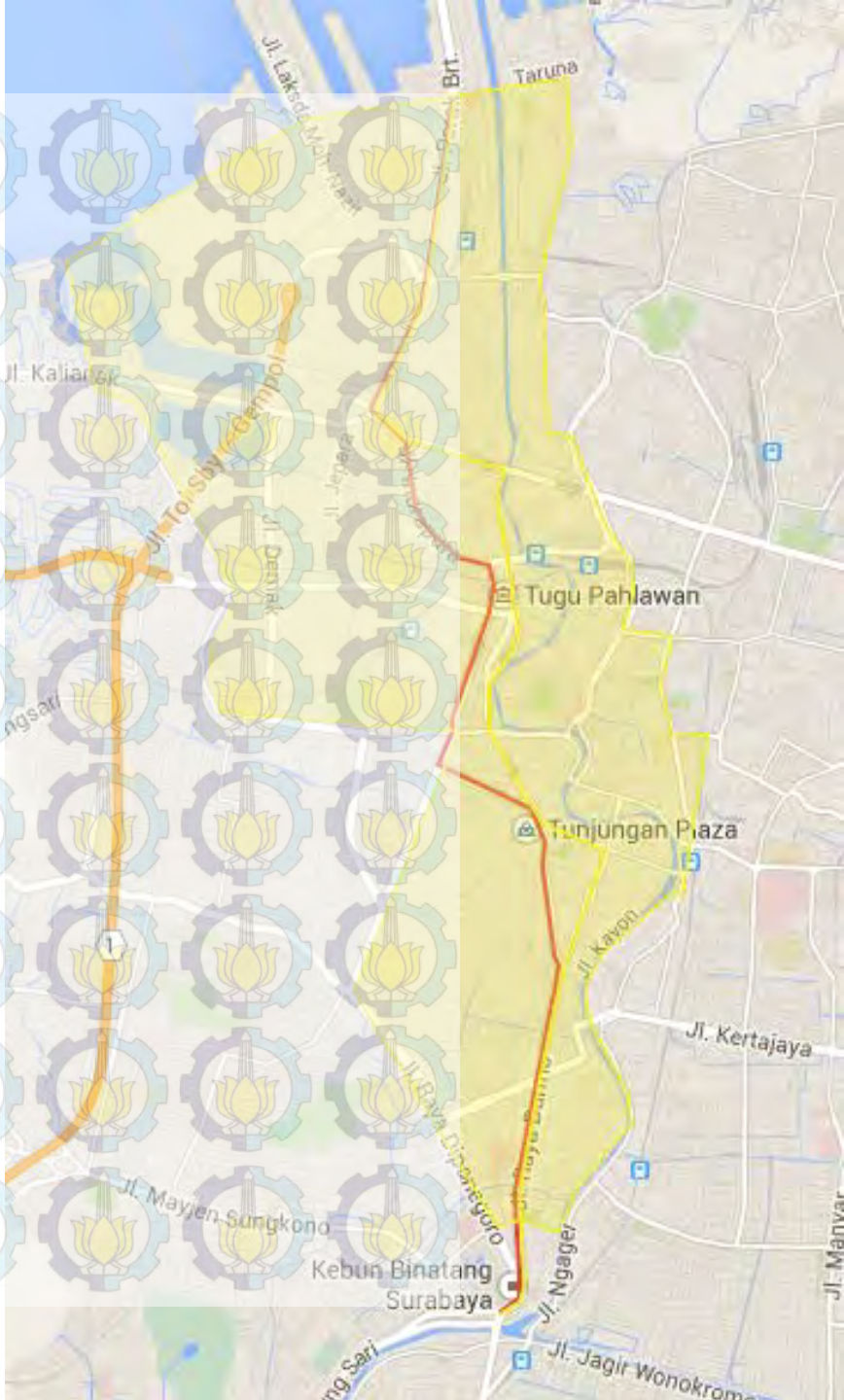
Loss / Areas	Frekuensi (MHz)	URBAN (dB)
Okumura-Hata	900	104,5321 – 179,0653
	1800	112,407 – 186,9402
COST-231 Walfisch-Ikegami	900	118.6814 – 194.6814
	1800	134.1123 – 210.1123

Loss / Areas	Frekuensi (MHz)	Radius (Km)
Okumura-Hata	900	3,6
	1800	2,2
COST-231 Walfisch-Ikegami	900	1,6
	1800	0,6



Design BTS Hotel

1. Asumsi lokasi Stasiun Tram dengan pendekatan Halte Bus eksisting



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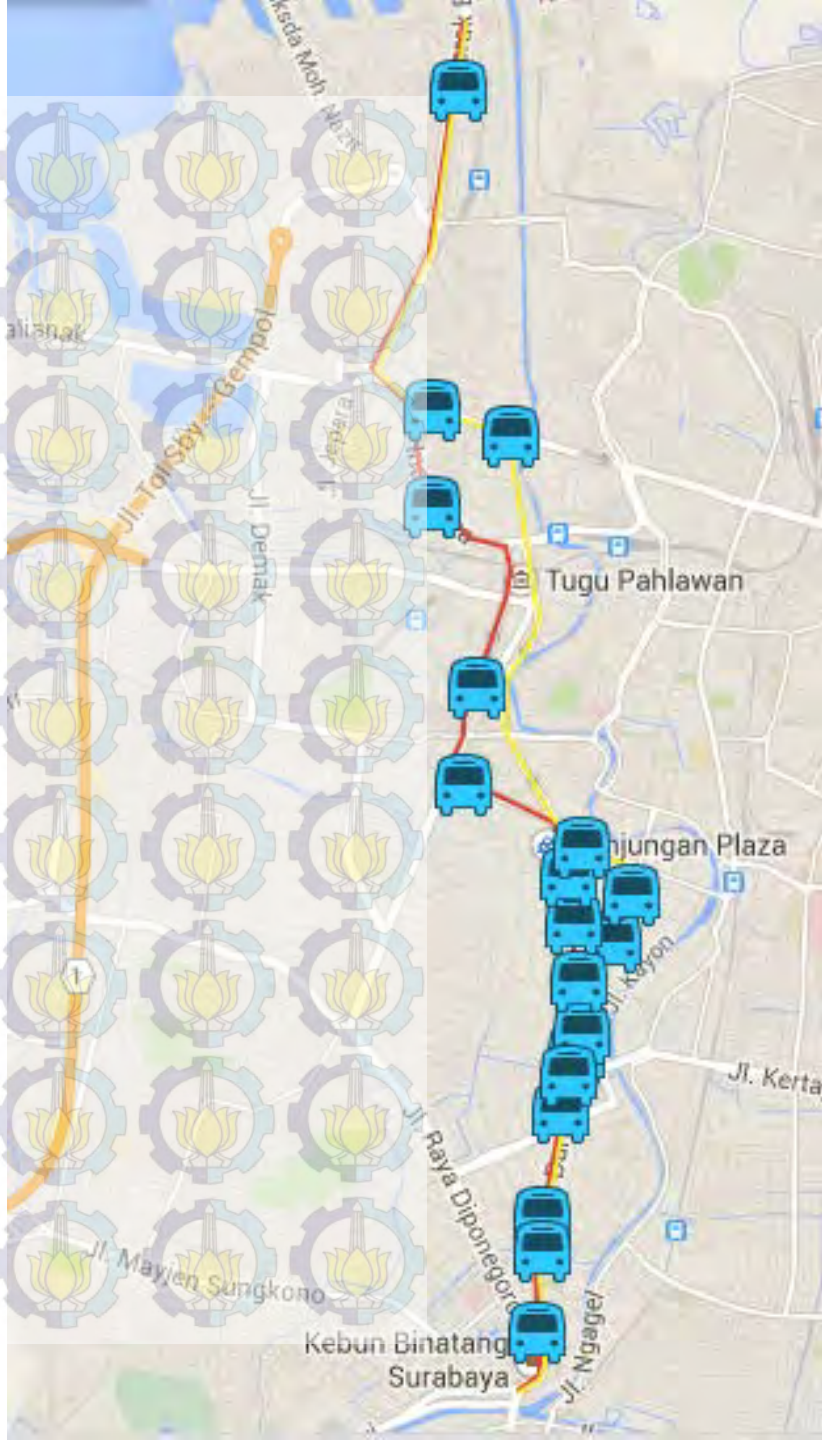

