Xtra Speed Ecosystem

MediaTek Filogic White Paper

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Key Insights

- MediaTek Mesh Boost increases overall mesh network throughput by over 20%.
- MediaTek Coordinated Spatial Reuse (Co-SR) increases throughput by up to 30%.
- MediaTek AI Anti-Noise reduces latency by up to 60%.

Introduction

Wi-Fi has emerged as the most viable alternative to traditional wireline connectivity solutions, such as Ethernet and coaxial cables. It offers the convenience of cable-free connectivity for many devices, such as laptops and televisions, without the constraints of physical attachments. While the peak throughput of Wi-Fi 7 is significantly higher than previous Wi-Fi generations and exceeds the requirements of many applications, users may occasionally experience intermittent jitter during streaming or video conferencing. This indicates Wi-Fi's susceptibility to environmental factors that impact signal quality and consistency.

Consider a typical home scenario during a family gathering where multiple devices are simultaneously connected to Wi-Fi service. This increases the demand for throughput and generates more interference due to the rise in Wi-Fi devices. Wi-Fi uses collision avoidance technology, requiring access points (APs) and clients to wait for a random period before retransmitting if collisions are detected. When numerous devices compete for airtime, this can increase the chance of collisions and slow down users' Wi-Fi access. In this white paper, we introduce Xtra Speed, a MediaTek Filogic ecosystem suite designed to adaptively enhance Wi-Fi performance not only under these conditions but also during daily use; for example, during peak hours when everyone is using Wi-Fi to access the internet.

- Mesh Boost utilizes Multi-Link Operation (MLO) technology in Wi-Fi mesh setups. With multiple APs, the home can better manage high-density environments, even in those tricky corners, ensuring that all family members enjoy smooth internet speeds and real-time communication without delays during gatherings.
- Coordinated Spatial Reuse (Co-SR) optimizes the transmission power of multiple APs, achieving optimal throughput while avoiding interference. This means that the various APs in the home will not experience significant interference, allowing family members to benefit from faster web page loading times and seamless downloads.
- AI Anti-Noise dynamically adjusts the network configuration to adaptively avoid interference. This ensures that the Wi-Fi network remains optimized and delivers an exceptional user experience. Conference calls will no longer suffer from fluctuating connection quality, high latency, or long buffering times, even in areas with a high number of active devices.

The MediaTek Filogic Xtra Speed ecosystem improves performance, offers higher throughput, and reduces latency, ultimately enhancing the user experience and makes every day online activities seamless, and more enjoyable.

Xtra Speed – a MediaTek Filogic Ecosystem

Figure 1 shows a typical family gathering at the Smiths' house where a visiting family of relations joins them for a day's activities. Everyone has their own electronic devices, such as smartphones, VR headsets, tablets, and laptops, while smart home gadgets also fill the house. The Smiths live in a spacious house with a basement and multiple rooms.

Figure 1. Smith house activities during a family gathering.

During the gathering, family members are using their devices at the same time (See Figure 1):

- Mr. Smith and is video conferencing while collaboratively working on documents with remote coworkers.
- Ms. Smith and her sister are in the kitchen, using their tablet to make video calls to other family members who couldn't join the gathering.
- The children are separated into three groups between the living room, guest bedroom and gaming room. One group is watching a video stream, playing online games with friends and video chatting. Another group downloads files for a school project and streams music, while other children are enjoying VR games together. The children often move around to chat to each other and with other family members during the gathering, sometimes bringing their devices with them.

Given the multitude of electronic devices and various applications, maintaining reliable and high-performance Wi-Fi is extremely challenging in the Smith household. Interference and signal disruptions are inevitable, resulting in poor connectivity and a diminished user experience. Implementing advanced technology, such as MediaTek Xtra Speed, is essential to address these issues and ensure seamless Wi-Fi coverage throughout the home.

MediaTek Mesh Boost

User Scenario:

As shown in Figure 2, four children are enjoying a group VR gaming session, which requires over 1Gbps Wi-Fi throughput to ensure a seamless experience. Fortunately, the Smiths have a tri-band Wi-Fi 7 4x4 Mesh AP setup at home. To guarantee coverage throughout the house, the network topology consists of a two-hop mesh configuration with three APs. The Internet is connected to the master AP, which serves as the controller. The master AP is connected to slave AP1, which is connected to slave AP2 via Wi-Fi backhaul, as shown in Figure 3. Stations are connected to an AP based on their location and signal strength. The mesh deployment leverages Multi-Link Operation (MLO) by default, with all three bands (2.4GHz, 5GHz, and 6GHz) enabled.

