解决方案简介

亚信科技 AISWare 5G Billing

第二代英特尔®至强®可扩展处理器产品家族

英特尔® 傲腾™ 数据中心级持久内存

电信

英特尔® 傲腾™ 数据中心级持久内存加速亚信科技 5G 场景计费系统助力面向 5G 的网络变革

英特尔® 傲腾™ 数据中心级持久内存，是助力亚信科技领导下一代电信服务计费系统的不可或缺的力量。

与 3G/4G 网络相比，5G 网络具备高速率、低延迟、广泛连接等特性，不仅带来了数十亿物联网设备，还能够支持增强现实/虚拟现实、完全连接的无人驾驶汽车等新型应用，极大地扩展网络服务的规模，并提供前所未有的终端和数据类型。在 5G 网络逐步实现商用的背景下，全球电信行业需要作出巨大变革，以适应电信服务方式的根本性转变。

推动网络变革的另外一个因素在于，采用云计算和边缘计算的业务将继续增多，从而对网络提出了进一步需求。亚信科技* 创始人田溯宁说：“随着 5G 时代的到来，我们正在从百亿连接进入到万亿连接时代，会形成各种各样连接产生的智能场景，运营商网络需要进行进一步创新，以帮助企业实现快速的创新能力、敏捷的生产能力。”

数据的激增和新的使用模式将对计费系统提出新的要求，这从市场预期中可见一斑。预测数据显示，全球数字业务支撑系统将从 2018 年的 28 亿美元增长到 2023 年的 58 亿美元，年复合增长率（CAGR）达 15.2%。

亚信科技通过涵盖软件和硬件的计费系统创新，将帮助推动这一增长趋势，应对未来挑战。亚信科技是中国领先的业务支撑提供商，为中国电信运营商提供 IT 解决方案和服务，帮助电信运营商迅速响应市场变化，降低运营成本，提升盈利能力。目前，亚信科技提供的软件方案和服务涉及 IP、VoIP、宽带、无线、3G 等等技术领域，包括业务支撑系统、电信增值应用系统以及电信级网络解决方案等。

亚信科技推出的电信综合计费产品涵盖了包括记费、账务、收费及结算等在内所有主要的计费功能，这些产品能够实时管理所有最终用户的计费账务相关活动，提供灵活的定价机制及记忆数据库技术，支持复杂的定价及账务业务，使客户可以提供创新的、个性化的服务套餐，以吸引新的最终用户并提升现有最终用户的黏性。面向 5G 计费场景，亚信科技推出了 AISWare 5G Billing（5G 场景计费）系统，实现多量纲计费、权益共享、SLA 定

价、能力开放变现、多种计费模式组合。其计费结算对象，也从传统的以人和物为中心，向着以场景为中心的计费对象转变，从而通过 5G 场景计费，助力 5G 价值变现。

亚信科技还使用英特尔® 傲腾™ 数据中心级持久内存对其计费系统进行优化，以降低延迟、改进客户体验。

亚信科技

业务支撑系统

客户的难点：

- 大容量（768 GB 以上）配置的 DRAM 成本高
- 复杂查询的执行时间长

为何选择英特尔® 傲腾™ 数据中心级持久内存：

- 在接近处理器的地方储存更多数据
- 减少对磁盘的频繁访问

价值定位：

- 复杂查询的延迟更低/响应更快

定制计费运营，应对新型挑战

由于电信行业的竞争日益激烈，运营商必须审慎使用技术、设备等各种资源。随着运营商推出或扩大对 5G、物联网、云计算和边缘计算等趋势的支持，这一因素发挥着重要作用。尤其是在计费服务器硬件领域，DRAM 的成本增加使得运营商更加难以在成本和性能要求之间作出平衡。

