

Fujitsu's R&D Initiatives for LTE System Development

- Technologies that differentiate Fujitsu-

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FUJITSU LABORATORIES LTD.**

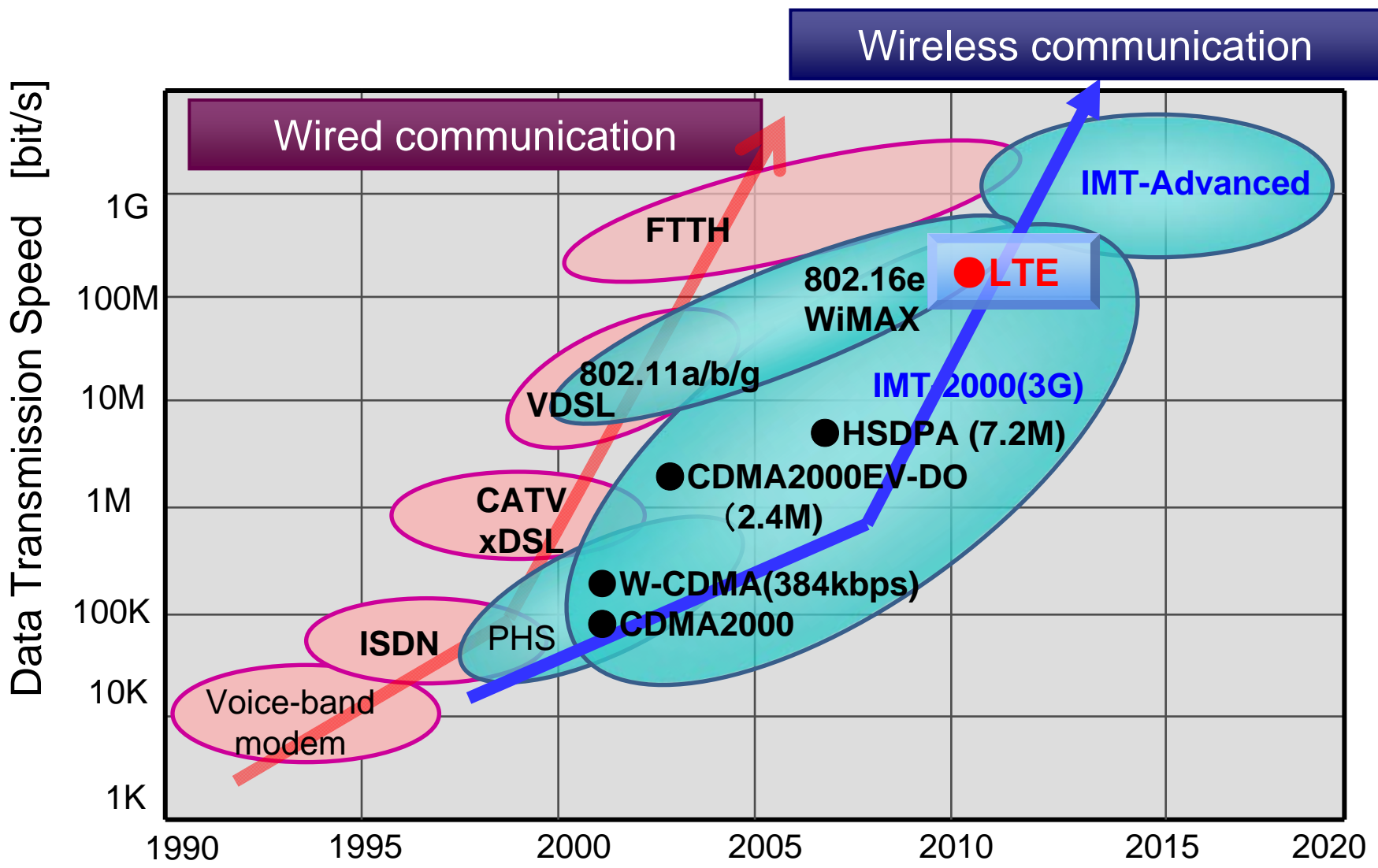
- Market Trend and New ICT World
- Technical Tasks for LTE
- Enablers to accomplish the tasks
 - Wireless Network Engineering
 - Optimization of BTS (Shared Amplifier, Interference Control)
 - Multi-band Antenna for Terminals
- Summary

LTE: Long Term Evolution

Next-generation cellular telephone system specifications being promulgated by the 3rd Generation Partnership Project (3GPP)