Figure 2. Four family members playing VR games

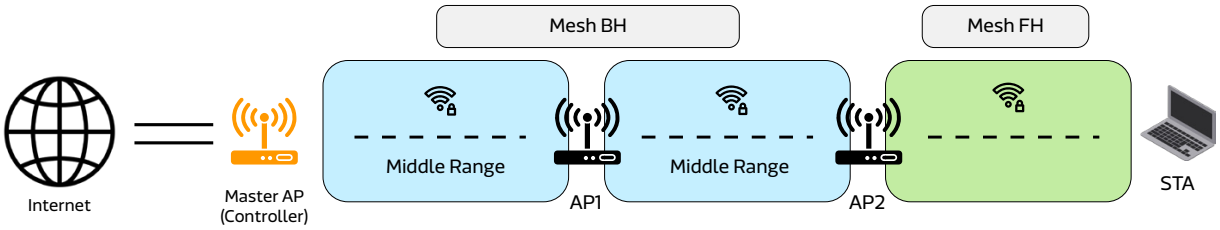

Figure 3. The home Mesh topology

Issues:

As a typical home mesh deployment, both the backhaul and fronthaul use the same channel and share the bandwidth. They end up competing for airtime access, which increases the network contention and lowers the throughput. The mesh deployment is primarily for whole-home coverage and good for most daily use, but not suitable for dense clients or peak hours. During the family gatherings the children regularly experience inconsistent connectivity and lag in their VR games.

Technology:

Mesh Boost is an advanced link adaptation algorithm that optimizes Wi-Fi channel assignments. There are two key factors that improve the performance:

1. Adaptively assigning different links to backhaul and fronthaul to avoid interference.
2. Ensure that the backhaul throughput is always larger than, or equal to that of fronthaul.

Figure 4 illustrates link adaptation. The left part of Figure 4 is what we usually have today. All available links are connected to every Wi-Fi device. They are competing for accessibility in every transmission. When Mesh Boost is enabled, as shown in the right part of Figure 4, the backhaul will pick a link with the highest throughput and assign other links to serve as fronthaul. By isolating backhaul traffic from fronthaul traffic, Wi-Fi clients no longer compete for airtime with APs. This reduces the number of Wi-Fi conflicts and enhances throughput.

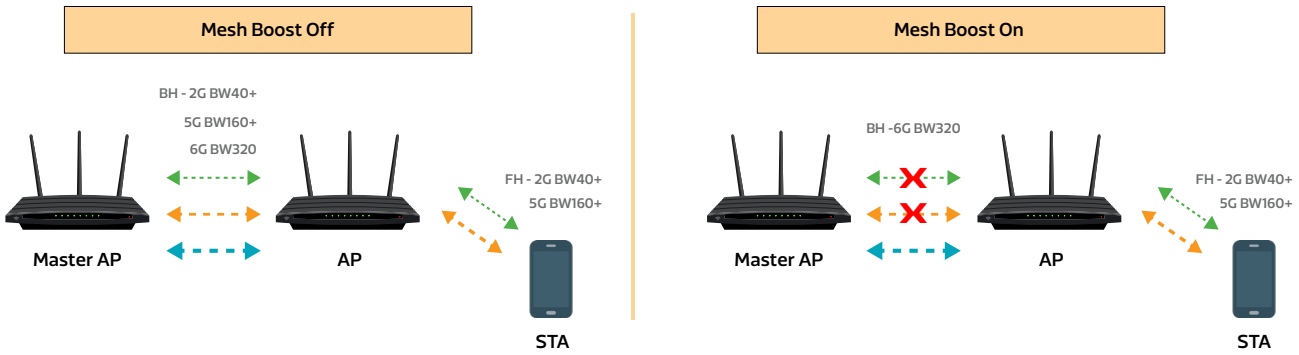

Figure 4. Mesh Boost On/Off Illustration

Table 1 shows the experimental results conducted in MediaTek Lab which simulated the Smith house with two APs, testing the peak download throughput. Due to client limitations, the maximum bandwidth is 160MHz. The 5GHz band throughput will be better than 6GHz due to the maximum transmission power allowed. In the experiment, the client was connected to the slave AP1. Mesh Boost adaptively adjusts backhaul and fronthaul MLO links dynamically. As shown in Table 1, Mesh Boost offers more than 20% throughput gain when clients are using 6GHz as fronthaul. Compared to the 6GHz, using the 5GHz as backhaul is better due to the lower air attenuation.