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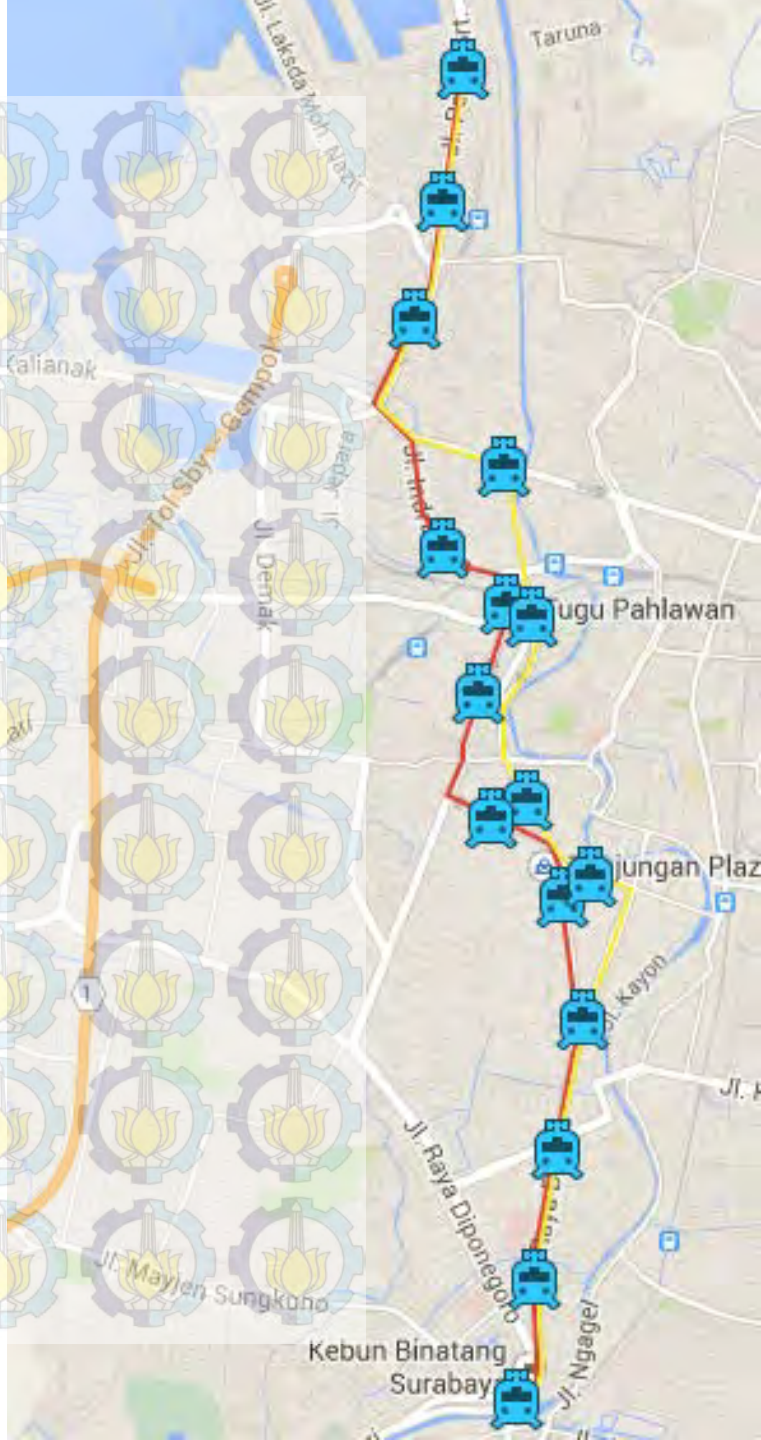
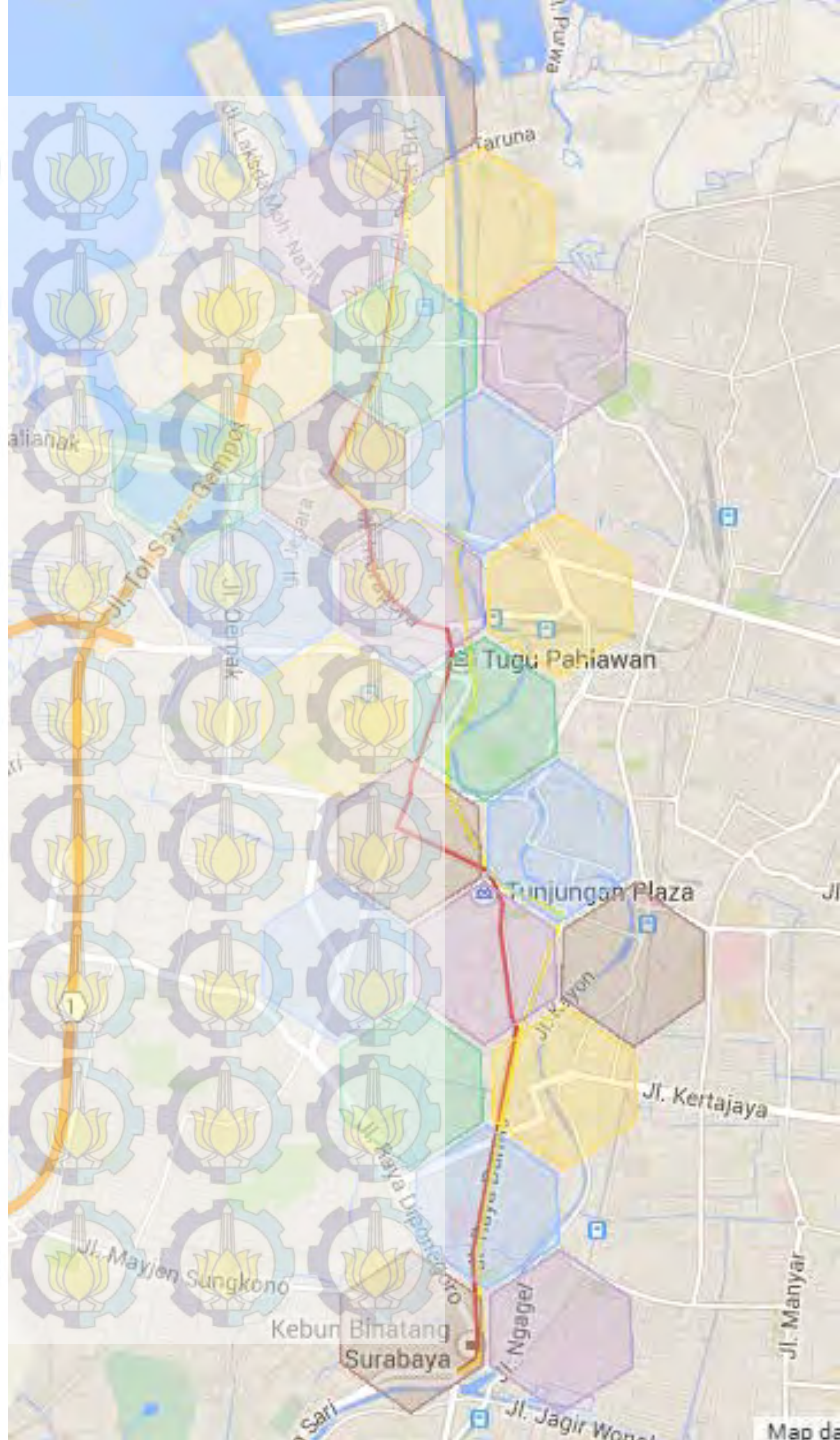