ICT: Information and Communication Technology

Transition of Data Transmission Speeds **FUJITSU**



Source: Ministry of International Affairs and Communications, Japan

From 3G to LTE / LTE-Advanced



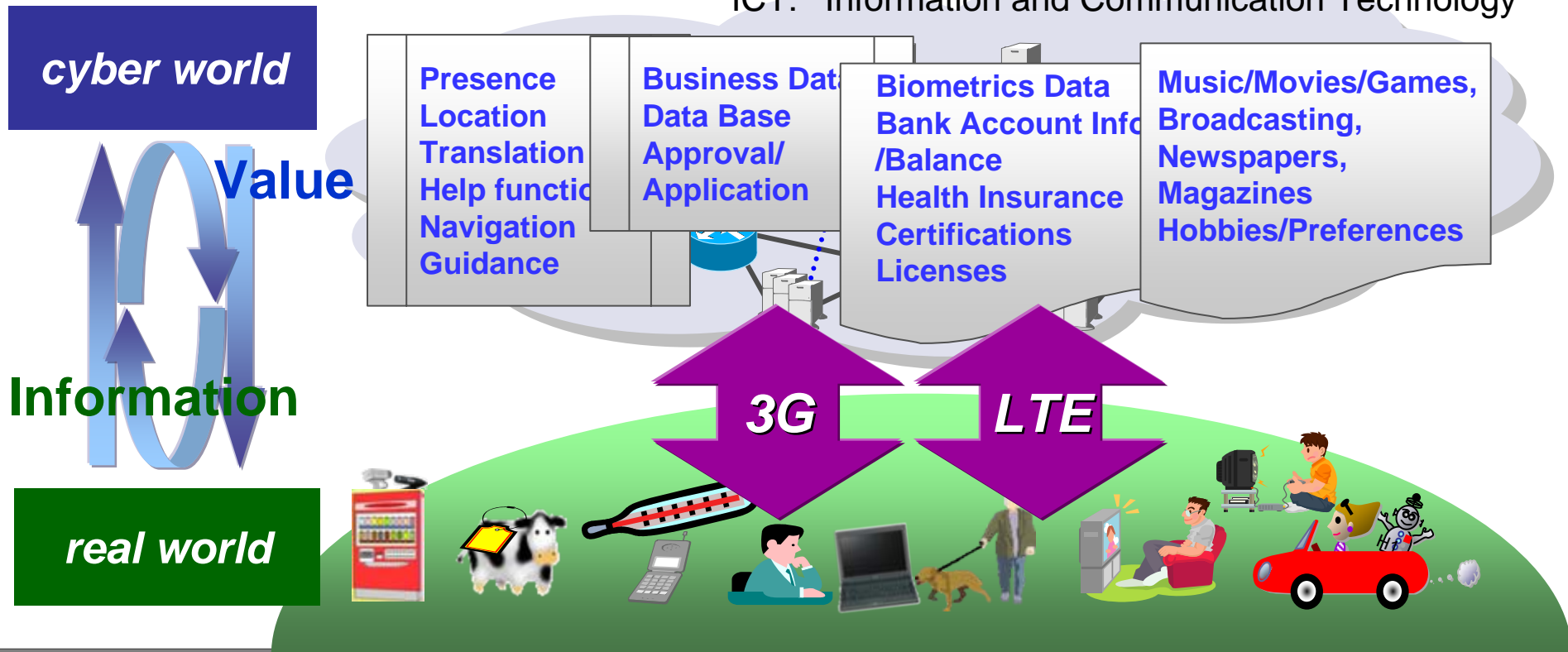
	W-CDMA (3G)	HSDPA/EUL (3.5G)	CDMA2000 1xEV-DO		LTE	LTE-Advanced (4G)
			Rev.0	Rev.A		
Wireless Access	DL: CDMA UL: CDMA	DL: CDMA UL: CDMA	DL: CDMA UL: CDMA	DL: CDMA UL: CDMA	DL: OFDMA UL: SC-FDMA	DL: OFDM(?) UL: (?)
Frequency Bandwidth	5 MHz	5 MHz	1.25 MHz	1.25 MHz	20 MHz	>100 MHz
Modulation	HPSK,QPSK	HPSK QPSK 16QAM	BPSK,QPSK 8PSK, 16QAM	BPSK,QPSK 8PSK, 16QAM	QPSK 16QAM 64QAM,etc.	QPSK 16QAM 64QAM,etc.
Data rate (max.)	DL: 384kbps UL: 64kbps	DL: 14.4Mbps UL: 5.7Mbps	DL: 2.4Mbps UL: 154kbps	DL: 3.1Mbps UL: 1.8Mbps	DL: >200Mbps UL: 50Mbps	DL: 1~3Gbps UL: 500Mbps
Service-in	2000	HSDPA: 2006 EUL: 2008	2003	2006	Around 2010	In or after 2015