Backhaul	2.4GHz + 5GHz + 6GHz (4SS									
Fronthaul	2.4GHz (20MHz) (2SS)		5GHz (160MHz) (2SS)		6GHz (320MHz) (2SS)		2.4GHz + 5GHz (2SS)		2.4GHz + 6GHz (2SS)	
Mesh Boost	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON
Primary-AP1- STA	255	260	2050	2293	3090	3720	2301	2513	3224	3464
Gain		1.96%		11.85%		20.39%		9.21%		7.44%

Table 1. The maximum download throughput when using Mesh Boost

Coordinated Spatial Reuse (Co-SR)

User Scenario:

John is in the living room on the first floor, downloading multiple 4K movies from Netflix ahead of his upcoming trip. This task demands a lot of bandwidth. Mary is in the bedroom on the second floor, engaged in a VR gaming session, which also requires significant bandwidth (See Figure 5).

Figure 5. John and Mary's simultaneous online activities cause interference

The simultaneous, high-throughput activities create significant interference between AP1 and AP2. This interference leads to low throughput and long waiting times. John faces slow download speeds, while Mary encounters connection lag and interruption during her games.

Technology:

When compared to traditional Spatial Reuse (SR), which is a self-aware technology, MediaTek Xtra Speed Coordinated Spatial Reuse (Co-SR) enables the APs to negotiate appropriate transmission power and efficiently share airtime, benefiting all existing APs in the environment (see Figure 6). On the left side, the transmission power is set to the maximum to cover the largest range by default. Without SR technology, excessive transmission power can become a source of interference, and in severe cases, it can even disrupt the original transmission. On the right side, when Co-SR is applied, both APs reduce their power to cover the correct range, allowing John and Mary to have faster connection speeds simultaneously.

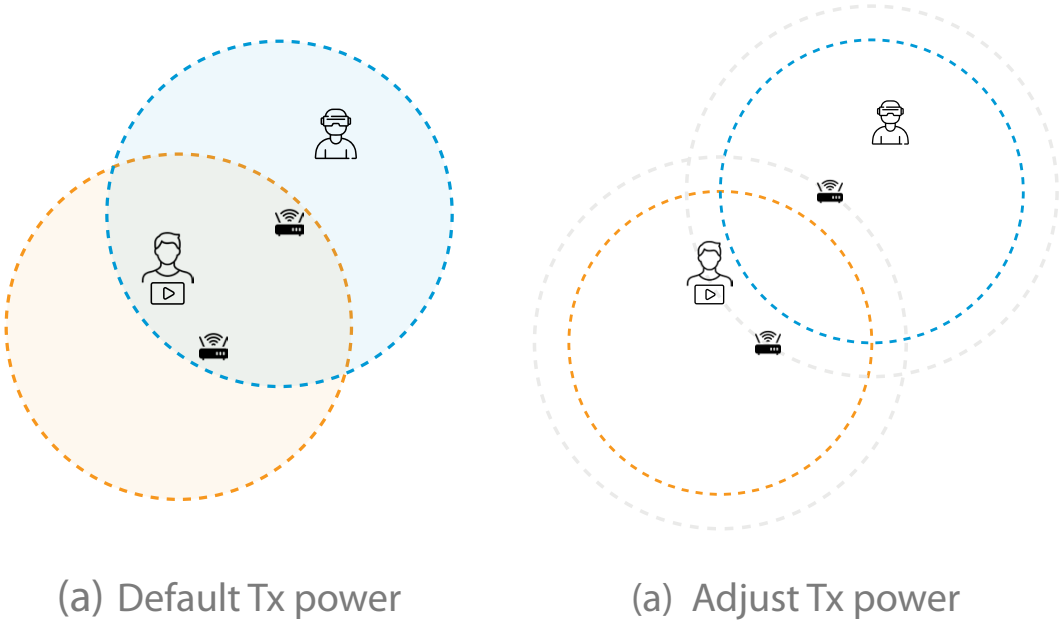

Figure 6. Co-SR Adjusts TX Power to Have Simultaneous Communication

The APs regularly conduct cross-BSS (Basic Service Set) signal level measurements and share information across BSSes. This process helps the APs estimate the signal and interference levels present in the environment.