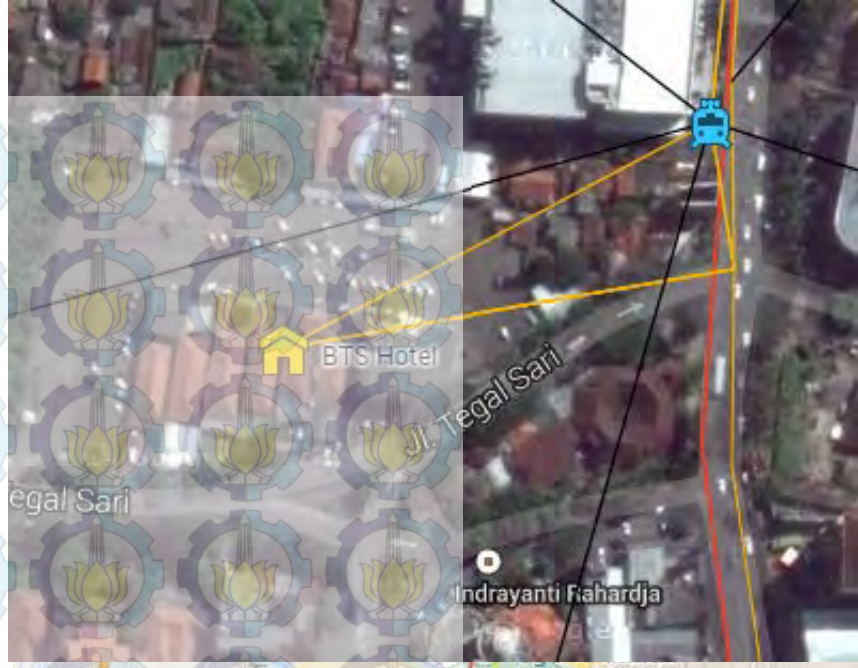
Design BTS Hotel

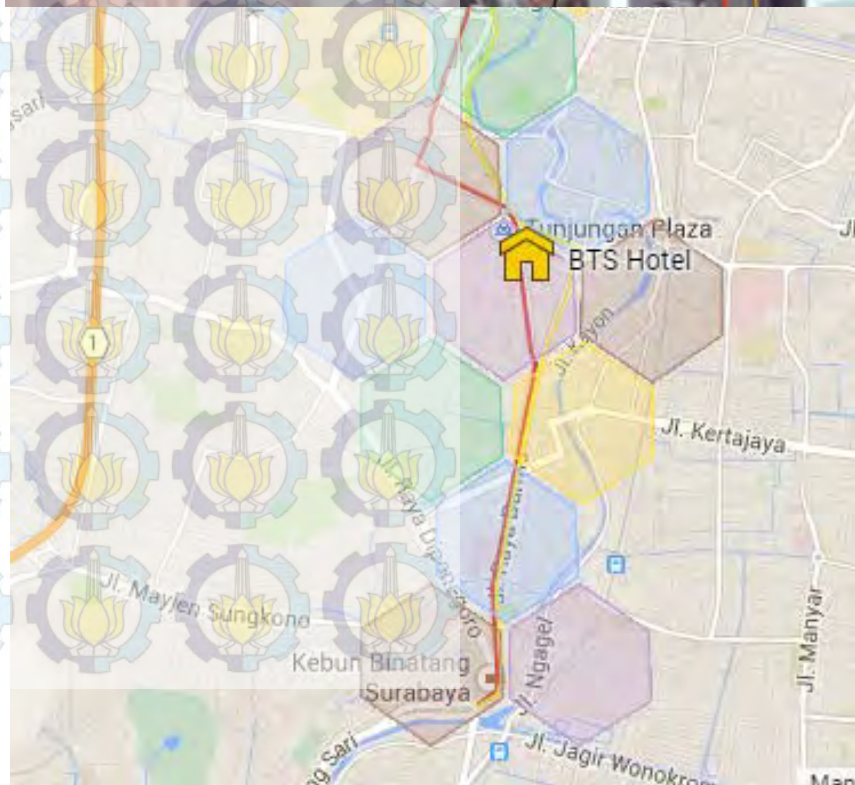
1. Asumsi lokasi Stasiun Tram dengan pendekatan Halte Bus eksisting
2. Sel eNode B, dengan parameter LTE 1800 MHz. Radius sel 0.6 km



Design BTS Hotel

1. Asumsi lokasi Stasiun Tram dengan pendekatan Halte Bus eksisting
2. Sel eNode B, dengan parameter LTE 900 MHz. Radius sel 0.68 km
3. Lokasi BTS Hotel di Jalan Tegal Sari. Dengan asumsi menggunakan gedung park & ride