对于电信计费系统来说，内存的速度和容量对计费服务器的效率至关重要。如果内存容量不足，系统延迟和响应时间就会增加。

企业级高容量 DRAM 内存的价格很高。为达到所需的内存池容量，企业需要花费大量资金，所以很难实现计费服务器的总体拥有成本 (TCO) 控制目标。为应对这一挑战，亚信科技决定采用英特尔® 傲腾™ 数据中心级持久内存对其计费系统进行优化。

亚信科技 5G 场景计费与英特尔® 傲腾™ 数据中心级持久内存(PMEM)的新技术相结合，进一步提升了面向 5G 的新一代计费系统的系统架构。在本次 PoC 过程中对于 PMEM 带来的系统性能提升和系统资源节约等方面得到了很好的验证。希望在后续更加深入的交流合作中，能够进一步挖掘新场景的应用潜力，共同为移动 5G 业务支撑和新业务拓展，提供高性价比的系统解决新方案。

应理静
中国移动计费研发方案总工
计费产品研发与交付中心
产品研发中心

英特尔® 傲腾™ 数据中心级持久内存的成本低于 DRAM，但性能相差无几，使得计费服务器能够在几乎不增加系统成本的前提下，获得更大的内存总量。内存容量的增大减少了数据溢出，使得数据无需频繁落在低速率磁盘上，从而确保快速访问。

亚信科技 5G 场景计费系统同时为传统电信服务提供商、现代数字服务提供商提供面向客户的业务运营（如 OTT 内容）支持，该系统提供了灵活的高性能服务，能够帮助服务提供商跨业务类别有效管理客户、产品、订单和收入，包括：

- **客户类型：**消费者和企业
- **支付方式：**预付、后付和混合
- **网络连接：**移动、固定场所和 IP
- **服务类型：**语音、数据、消息和视频

在英特尔® 傲腾™ 数据中心级持久内存的开发过程中，亚信科技与英特尔进行合作，采用新的内存架构，优化其计费系统。该工作包括重新设计软件框架的关键部分，它还需要开发针对硬件和软件的基准测试技术，以准确灵活地测量配备英特尔® 傲腾™ 数据中心级持久内存的系统的关键绩效指标。

提高业务运营的响应能力

由于内存容量是亚信科技 5G 场景计费系统系统的性能瓶颈之一，因此在采用英特尔® 傲腾™ 数据中心级持久内存之后，其性能的提升非常显著。与五年前的典型计费服务器相比，基于第二代英特尔® 至强® 可扩展处理器（配备英特尔® 傲腾™ 数据中心级持久内存）的计费服务器大幅缩短了复杂查询的响应时间。与仅使用 DRAM 的服务器相比，通过在该服务器中增加英特尔® 傲腾™ 数据中心级持久内存，亚信科技 5G 场景计费系统的响应时间也大幅缩短。

英特尔® 傲腾™ 数据中心级持久内存提供了行业领先的高吞吐率、低延时、高服务质量和超高的耐用性，可以提供接近内存的延迟，并支持快速缓存和快速存储，对应用进行加速，在性能上表现卓越。

此外，英特尔® 傲腾™ 数据中心级持久内存的单设备最大容量达到 512GB，远超 DRAM 内存的 128GB，这使得可以更加轻松的在单台服务器上实现更大的内存总量。而且，英特尔® 傲腾™ 数据中心级持久内存的单位容量价格要远低于 DRAM 内存，这些特性支持亚信科技能够以更低的成本构建容量更高的内存池，并提供更高的数据吞吐能力，以及更低的延时。

通过加快查询速度，亚信科技使得服务提供商能够在更短时间内处理更多业务数据，从而从中获得更多价值。例如，通过加快商业智能运营，电信运营商可以在用户数据的基础上执行更多更复杂的分析。这带来了更高程度的洞察力，从而便于他们以更明智的决策指导日常业务运营，提升竞争优势。

