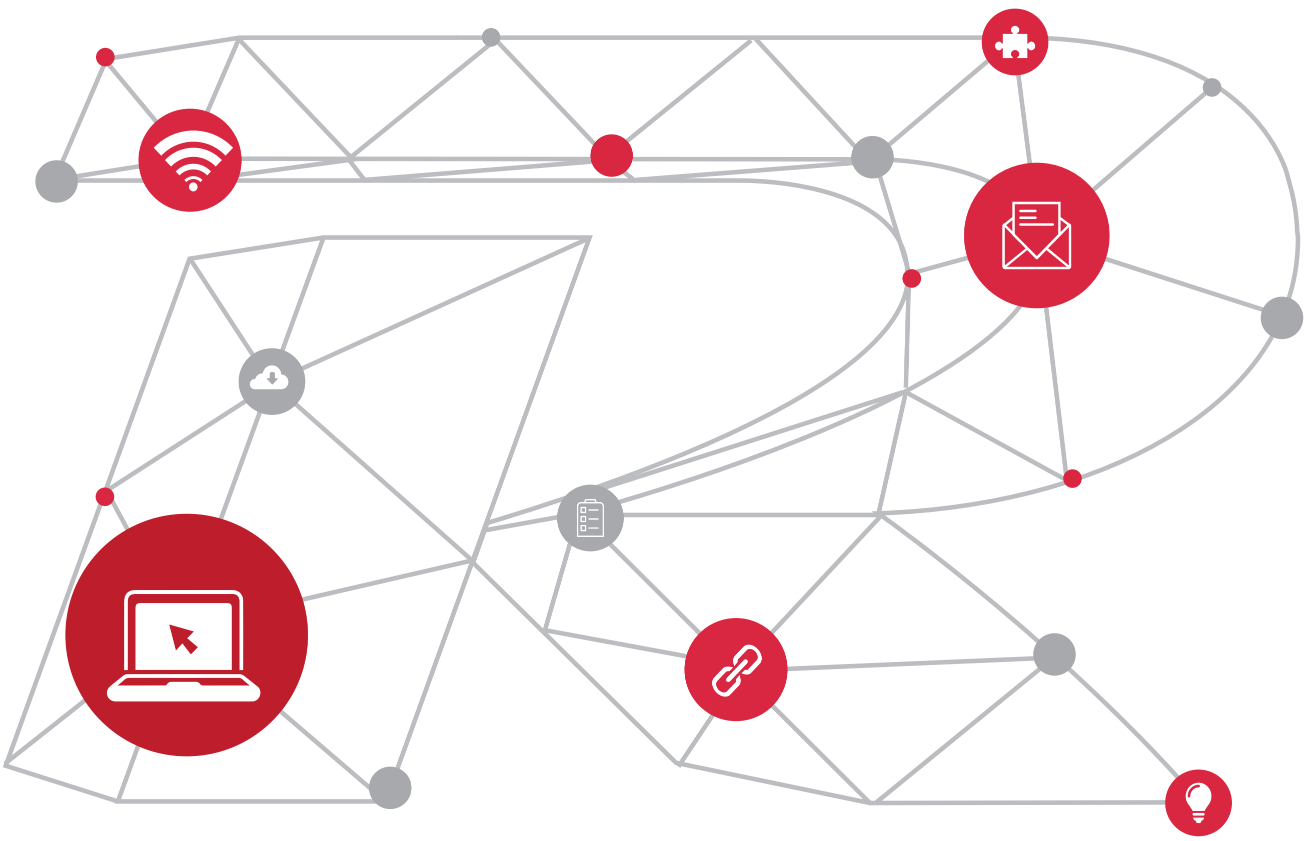
Ruijie Fair Scheduling

White Paper



Contents

Introduction

This document describes the Commited Access Time (CAT) fair scheduling technology used on wireless access points (APs).