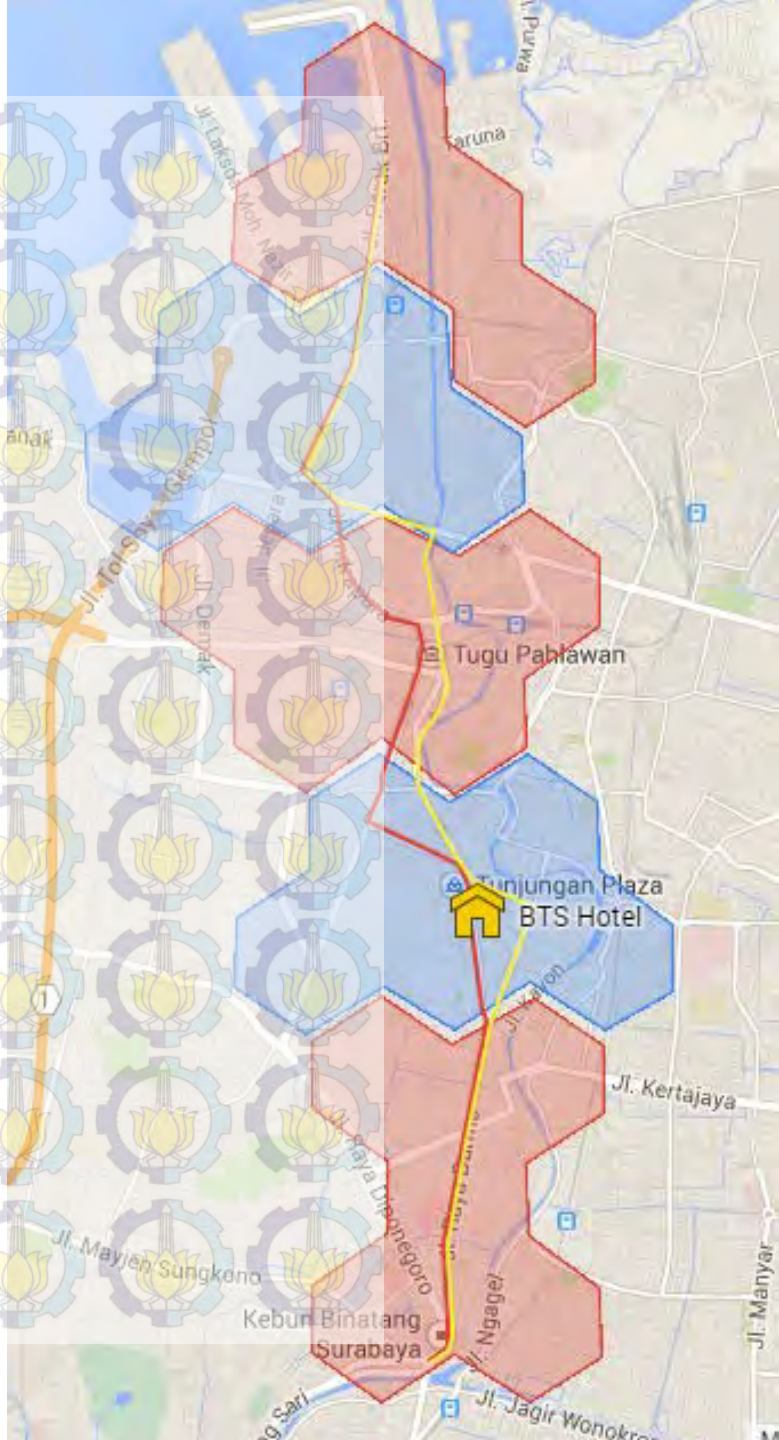




Design BTS Hotel
Fiber Optik

Parameter Fiber Optik		
Daya Keluaran Sumber Optik (OLT/ONU)	5	dBm
Sensitivitas Detektor (OLT/ONU)	-29	dBm
Redaman FO Single Mode G.652 (1310 nm)	0.4	dB/Km
Redaman FO Single Mode G.652 (1550 nm)	0.3	dB/Km
Redaman Splice	0.05	dB/splice
Konektor	0.2	dB
Jenis PS 1:8	11	dB
Panjang Maksimal Serat Optik	2	Km

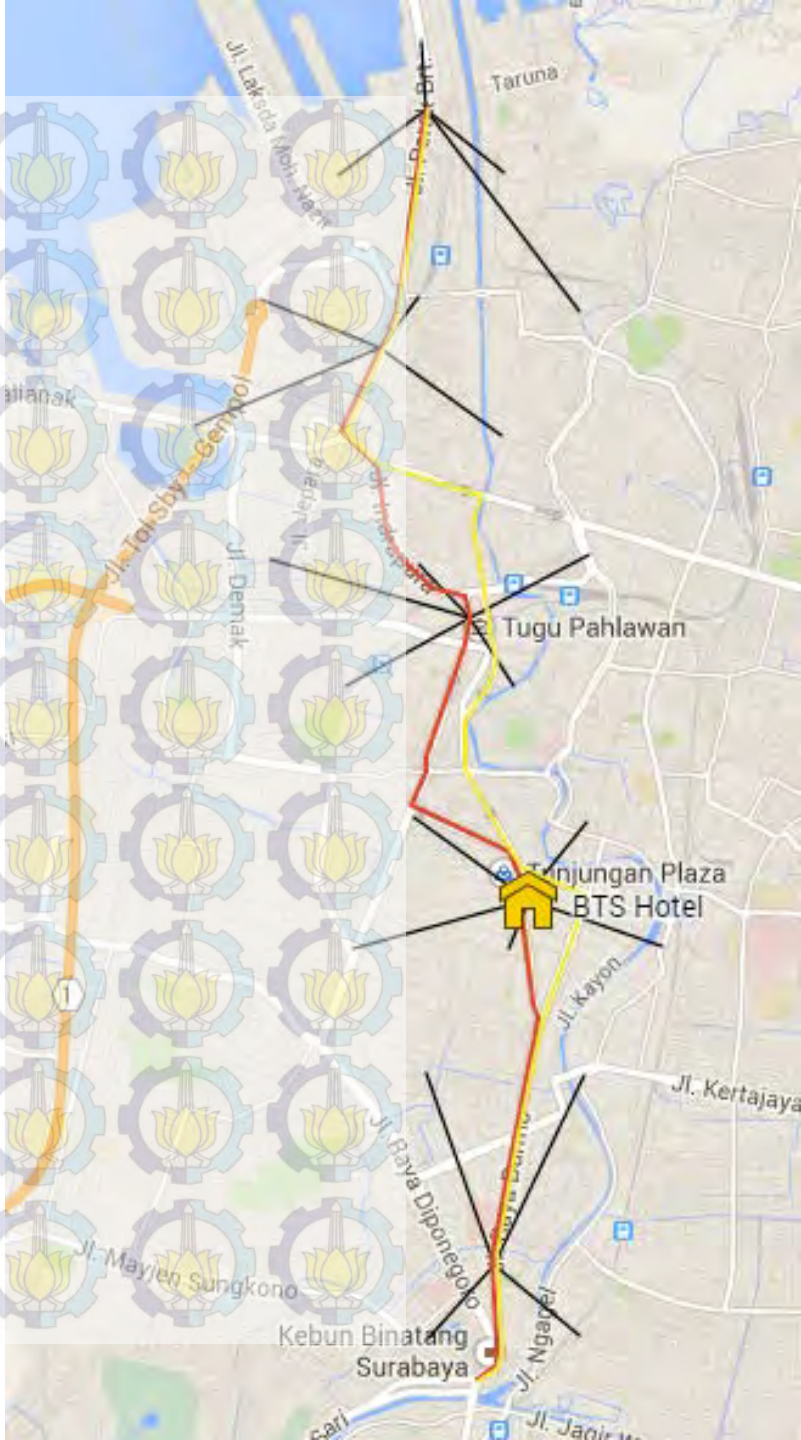
Link	Stasiun	Jarak (Km)	Jumlah Sambungan
1	Taman Bungkul	2.92	1
2	Basuki Rahmat	0.134	0
3	Bank Indonesia	2.8	1
4	Perak 1	5.44	2
5	Perak 3	7.38	3