DL: Down Link UL: Up Link W-CDMA: Wideband Code Division Multiple Access EV-DO: Evolution Data Only
HSDPA: High Speed Downlink Packet Access OFDMA: Orthogonal Frequency Division Multiple Access
EUL: Enhanced Up LINK SC-FDMA: Single-Carrier Frequency Division Multiple Access

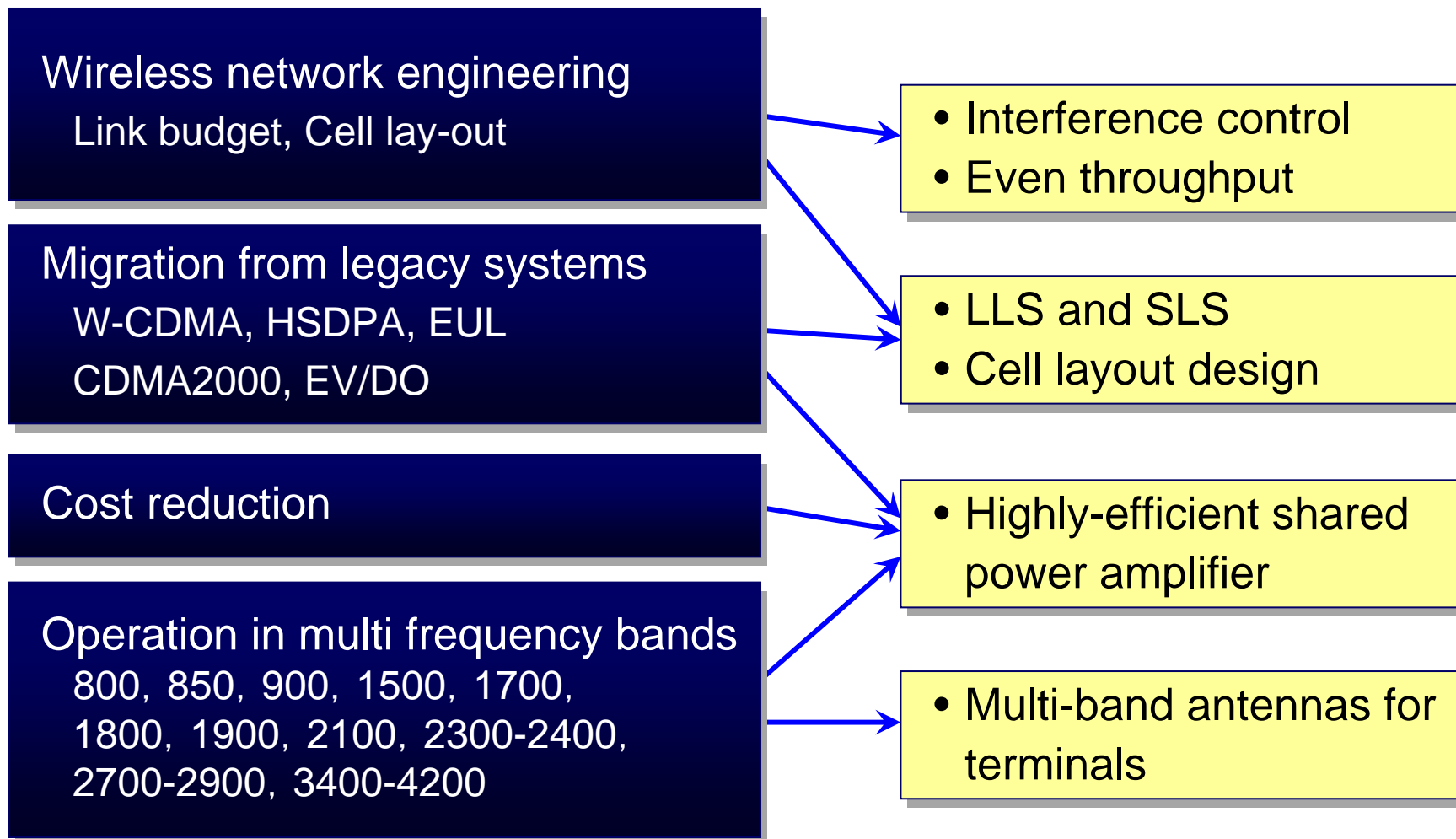
New "ICT world" driven by LTE

- Social infrastructure where IT resources (servers, data services, etc.) and applications are tailored according to individual requirements
- Mutual interaction between *real world* and *cyber world*