Each Spatial Reuse (SR) opportunity is managed by the Sharing AP. In this scenario, AP1, which is connected to John, serves as the sharing AP. AP1 determines the maximum transmission power that AP2, connected to Mary, can utilize based on its own signal and interference levels.

AP1 transmits a CSR-A (Announce) frame to AP2, containing the maximum allowable transmission power and the duration information for the PPDU (Physical Protocol Data Unit). Following AP1's instructions, AP2 initiates a concurrent transmission (i.e., SR) with reduced power and a limited PPDU duration.

As shown in Figure 7, there are three phases in the Co-SR operation: the Cross-BSS Measurement Phase, the Multi-AP Coordination Phase, and the Concurrent Transmission Phase.

1. The Cross-BSS Measurement Phase: The APs in a Co-SR group measure the interference strength on Cross-BSS STAs and exchange this information among the APs.

2. The Multi-AP Coordination Phase: The Co-SR is initiated by the Sharing AP which is not limited to the master AP. The sharing AP sends out a Co-SR Announce frame, indicating which APs can participate in the next phase and specifying any transmit power limitations.

3. The Concurrent Transmission Phase: The shared APs transmit data simultaneously with the sharing AP.

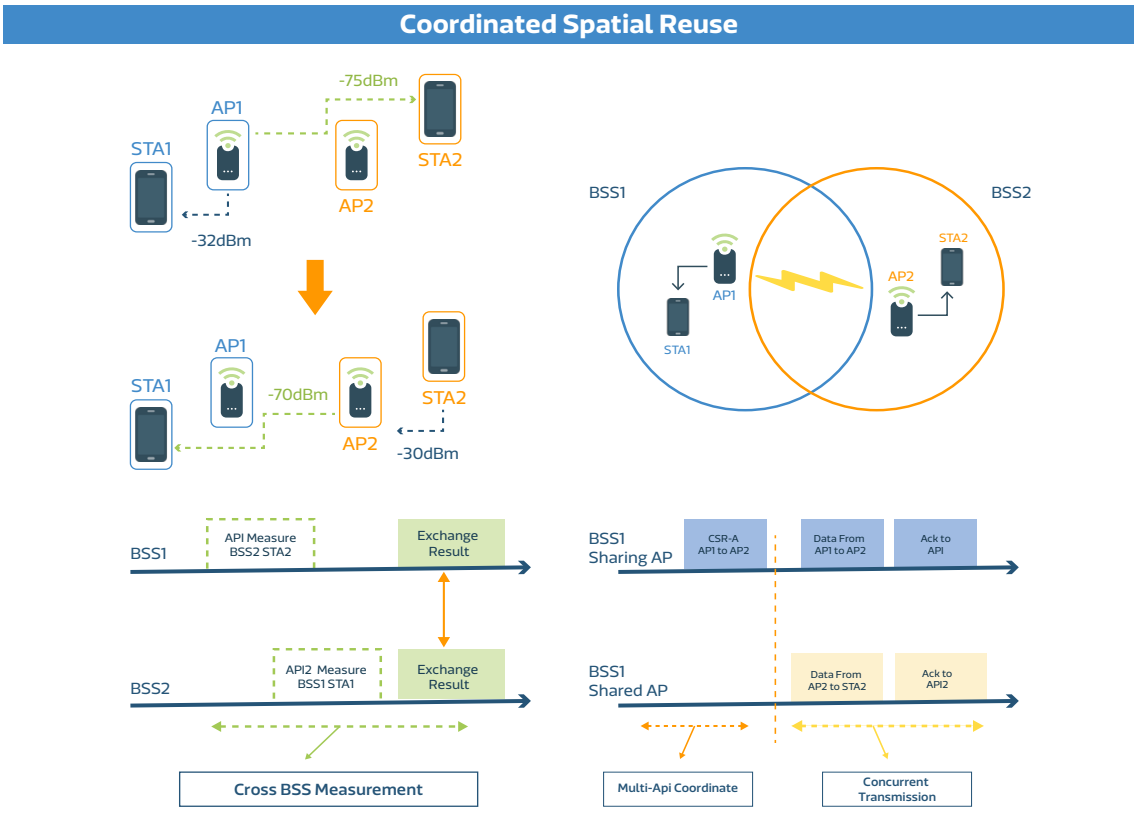

Figure 7. Co-SR Operation Sequence

Table 2 shows the experimental results conducted in the MediaTek Lab. We simulated the house with two and three AP mesh setups. Using the third case, titled "3AP (3m, RSSI -38dBm)", as an example, this scenario has three access points (APs) and two clients situated approximately 3 meters from their associated