Design BTS Hotel

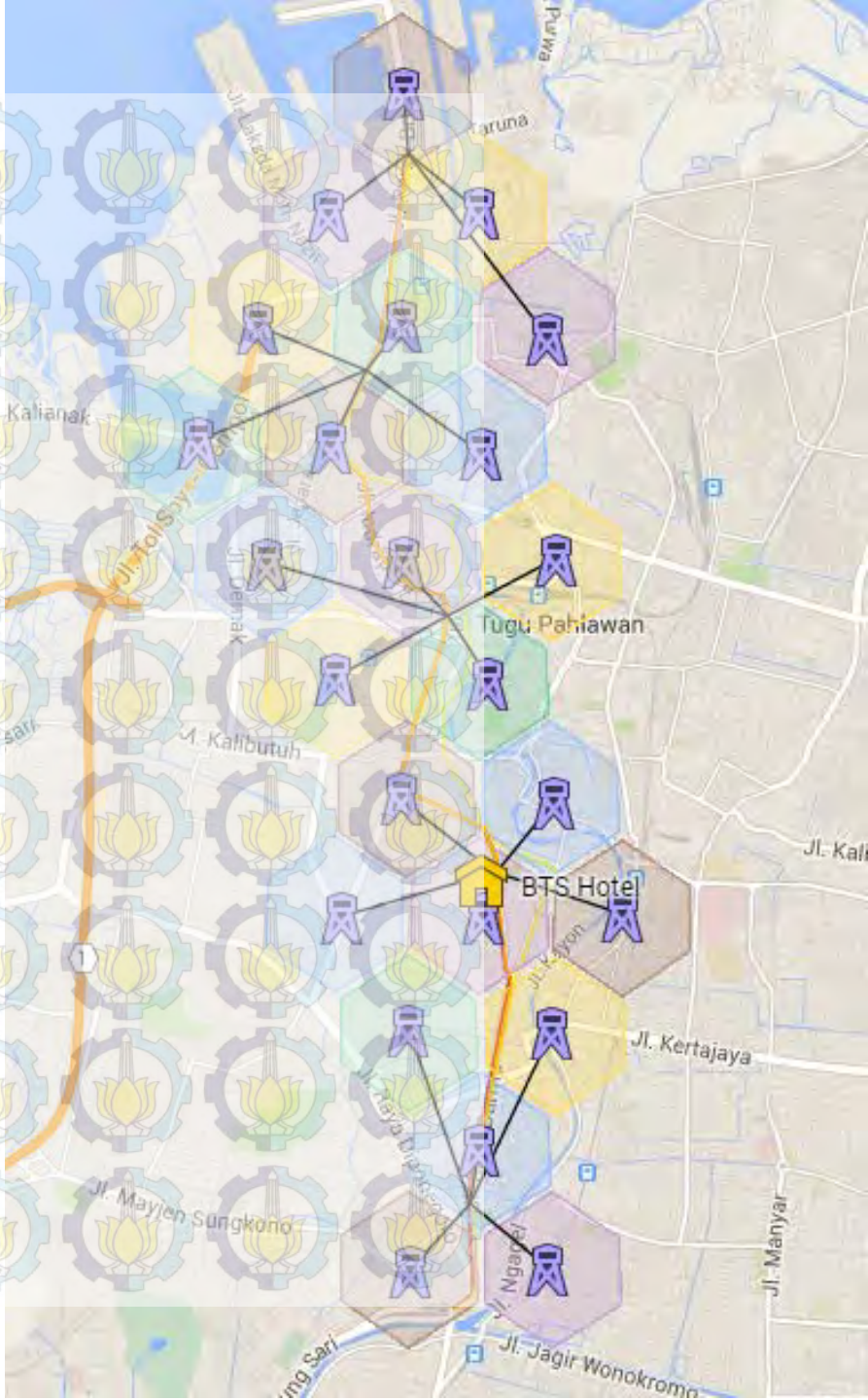
Fiber Optik

	Link Power Budget				
	Downlink (1310 nm)				
	Link 1	Link 2	Link 3	Link 4	Link 5
a_{total}	15.618	14.4	15.57	16.676	17.502
Pr	-16.618	-15.4	-16.57	-17.676	-18.502
M	12.382	13.6	12.43	11.324	10.498
	Uplink (1550 nm)				
	Link 1	Link 2	Link 3	Link 4	Link 5
a_{total}	15.326	14.4	15.29	16.132	16.764
Pr	-16.326	-15.4	-16.29	-17.132	-17.764
M	12.674	13.6	12.71	11.868	11.236