• Terminology

Terminology	Description
CAR	Committed Access Rate
CAT	Committed Access Time
CSMA/CA	Carrier Sense Multiple Access with Collision Avoidance
DCF	Distributed Coordination Function
FIFO	First In First Out
STA	Station
WNIC	wireless network interface card

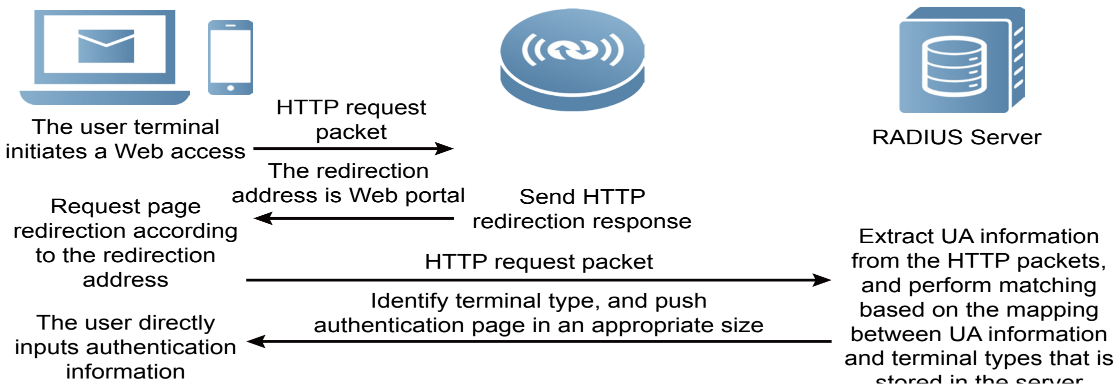
• Overview

The wireless networks adhering to IEEE 802.11 standards (hereinafter referred to as IEEE 802.11 networks, including Wi-Fi networks) are half-duplex links, adopting the Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) mechanism. Such links permit only one device to transport data at a time. Otherwise, the signals will be damaged, and the data transmission will fail. Moreover, all STAs (an AP is a special STA) share the same opportunity to enjoy link resources. However, in an AP-based wireless network, the following problems may occur:

* **A lower-rate STA may occupy the link with longer time while less transmission than a higher-rate STA does. This happens when they transmit same-size data and will reduce the overall throughput. During a given period of time, the available duration of the wireless link determines the available resources. Once a lower-rate STA hogs the resources, the entire throughput will shrink subsequently.**

* **The downlink rate of non-AP STAs maybe instable even if they possess uniform access rate and RF technology. This happens to a FIFO-manner network. When a STA wins a channel, the channel will be dominated by the uplink frames against the downlink frames triggered. As a result, the download traffic of the STA will fluctuate. See Figure 1.**

Figure 1



If two STAs under a FIFO AP are downloading concurrently, their downlink transmission rates vary with time conversely.

To achieve the objective, the following technical indicators are defined.

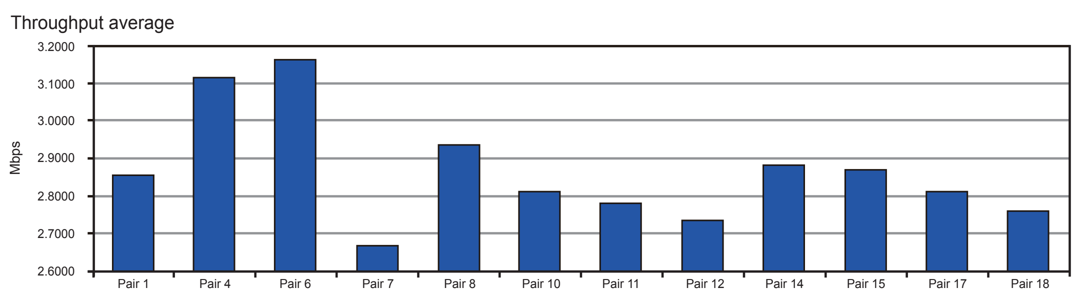
* **Each wireless network interface card (WNIC) on the AP supports scheduling a maximum of 23 STAs.**

* **Each WNIC buffers a maximum of 512 packets and discards excess packets.**

* **When the number of associated STAs is from 2 to 32, after IxChariot measures the wired-to-wireless download traffic, the rate jitter of each STA is within 50% of its average rate (the test should be conducted in a shielding room).**