AP, with an RSSI of around -38dBm. The Wi-Fi 7 backhaul utilizes the 5GHz band, while the fronthaul serves Wi-Fi 6 clients also on the 5GHz band. As shown in the results, the client achieves a 29% gain in throughput when Co-SR is enabled. The gain may reach 30% if those two clients are closer to their associated APs.

	BH	FH	Griffin Mesh T-put (Mbps)		
			Co-SR Off	Co-SR On	Gain
2AP	MLO 2+5	MLO 2+5	1081	1258	16.3%
3AP (1ms, RSSI-25dBm)	EHT 5G	HE 5G	2036	2657	30%
3AP (3ms, RSSI-38dBm)			1860	2406	29%
3AP (5ms, RSSI-52dBm)			1803	2035	12%

Table 2. Co-SR Experimental Results

Filogic AI Anti-Noise

User scenario:

Tom is in the living room, fully immersed in a video conference with his colleagues. Being a central social space in the house, family members routinely come in and out of the room. Tom decides to move to the basement for a quieter environment. Video conferencing requires a low latency connection for a seamless video conference as shown in Figure 8.

Figure 8. Tom moves to the basement to focus on his conference call. Issues:

Issues:

The house has a hidden node problem in the basement due to its layout, and the deployment of the network APs. As shown in Figure 9, Tom's notebook receives signals from AP1 and AP2. The notebook will connect to AP1 as it can achieve a higher bandwidth. However, the signal to Tom's notebook is occasionally interrupted by the signal from AP2. AP1 and AP2 are far away and do not realize each other's existence, so there are occasional wireless signal collisions between AP1 and AP2.

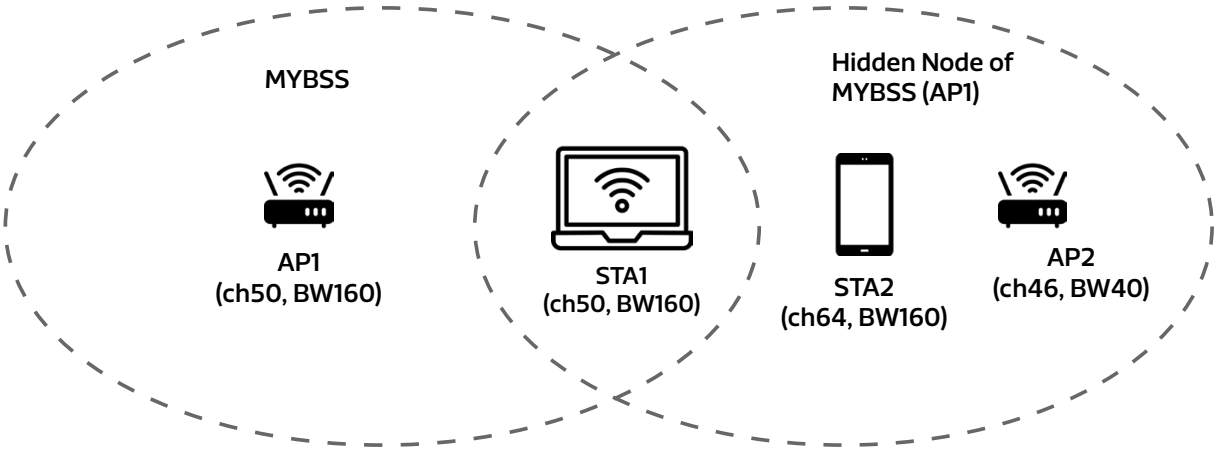

Figure 9. Hidden Node Problem, The AP1-STA1 transmission is impacted by AP2-STA2 transmission.