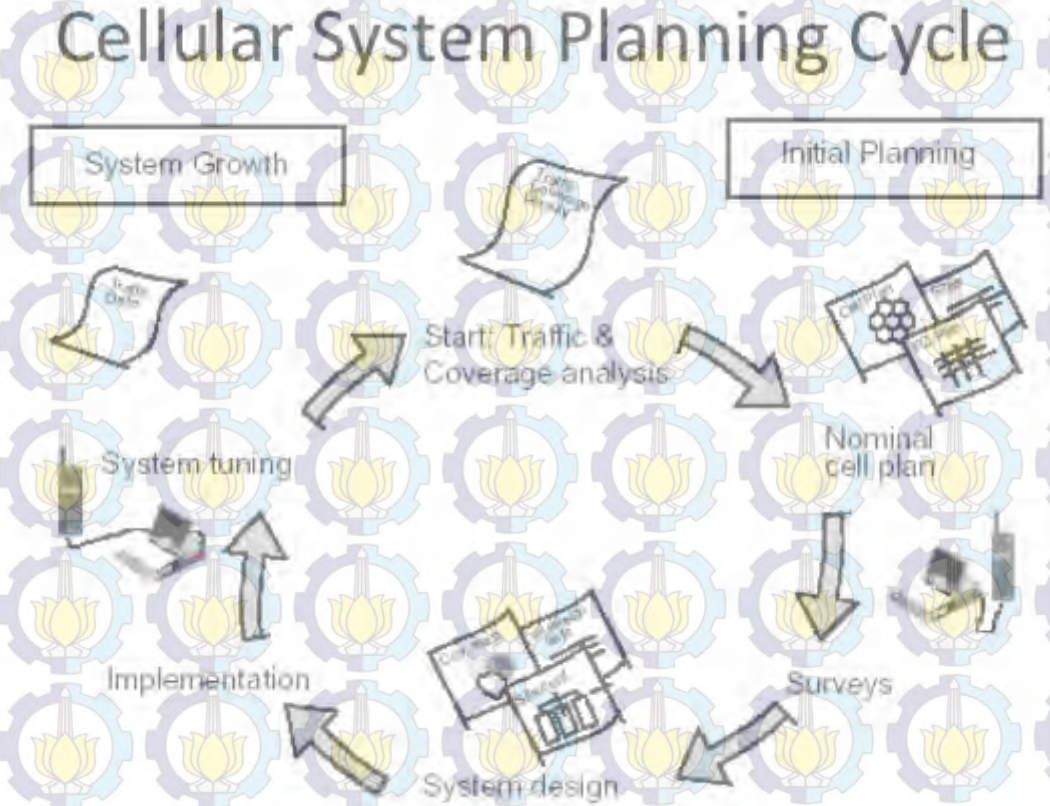
Design BTS Hotel

Rekapitulasi Perancangan BTS Hotel dengan Teknologi LTE		
Daerah Perencanaan	Jalur Tram	
Luas Total	27.33	Km^2
Total Penduduk (2014)	419.102	Jiwa
Total Penduduk (2020)	435.196	Jiwa
Capacity Planning		
Kepadatan Pengguna LTE	1061.565584	$Jiwa/Km^2$
Total OBQ	14.45	$Mbps/Km^2$
Kapasitas Sel	17.78	Mbps
Coverage Planning		
Luas Cakupan Sel	1.162569218	Km^2.sell
eNode	24	buah
Radius sel	668	m
Model Propagasi		
Okumura-Hata	124.0670	dB (900 MHz)
Okumura-Hata	131.9419	dB (1800 Mhz)
COST-231 Walfish-Ikegami	138.6007	dB (900 MHz)
COST-231 Walfish-Ikegami	154.0316	dB (1800 Mhz)
MAPL		
Uplink	155,661496	dB
Downlink	151	dB