ICT: Information and Communication Technology



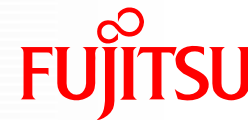
Technical Tasks for LTE



SDR: Software Defined Radio

LLS : Link Level Simulator

LTE Field Test



■ Joint field test by NTT docomo and Fujitsu

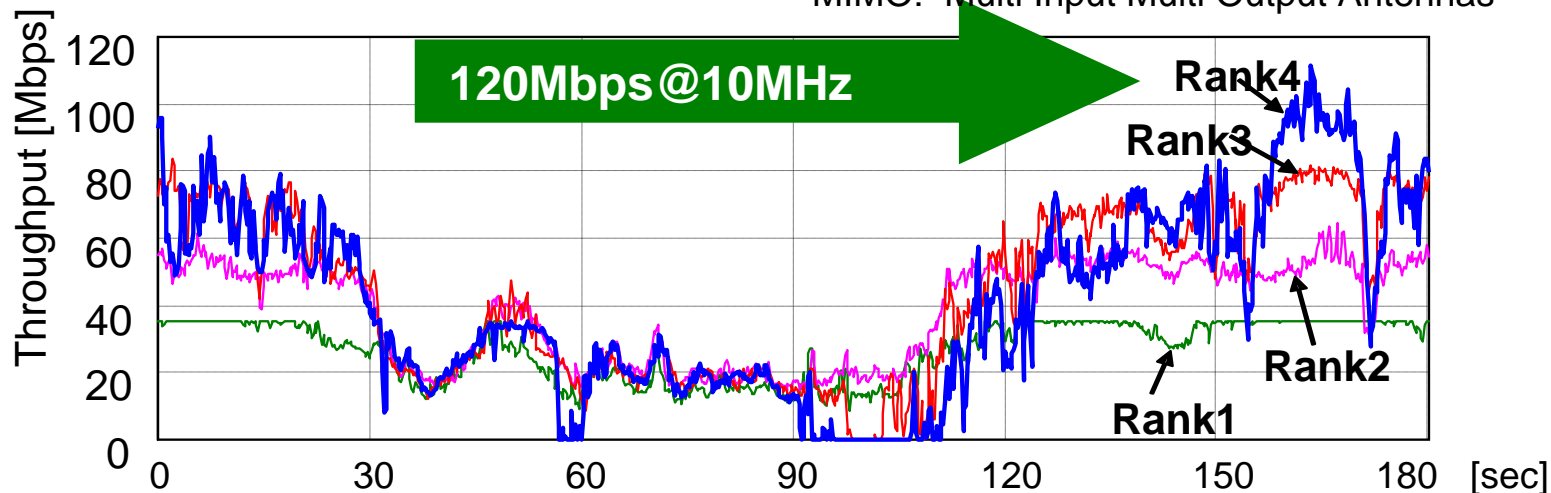
■ Objectives

- Propagation result
- Down link throughput
- Frequency scheduling

■ Results

- **Max. 240Mbps(@20MHz bandwidth)** throughput verified
- Adaptive antenna multiplexing for MIMO (Rank) confirmed

MIMO: Multi Input Multi Output Antennas



LTE Field Test Press Release

Fujitsu Conducts Collaborative Field Testing of LTE

Tokyo and Kawasaki, Japan, March 16, 2009 — Fujitsu Limited and Fujitsu Laboratories Limited today announced that, in collaboration with NTT DOCOMO, INC., they have conducted successful field testing for Long-term Evolution (LTE⁽¹⁾), a core technology standard for high-speed wireless communications, using 4x4 MIMO⁽²⁾.

The testing took place in the Special Ubiquitous Zone, an area of the northern Japanese city of Sapporo in Hokkaido, designated by the Ministry of Internal Affairs and Communications in 2008 as a wireless communications testing area, and used prototypes of the wireless LTE base stations developed jointly by NTT DOCOMO, Fujitsu and Fujitsu Laboratories which, with the use of MIMO technology, resulted in high-speed wireless transmissions in the range of 120 Mbps (using 10 MHz bandwidth) in Sapporo's urban environment.