* **For up-to-32 STAs associated with the same AP and WNIC, after the IxChariot measurement, the difference between the average rate of each STA and that of all the STAs does not exceed 15% (the test should be conducted in a shielding room).**

Figure 2 Average Throughputs of 12 STAs



Technical Principle

In the existing wireless packet forwarding model, some STAs occupy wireless links for too long, while other STAs cannot transmit packets to radio channels via the AP. Based on the foregoing problem analysis, the root cause is the FIFO policy. To troubleshoot this problem, it is critical to invoke time-limit for link usage assuring equal timeslots for engaged STAs. With reference to Committed Access Rate (CAR), we have proposed Committed Access Time (CAT). CAT aims to ensure that all non-AP STAs occupy a radio link for an equal period of time (that is, the AP linking duration is evenly allocated to all the STAs).

The prerequisite for CAT implementation is the following assumptions:

* **Assumption 1: The packet transmission rate of each STA is stable within a short period of time, which can be set to tens of milliseconds.**

* **Assumption 2: At the link layer, the packet transmission in one direction can be suppressed by controlling the packet transmission in the other direction. This adapts to most of the applications imbedded with a certain acknowledgment mechanism.**

The assumption 2 is required, for the current DCF operating mode only allows the AP to control packet transmission. In this case, the fair scheduling can be achieved just by suppressing packets sent from the AP.

Based on the software architecture of Ruijie APs, this algorithm can be implemented at two layers: driver layer and fast-forwarding layer.

* **Driver layer: The driver varies with hardware. It relies on manufacturer-supplied SDK, which is responsible for its hard change due to special optimization. However, a coin has two sides. The driver layer seizes details about each packet, thereby ensuring precise scheduling algorithm.**

* **Fast-forwarding layer: This layer has a great advantage over the application-differentiated driver layer. It can be thought to be hardware-independent (though this simply concerns the packet forwarding part). The CAT calculation at this layer requires only a slight change of SDK scheduling instead of the hardware. Other anticipated benefits of this layer contains: establishing multiple queues, integrating multiple scheduling modes, and even addressing IP packets directly. In addition, it invokes the driver interface to obtain some STA information. Though the obtainment is not real-time, it occurs at regular time. Currently, the accessible information includes the rate of radio transmit from the AP to STAs and STA Tx/Rx frame counter. As the algorithm is being improved, the following items will be added on demand: the error frame counter, retransmission counter, aggregate frame counter and others of STAs.**

After the above comparison, we have decided to implement the CAT algorithm at the fast-forwarding layer.