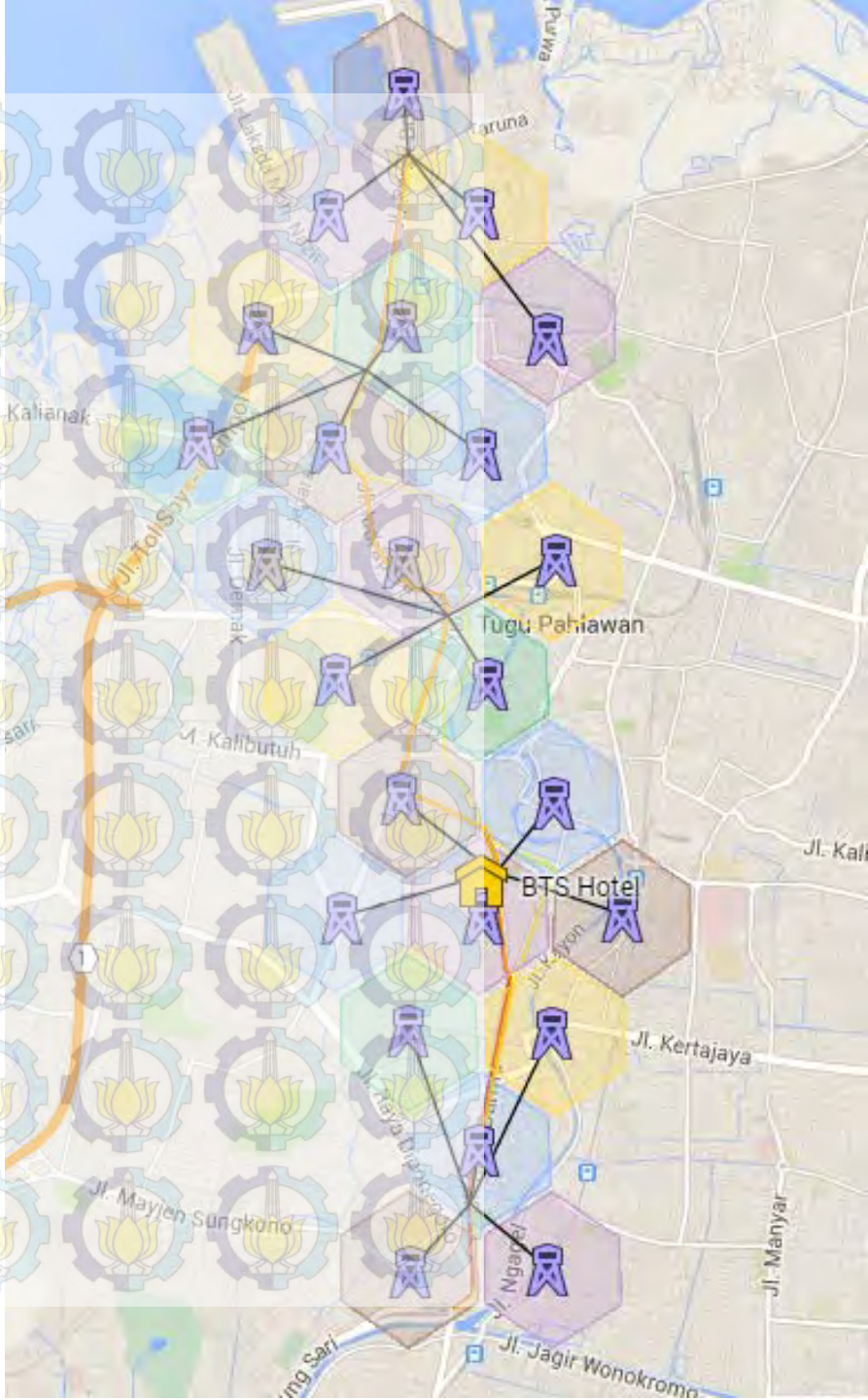


Design BTS Hotel

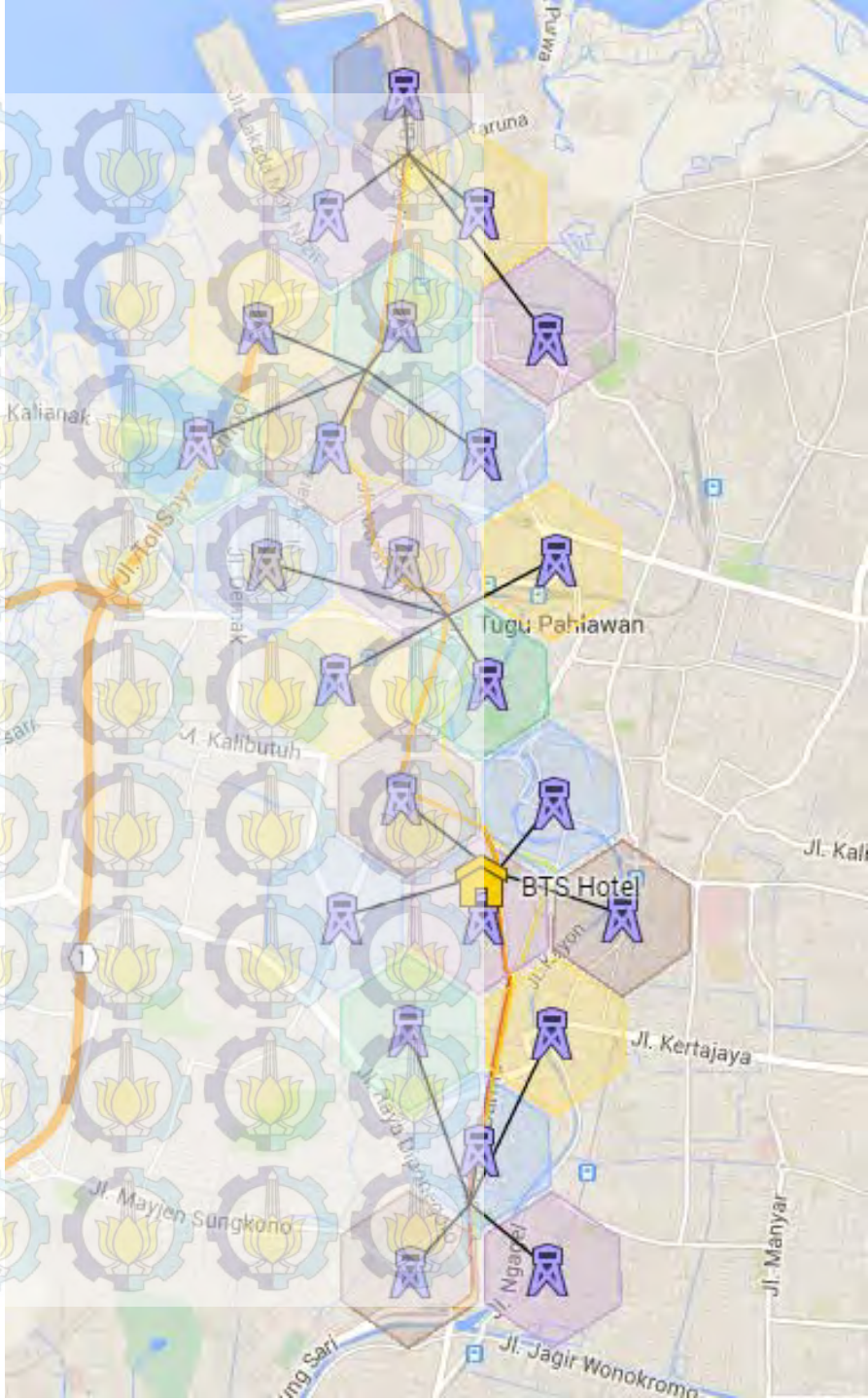
Saran



1. Quality
2. Cost (Business Consideration)
3. Regulation



Terima Kasih.



LTE Key Parameters

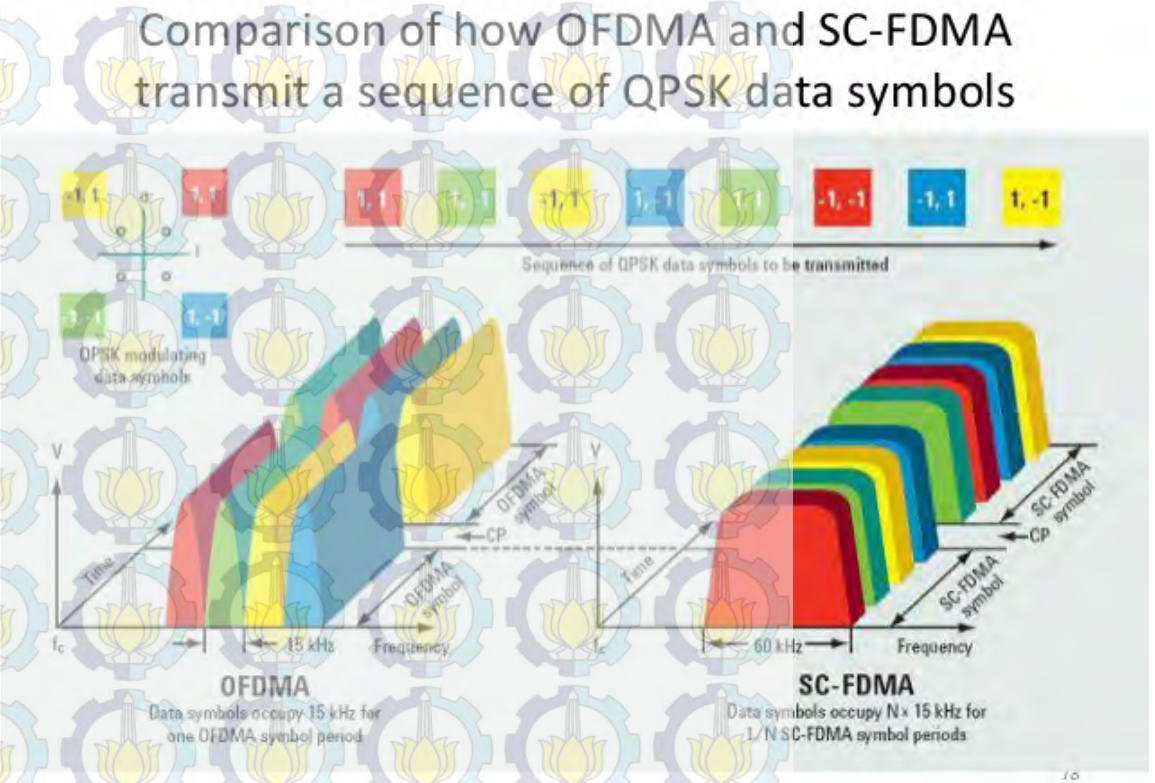
Frequency Range	UMTS FDD bands and UMTS TDD bands					
Channel bandwidth, 1 Resource Block=180 kHz	1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz
	6 Resource Blocks	15 Resource Blocks	25 Resource Blocks	50 Resource Blocks	75 Resource Blocks	100 Resource Blocks
Modulation Schemes	**Downlink:** QPSK, 16QAM, 64QAM **Uplink:** QPSK, 16QAM, 64QAM (optional for handset)					
Multiple Access	**Downlink:** OFDMA (Orthogonal Frequency Division Multiple Access) **Uplink:** SC-FDMA (Single Carrier Frequency Division Multiple Access)					
MIMO technology	**Downlink:** Wide choice of MIMO configuration options for transmit diversity, spatial multiplexing, and cyclic delay diversity (max. 4 antennas at base station and handset) **Uplink:** Multi user collaborative MIMO					
Peak Data Rate	**Downlink:** 150 Mbps (UE category 4, 2x2 MIMO, 20 MHz) 300 Mbps (UE category 5, 4x4 MIMO, 20 MHz) **Uplink:** 75 Mbps (20 MHz)					

OFDM Concept: Mutipath Propagation

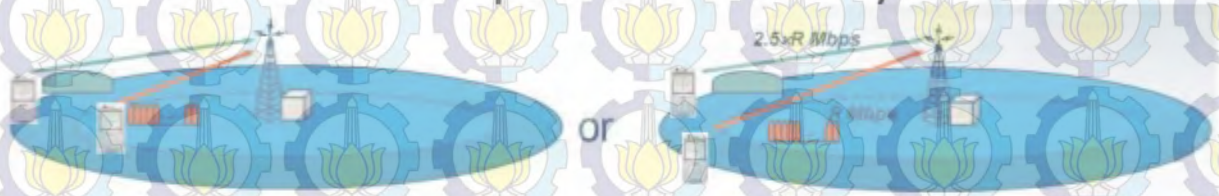
- Sinyal-sinyal multipath datang pada waktu yang berbeda dengan amplitudo dan pergeseran fasa yang berbeda, yang menyebabkan pelemahan dan penguatan daya sinyal yang diterima.
- Propagasi multipath berpengaruh terhadap performansi link dan coverage.
- Selubung (envelop) sinyal Rx berfluktuasi secara acak.