Tom's video conference faces considerable interference, and the Hidden Node Problem also affects other devices connected to AP1 and AP2. This situation results in packet loss, the need for retransmissions, and a decline in signal quality.

Technology:

Instead of a static puncturing method, MediaTek Xtra Speed AI Anti-Noise is an intelligent preamble puncturing mechanism. AI Anti-Noise enables the AP to modify the puncturing pattern in real time by leveraging interference data from both the AP and the station. This adaptive approach allows the network to respond to changes in the interference environment, resulting in significant improvements in both throughput and latency, effectively addressing the hidden network problem.

As shown in Figure 9, Tom's notebook uses a contiguous 160MHz bandwidth in the 5GHz band when connecting to AP1 on channel 50, while an old tablet, STA2, also uses the 5GHz band with 40MHz bandwidth to connect to AP2 on channel 46. The test result is given in Figure 10. Three transmission periods are described in Part (a).

1. When transmitting between AP1 and STA1 only, the throughput is good, and latency is acceptable.
2. When the transmission between AP2 and STA2 is occurring, the data from AP1 to STA1 becomes corrupted. To overcome this interference, the MCS rate between AP1 and STA1 is lowered. As shown in the part (c), the obtained throughput is less than 10% and latency is more than double compared to the first period.
3. In this period, AI Anti-Noise has been enabled; AP1 has learned that channel 46, using BW40, is noisy. AP1 makes a preamble puncturing mark on the second BW40 within BW160. The MRU then combines a BW40 with a BW80 (which equates to a 484-tone RU plus a 996-tone RU). The throughput returns to around 400Mbps, about 73%, and the latency decreases to 50ms, which is about a 58% improvement compared to the second period.

Figure 10. AI Anti-Noise Experimental Results

Conclusion

Wi-Fi has become the leading alternative to traditional wireline connectivity, but despite Wi-Fi 7's higher throughput, users may occasionally experience jitter due to environmental factors. This white paper introduces Xtra Speed, part of the MediaTek Filogic ecosystem, designed to enhance the Wi-Fi experience by addressing interference issues.

- Mesh Boost leverages MLO and uses adaptive link adaptation algorithms to maintain backhaul and fronthaul links with the highest throughput and without interference.
- Coordinated Spatial Reuse (Co-SR) optimizes the transmission power of multiple APs, achieving optimal throughput while avoiding interference with one another.
- AI Anti-Noise uses intelligent preamble puncturing to avoid interference between multiple APs.

The integration of Mesh Boost, Co-SR, and AI Anti-Noise ensures that network performance is maximized, providing seamless wireless connectivity, and the freedom to be fully mobile throughout the house.

MediaTek in the Wi-Fi Industry

MediaTek is the world's largest supplier of Wi-Fi solutions, including standalone networking products such as routers, repeaters, and mesh APs, and devices with embedded Wi-Fi connectivity such as smartphones, tablets, TVs, IoT, smart home devices, PCs and laptops, game consoles, and many others.

Besides delivering high performance and low power integrated solutions to these platforms, MediaTek is actively participating in IEEE and Wi-Fi Alliance certification development to ensure top performance and industry interoperability. Some recent examples include the selection of MediaTek's Filogic platforms such as Wi-Fi 6E and Wi-Fi 6 R2 testbed devices. With Wi-Fi 7 and beyond, MediaTek continues to contribute technical expertise and knowledge of diverse market segment standards for improved Wi-Fi performance in daily applications.

Wi-Fi 7 powered by MediaTek Filogic

Discover MediaTek's extensive Wi-Fi 7 platforms at mediatek.com

https://www.mediatek.com/technology/wifi-7

Acknowledgments

Author:

- **Henry Chu** (Senior Director of intelligent Connectivity Business)

Contributor:

- **David de la Bastida** (Product Manager of intelligent Connectivity Business)
- **Dylen Kang** (Sr. Research Engineer of Connectivity Technology Development),
- **James Chiang** (Sr. Technical Marketing Manager of intelligent Connectivity Business) ,

Editor:

- **Wilfred Lin** (Director, Marketing of intelligent Connectivity Business)