LTE, sometimes referred to as the 3.9G wireless standard, is a standard for wireless communications that enables broadband communications for mobile phones. It is an international standard created by the standard-setting organization 3GPP⁽³⁾ and is intended to produce dramatic improvements in wireless performance, including faster, higher-capacity data communications, reduced connection lag times, and more efficient bandwidth frequency utilization.

Fujitsu and Fujitsu Laboratories were selected by NTT DOCOMO in 2006 to be the developer and manufacturer of their wireless LTE base stations. Since then, they have worked together with NTT DOCOMO to develop these technologies using 4x4 MIMO, which increases speed and capacity in both transmitting base stations and receiving mobile stations, and the three companies have performed successful tests of a prototype three-sector LTE base station that has a transmission capacity of 300 Mbps per sector on the downlink (20 MHz band).

The field testing involved LTE transmissions using NTT DOCOMO test stations in Sapporo's urban environment, assessing the throughput characteristics of 4x4 pre-coding MIMO⁽⁴⁾ on the downlink and confirming that a maximum of 120 Mbps (using 10 MHz bandwidth) could be attained over a measured course. The

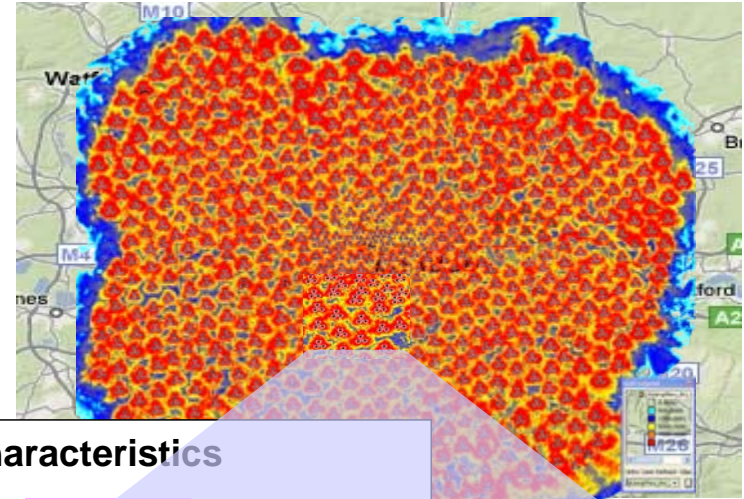
Transmitting different signals at the same time, over the same frequency, using four antennae



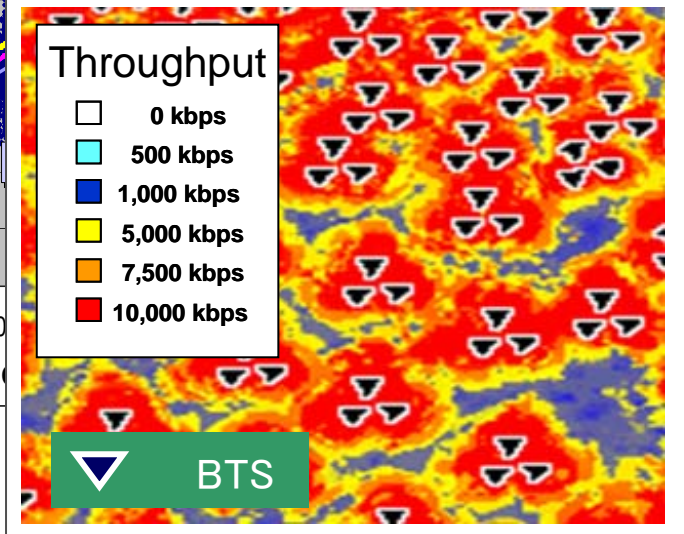
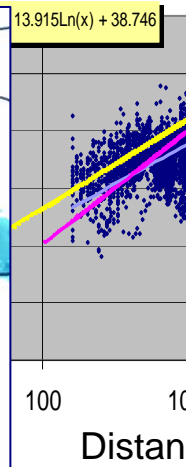
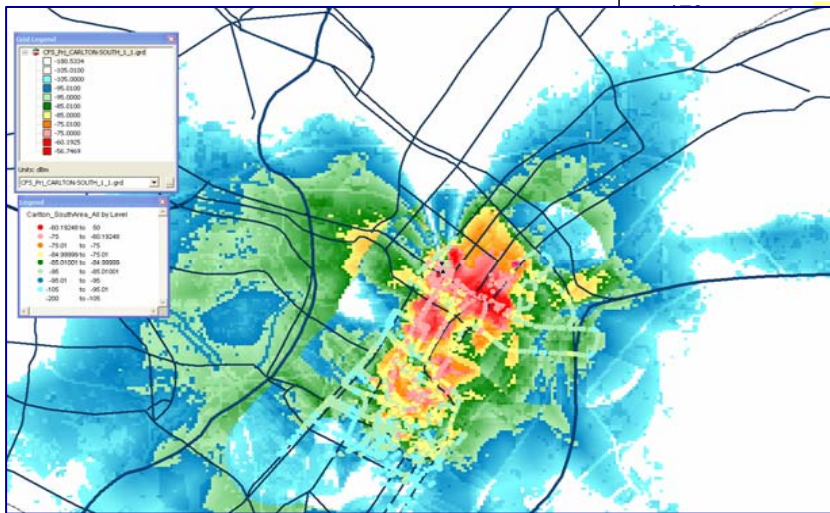
BTS Prototype