LTE Uplink Transmission Scheme: SC-FDMA

- Pemilihan OFDMA dianggap optimum untuk memenuhi persyaratan LTE pada arah downlink, tetapi OFDMA memiliki properti yang kurang menguntungkan pada arah Uplink.
- Hal tsb terutama disebabkan oleh lemahnya peak-to-average power ratio (PAPR) dari sinyal OFDMA, yang mengakibatkan buruknya coverage uplink.
- Oleh karena itu, skema transmisi Uplink LTE untuk mode FDD maupun TDD didasarkan pada SC-FDMA, yang mempunyai properti PAPR lebih baik.
- Pemrosesan sinyal SC-FDMA memiliki beberapa kesamaan dengan pemrosesan sinyal OFDMA, sehingga parameter-parameter DL dan UL dapat diharmonisasi.
- Untuk membangkitkan sinyal SC-FDMA, E-UTRA telah memilih DFT- spread-OFDM (DFT-s-OFDM).



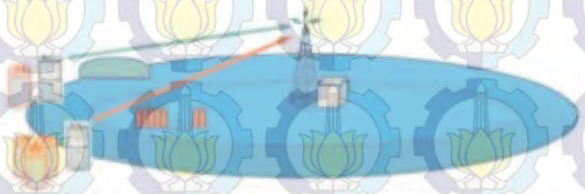
Improved UL Performance
SC-FDMA compared to ordinary OFDM



Improved coverage
(> 60% improvement)

or

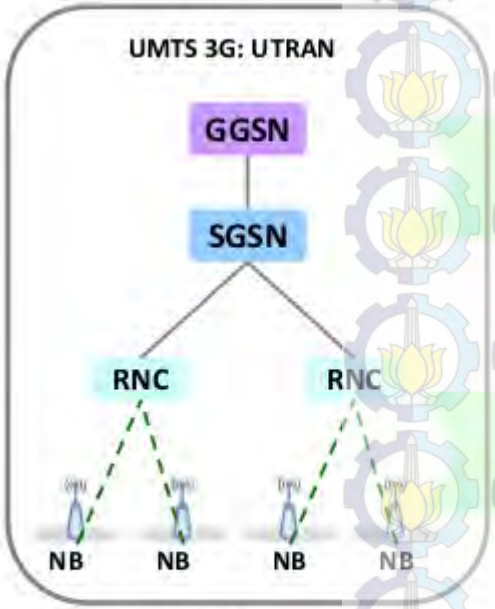
Higher data rates
(> 2.5 times improvement)



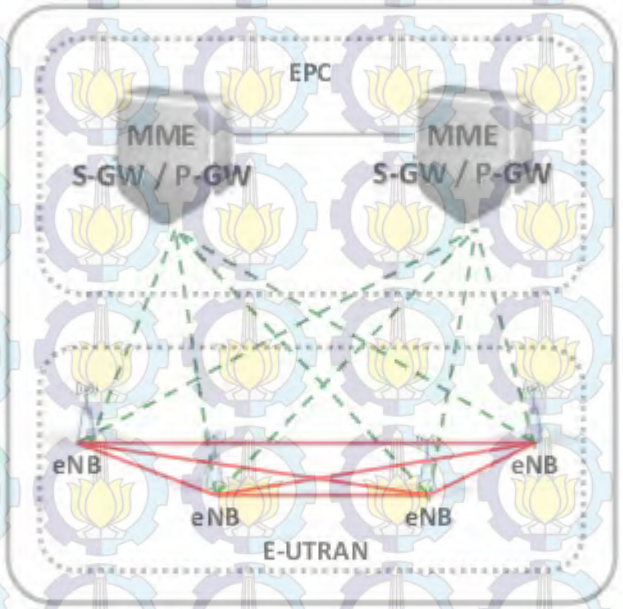
Reduced power consumption
Longer battery life

Single-carrier transmission in uplink enables low PAPR that gives more 4 dB better link budget and reduced power consumption compared to OFDM

LTE Network Architecture

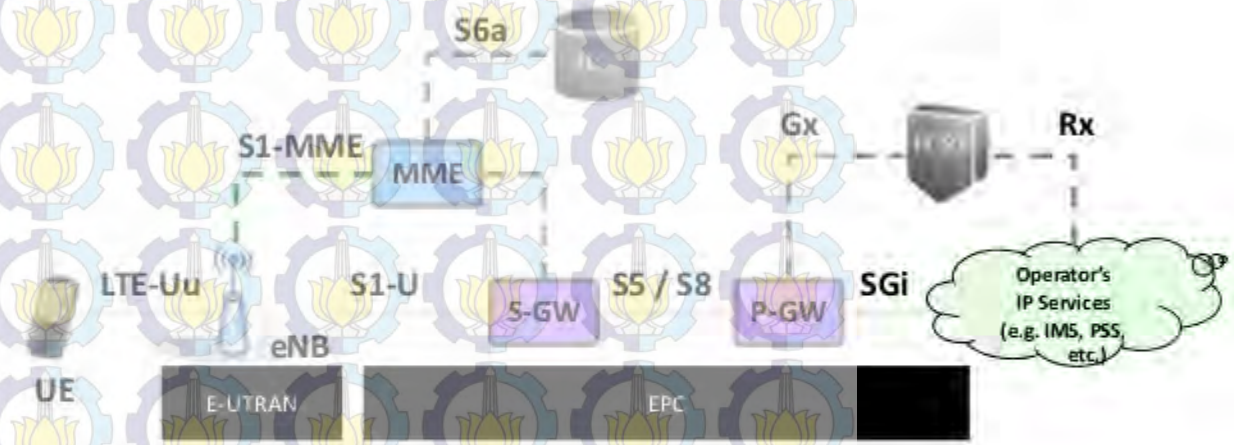


UMTS : Universal Mobile Telecommunications System
UTRAN : Universal Terrestrial Radio Access Network
GGSN : Gateway GPRS Support Node
GPRS: General Packet Radio Service
SGSN : Serving GPRS Support Node
RNC: Radio Network Controller
NB: Node B



EPC ; Evolved Packet Core
MME : Mobility Management Entity
S-GC : Serving Gateway
P-GW : PDN Gateway
PDN : Packet Data Network
eNB : E-UTRAN Node B / Evolved Node B
E-UTRAN ; Evolved-UTRAN

EPS Network Elements



- UE, E-UTRAN and EPC together represent the Internet Protocol (IP) Connectivity Layer.
- This part of the system is also called the Evolved Packet System (EPS).
- The main function of this layer is to provide IP based connectivity, and it is highly optimized for that purpose only.
- All services will be offered on top of IP, and circuit switched nodes and interfaces seen in earlier 3GPP architectures are not present in E-UTRAN and EPC at all.
- IP technologies are also dominant in the transport, where everything is designed to be operated on top of IP transport.