DOCOMO 6G OAM Sub-THz Communication System Architecture

Input Layer - Configuration Parameters

Scenario Selector
Indoor
Lab
Outdoor
Mobility

Distance Range
1m to 5000m
Range Slider

Frequency Bands
28/60/140/300
450/600 GHz

Weather Conditions
Clear/Light Rain
Heavy Rain/Fog/Snow

Mobility Patterns
Static/Pedestrian
Vehicular/High-speed

Physics Engine Core - Central Processing

Atmospheric Models

- ITU-R P.676-13 (O_2, H_2O)
- ITU-R P.838-3 (0-100 mm/h)
- Kolmogorov turbulence (Cn^2)
- Input: T(-40,+60°C), RH(0-100%)
- P(80-120 kPa)
- Output: 0.1-50 dB/km attenuation

OAM Beam Generator

- Laguerre-Gaussian (l=0-10, p=0-5)
- w_0 = 0.01-1.0m, λ = 0.5-10.7mm
- Mode purity: 0.6-0.99
- Spatial multiplexing: 1-10 modes
- OAM beam matrix generation
- Spatial gain: 1-10x

Channel Simulator

- FSPL: $20\log_{10}(4\pi df/c)$
- Pointing loss: 0.1-20 dB
- Rician K: -20 to +20 dB
- Rayleigh fading
- Doppler: fd = vf·cos(θ)/c
- Range: 0-10 kHz

Key Mathematical Models

Path Loss (dB) = $20\log_{10}(4\pi df/c)$ + Atmospheric + Pointing + Hardware

Shannon Capacity (bps) = B × $\log_2(1 + SINR)$ × OAM_gain

SINR (dB) = Tx_Power - Total_Loss - Noise_Interference

OAM Spatial Gain = η × N_modes × $Mode\_Purity^2$

Hardware Layer - Physical Implementation

Transmitter

- Power Amplifier: 5-50 dBm
- Phase Noise: -120 to -60 dBc/Hz
- IQ Modulator: 0.1-5.0 dB imbalance
- DAC Resolution: 8-16 bits
- Modulation: QPSK to 1024-QAM
- Coding: LDPC, Polar codes

Antenna Array

- OAM Mode Selector: Spiral plates
- Beam Steering: ±60° az/el
- Antenna Gain: 20-60 dBi
- Mutual Coupling: -50 to -10 dB
- Array Elements: 16x16 to 64x64
- Frequency: 28-600 GHz

Receiver

- LNA Noise Figure: 2-18 dB
- ADC Resolution: 8-16 bits
- OAM Demultiplexing
- Channel Estimation
- Equalization Algorithms
- Signal Processing Chain

Propagation Channel - Physical Medium

Distance: 1m — 5km

Clear
0.1-2.0 dB/km

Light Rain
2.0-10.0 dB/km

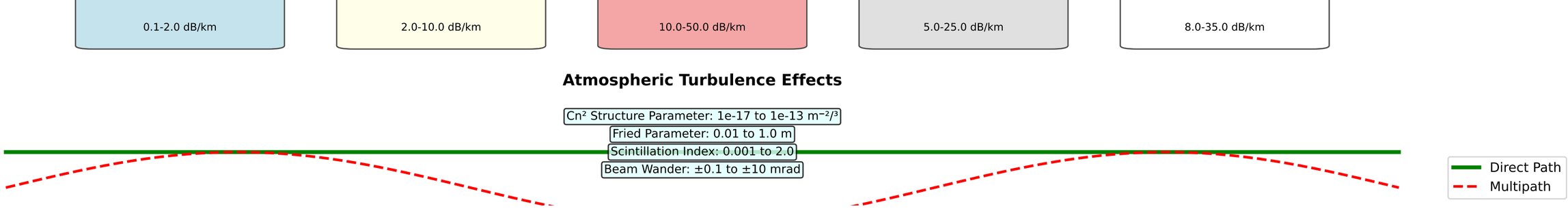
Heavy Rain
10.0-50.0 dB/km

Fog
5.0-25.0 dB/km

Snow
8.0-35.0 dB/km

Atmospheric Turbulence Effects

Cn^2 Structure Parameter: 1e-17 to 1e-13 $m^{-2/3}$
Fried Parameter: 0.01 to 1.0 m
Scintillation Index: 0.001 to 2.0
Beam Wander: ±0.1 to ±10 mrad



Output Layer - KPI Dashboard

SINR Meter
-30 to +50 dB
Color Coded Quality

Throughput
0.1-1000 Gbps
Log Scale

Latency
0.01-10 ms
Target: ≤1ms
0.1 ms

Reliability
90-99.999%
5-9s Target
99.95%

Energy Eff.
bits/Joule
100x 5G

Real-Time Performance Values

Current SINR: +35 dB (Excellent)
Achieved Throughput: 750 Gbps
Measured Latency: 0.05 ms
System Reliability: 99.97%
Energy Efficiency: 850 bits/J

RL Agent - Feedback Control Loop

- State Space: 32 dimensions
- Action Space: 16 control parameters
- Algorithms: Double DQN, Dueling DQN, Multi-Agent
- Reward Functions: Throughput, Latency, Reliability, Energy
- Learning Rate: 0.001-0.01
- Exploration: ε-greedy (ε=0.1-0.9)
- Experience Replay Buffer: 100K samples
- Target Network Update: τ=0.001

Standards Compliance Indicators

✅ DOCOMO 6G Compliance
Peak Rate: ≥100 Gbps ✅ (750 Gbps achieved)
Latency: ≤1 ms ✅ (0.05 ms achieved)
Reliability: 99.999% ⚠ (99.97% achieved)

✅ ITU-R IMT-2030 Compliance
Peak Rate: 50-200 Gbps ✅ (750 Gbps)
User Latency: 0.1-1 ms ✅ (0.05 ms)
Area Capacity: 1000x improvement ✅

✅ 3GPP Release 21+ Features
Network Slicing: eMBB/uRLLC/mMTC ✅
AI/ML Native: Integrated RL ✅
THz Spectrum: 300-600 GHz ✅