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Emerging Technologies Across The Field

In this issue

- Energy consumption in Denpasar
- Kano analysis
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- UAV contactless vital sign monitoring
- Monitoring water health with UAVs
- Narrowband and wideband FM

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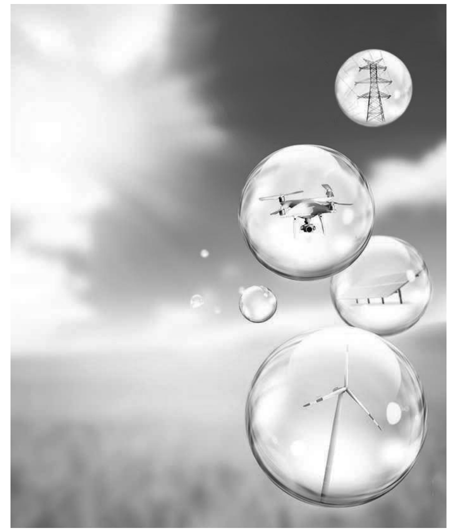

ON THE COVER:
Emerging technologies in energy consumption, UAVs tracking both water and human health, exploring user access via the Kano method, and more.

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Energy consumption on high-speed downlink packet access transmission in the Denpasar area in 2014

Ridho Yurham, Linawati, and Gede Sukadarmika

The need for cellular telecommunication services is increasing every year. Cellular technology is rapidly growing in developing countries because of the lack of wired physical networks. This has an impact on increasing the energy demand.

This article provides an analysis of energy consumption using 29 of the 3G-enabled base stations (BSs) as samples in the West Denpasar area, Bali Province, Indonesia.From a cellular traffic profile analysis, it turns out that a sleep mode method could be used from 3:00 a.m. until 5:00 a.m. every day. This approach could reduce the area's energy consumption.

With the sleep mode methodology, the energy consumption can be estimated to be lowered by up to 3,374 kW in a year. In March 2014, the energy consumption rate (ECR) ratio on sleep mode hours dropped by 5.96 W/Gb/s and, in April 2014, decreased by around 4.69 W/Gb/s compared to the existing conditions. The area power consumption (APC) per data rate (γ) value using sleep mode hours was reduced by 0.22 W/km^2/Gb/s in March and 0.17 W/km^2/Gb/s in April compared to the existing values. The APC ratio also shows that, in March, the use of sleep mode hours could lead to reductions around 146.487 W/km^2 and, in April, 111.98 W/km^2. The coverage reduction of up to 3.1% becomes the tradeoff of this methodology; this could be covered by the 2G system.

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Background

The need for telecommunication services—more specifically, cellular telecommunications—has rapidly developed. The cellular traffic load was estimated at 6.3 EB per month in 2015 (CISCO, 2015).

Developing countries have become the fastest growing in cellular telecommunications because of the lack of wired telecommunications facilities. This has become a reason why BS development has risen in those countries, which has an impact on energy demand. Many stakeholders have commenced the study of green cellular technology to face this.

One of those approaches is the sleep mode methodology, which uses traffic prediction to make the BS go into a sleep state during low-traffic

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conditions. Recent research was conducted by Morosi (2013), who used the sleep mode and maximum power transmission on the BS side to reduce energy consumption. The results showed that, during off-peak times, the energy consumption ratio had large differences.

Other research, conducted by Peng et al. (2012), proposed a self-organizing pilot-power adjustment mechanism algorithm. The results show that this approach could reduce the energy consumption 17% in homogenous cell deployment simulations.

Our research investigates an efficient sleep mode methodology applied to existing networks in the Denpasar area. We used a green metric value to compare the existing and sleep mode methodologies.

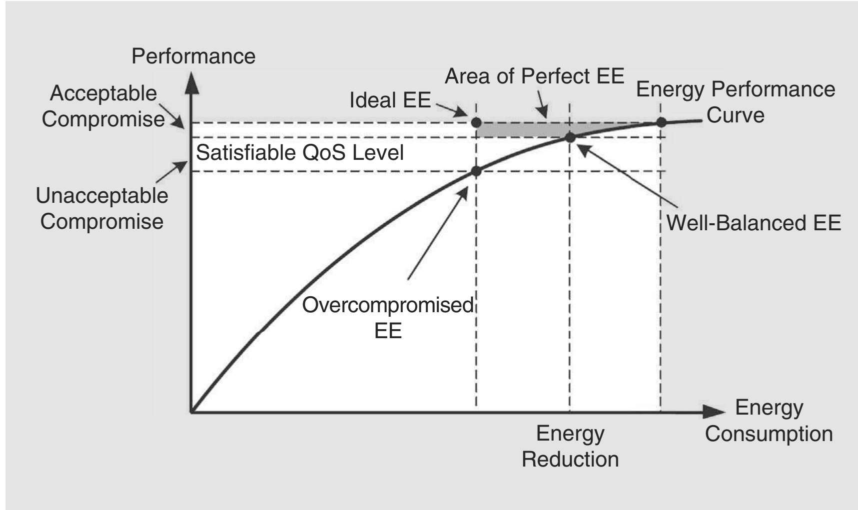

FIG1 The energy–performance tradeoff in mobile communications. EE: energy efficiency. (Source: Wang et al., 2011; used with permission.)

Literature review

Green cellular network

The demands on information and communications technology (ICT) facilities are growing and developing rapidly across the world. This condition will result in an energy crisis due to facility operational capacity. It also triggers greenhouse gases and global warming.

Based on that, industrial, government, and academic stakeholders are conducting research to build environment-friendly ICT facilities known as *green cellular networks*. This technology has a tradeoff between the energy consumption and network performance, like quality of service (QoS), throughput, and scalability. In addition to reducing the energy consumption, this approach could decrease the electrical bill, which would help cellular operators economically (Oh et al., 2011) (Fig. 1).

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Green metrics

Green metrics are the energy efficiency evaluation metrics in mobile communications. There are two types of green metrics: equipment- and facility-level ones (Wang et al., 2011). Equipment-level metrics evaluate each peripheral in low-level consumption. These include the ECR, consumer consumption rating developed by IXIA and Juniper, telecommunication energy efficiency rating proposed by the Alliance for Telecommunication Industry Solutions, and many more. At the facility level are the metrics that evaluate higher-level consumption from a macro perspective. These include the power usage effectiveness, data center infrastructure efficiency, and data center productivity proposed by Green Grid.

The ECR is the ratio of the energy used per bit of data, which is shown mathematically as

$$\mathrm{ECR} = \frac{P_{\max}}{C_{\max}} \ (\mathrm{W/b/s}). \tag{1}$$

The APC is a metric that can calculate power usage (P) per area (S) and is expressed by

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