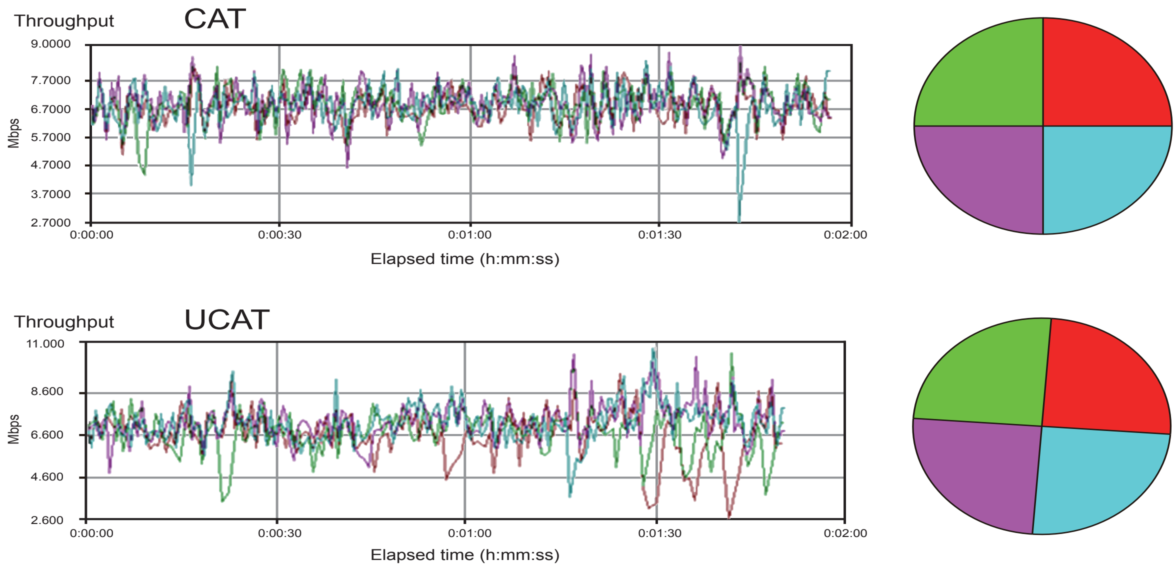
Typical Application

The fair scheduling algorithm is suitable for general wireless networks, especially those with a large number of subscribers.

Preliminary Test Results

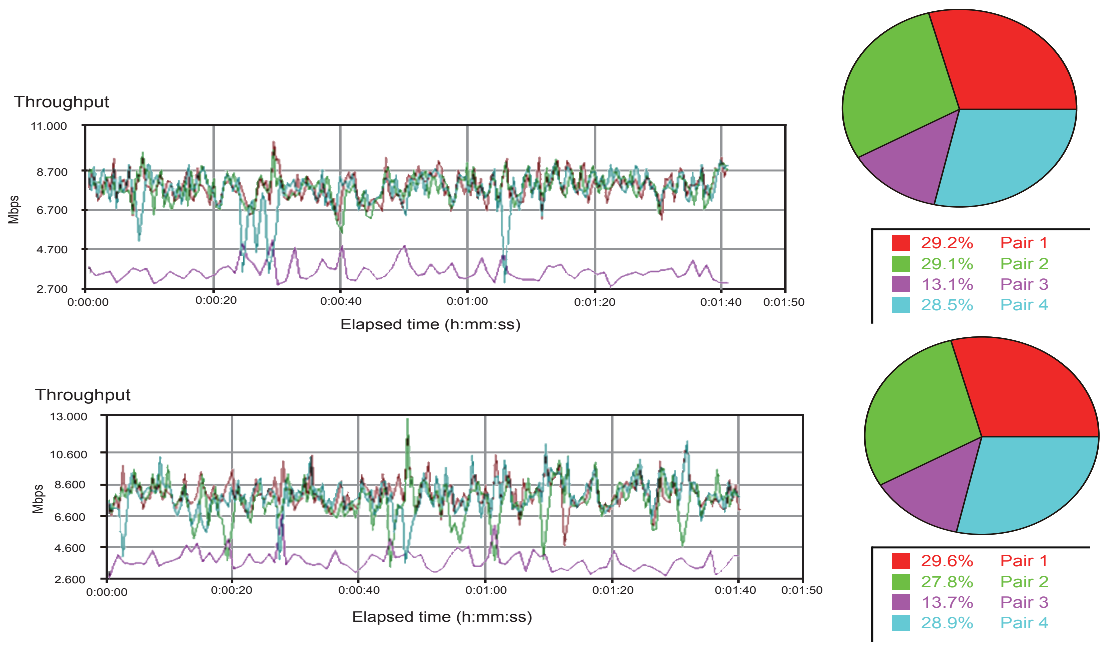
The following figures show the test results in the preliminary test.

Figure 3 Test Results of Four 802.11n Single-Flow WNIC (65 Mbps)



(The first figure shows the fair scheduling-enabled test result; the second figure shows the fair scheduling-disabled test result.)

Figure 4 Test Results of Three 802.11n Single-flow WNIC (65 Mbps) and One 802.11g WNIC (39 Mbps)



(The first figure shows the fair scheduling-enabled test result; the second figure shows the fair scheduling-disabled test result.)

Conclusion

Ruijie fair scheduling technology allocates balanced timeslots for a large number of subscribers in multi-type terminals and scenarios. This ensures that different end-users obtain equal radio network resources, thus improving user experience and network capability.

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For further information,please visit our website **http://www.ruijienetworks.com**