<http://www.fujitsu.com/global/news/pr/archives/month/2009/20090316-01.html>

- Analysis of propagation characteristics from real map
- Simulation of strength of received radiowave
- Estimation of throughput and optimization of BTS layout

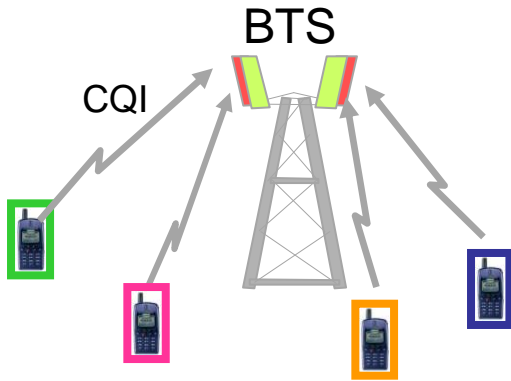


Propagation Characteristics

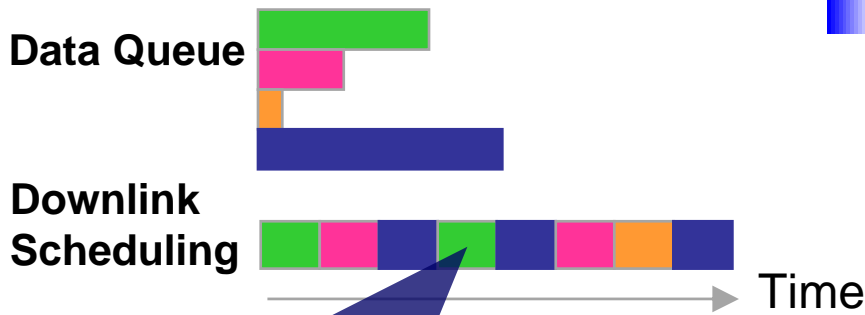


Technologies to enable even throughput

Optimal scheduling



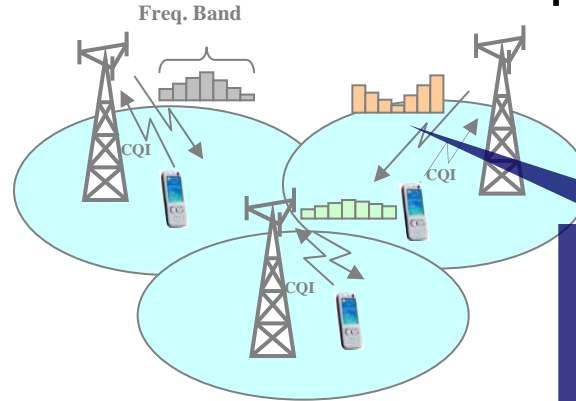
CQI: Channel Quality Indicator



Optimized order of packet transmission

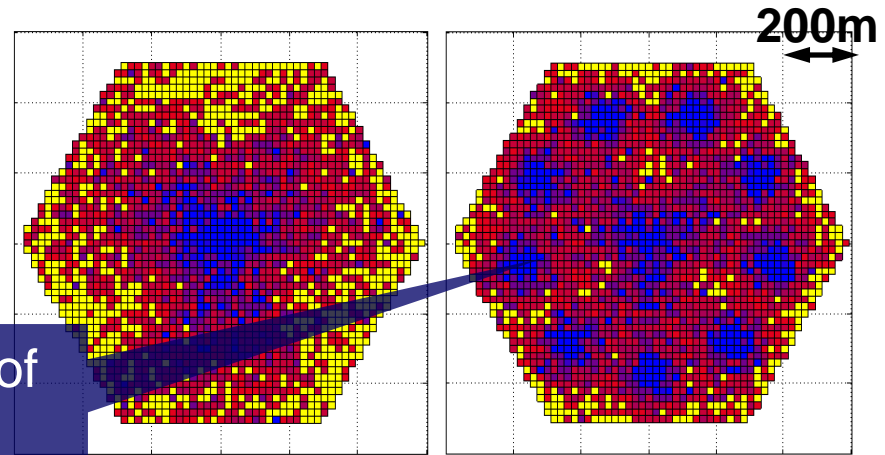
Improvement of throughput within a cell

FFR (Fractional Frequency Reuse)



Reduce interference (in-cell)

Relay Station (RS)

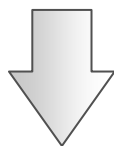


One BTS

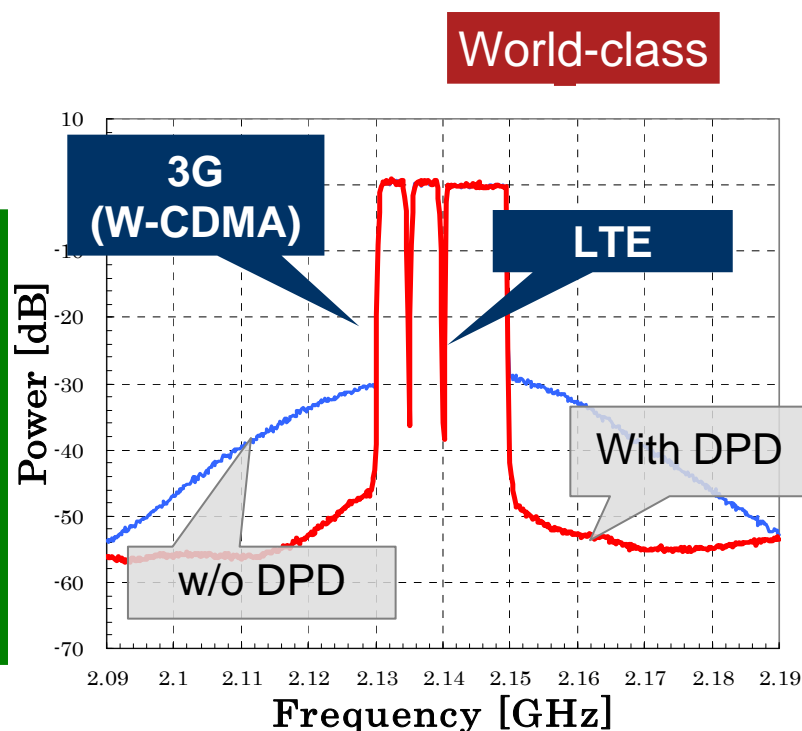
BTS + Relay

Shared Amplifier for Migration

- Power-efficient amplifier module using GaN device
- Higher efficiency using Digital Pre-Distortion (DPD) to reduce non-linear distortion
- Shared amplifier for both 3G and LTE



- Ecological base station (Green Wireless)
- Smooth migration from existing 3G to LTE

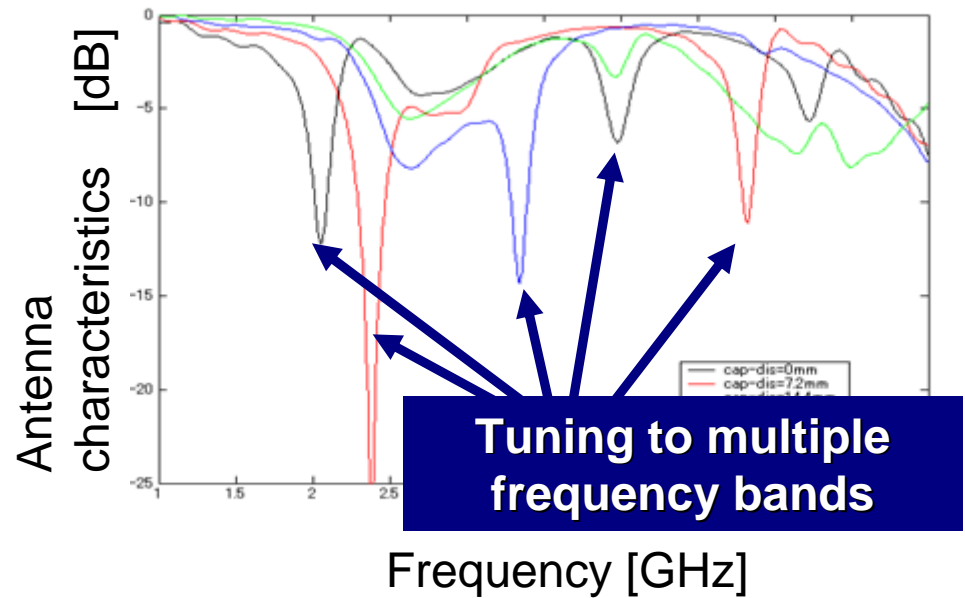
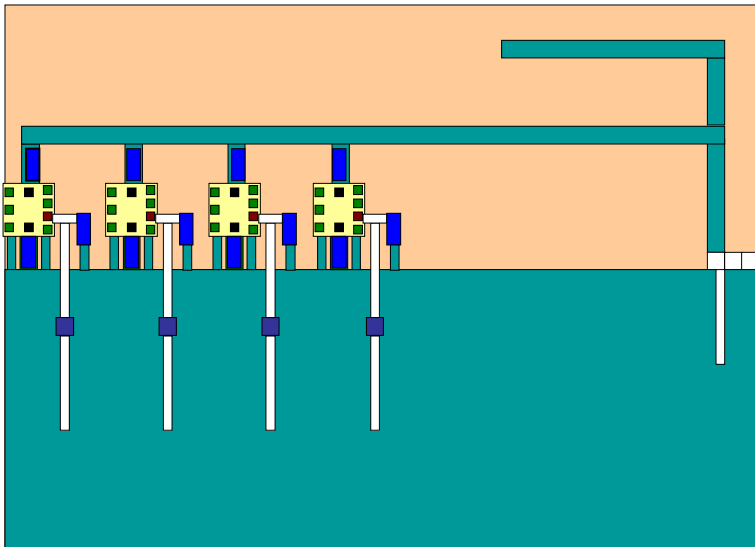


GaN: Gallium Nitride

DPD: Digital Pre-Distortion

Multi-Band Antennas

- Tunability to regional frequency bands
- Antenna element to cover 600MHz to 6GHz



Enabling an environment in which communication is possible anytime, anywhere, with anything (“available like air”),

- to entrust private functions to networks, and
- to keep “everything readily at hand” (full accessibility) without actually carrying anything.

Full Mobility

Global and seamless communication in any environment (home, office, outdoors, in transit: in-vehicle, on trains/aircraft)

Broadband

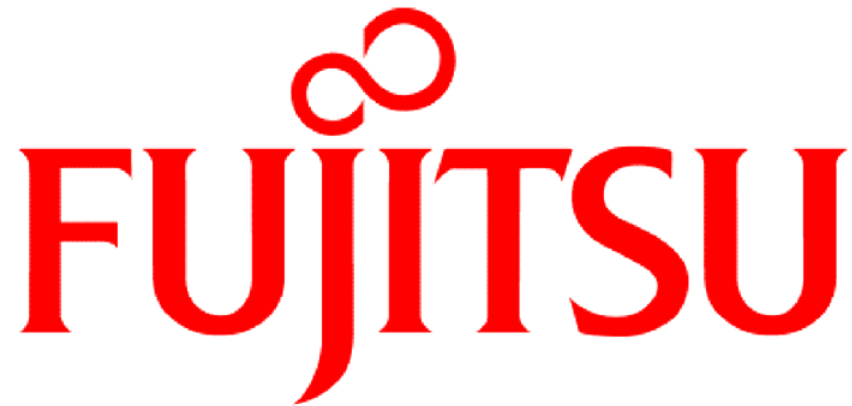
Stress-free wireless broadband communication (thin client, video streaming, broadcasting)

Individualization

Customization of processing of personal data, identities, credibility, and preferences

- Comprehensive and exhaustive R&D ranging from SoCs, wireless platforms, terminals, base stations, high-efficiency amplifiers, to core networks
- Technological contributor for deployment of LTE systems in and outside of Japan (global deployment)
- Catalyst for wide business expansion into new areas (cloud computing, thin client, etc.) leveraged by practical-use LTE

SoC: System on a Chip



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THE POSSIBILITIES ARE INFINITE

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