性能的提高也为更多能力的实现奠定了基础，如关键绩效指标的实时监控、个性化报告以及增值服务分析和推送等。

总体来说，通过在亚信科技 5G 场景计费系统的服务器上部署英特尔® 傲腾™ 数据中心级持久内存，有助于优化用户体验，极大地节约成本。

> 通过实验室中进行的英特尔®傲腾™数据中心级持久内存(PMEM)技术结合计费系统业务场景的综合测试得出的结论，可以说明英特尔®傲腾™数据中心级持久内存(PMEM)技术可以很好地解决计费业务支撑系统中大内存和高性能存储场景中的系统瓶颈，提升系统整体吞吐量；PMEM 作为一种新型的硬件解决技术方案，通过未来更多的应用场景优化及业务整合方案的完善，具有成为一种高性价比的系统解决方案的可能。
>
> 中国移动某省公司业务支撑部

重新定义企业存储层级

除了其相对于 DRAM 存储器的成本优势之外，英特尔® 傲腾™ 数据中心级持久内存还带来了内存子系统架构的深刻变化，使其成为工作数据和长期存储的主数据层。也就是说，它将类似于 DRAM 存储器的字节寻址能力和类似于存储的持久性合二为一。这种结合意味着它可以直接映射到应用程序地址空间，消除了与传统存储的读写相关的瓶颈。

英特尔® 傲腾™ 数据中心级持久内存提供了两种不同的操作模式：内存模式和应用直接访问模式。在内存模式中，它与普通的易失性（非持久性）系统存储器完全一样，但成本更低，所以能在稳定的系统预算中实现更高容量。模块的容量有 128 GB、256 GB 和 512 GB。

通过启用应用直接访问模式，亚信科技利用英特尔® 傲腾™ 数据中心级持久内存实现了更大价值。这一方法使得计费系统能够使用独立的易失和持久性内存存储。该软件可以将必须长期保留的大型数据结构和数据放在英特尔® 傲腾™ 数据中心级持久内存上，加快使用基于传统 DRAM 的数据缓存结构的操作速度。通过这种安排，亚信科技 5G 场景计费系统能够根据个人工作负载需求定制内存子系统，从而进一步提高性能。

第二代英特尔® 至强®可扩展处理器的卓越性能，使英特尔® 傲腾™ 数据中心级持久内存的性能优势得到了充分发挥。该处理器拥有 多达 28 个内核和六个内存通道，可在数据中心提供出色性能，并且可以配备多达 6 TB 的总系统内存。这种硬件组合体现了跨硬件堆栈的工程设计，赋予亚信科技及整个企业高于以往的性能。

在实际测试中，测试人员采用了浪潮 NF5280M5 高性能服务器。该服务器为基于全新一代英特尔® 至强® 可扩展处理器设计的 2U 2 路机架式服务器，用于满足互联网、IDC、云计算及电信业务应用需求。浪潮 5280M5 在更高安全性要求的业务场景下，应用内嵌硬件加密芯片（根据用户要求选择算法）安全防护能力来实现根密钥体

系，数据的安全存储等安全特性。支撑操作系统、中间件及上层应用的安全防护能力，保护根密钥、软件、固件及配置信息不被恶意篡改。

本次测试的浪潮 NF5280M5 高性能服务器采用了英特尔® 傲腾™数据中心持久内存（测试配置如表 1 所示、主机配置如表 2 所示），并测试了亚信科技内存数据库（AIMDB）在不同配置下的数据处理性能、启停和故障恢复能力、话单处理性能。

主机型号	台数	IP 地址	CPU	内存(G)	AEP(G)	备注
浪潮英信服务器 NF5280M5	6	10.10.12.150～10.10.12.155	2*20 Intel® Xeon® Gold 6248	12*16	12*128	网卡: Intel Corporation Ethernet Controller 10-Gigabit X540-AT2

表 1：测试配置

	配置 1：基准配置	配置 2：PMEM 内存模式配置	配置 3：PMEM 应用直接访问 模式配置
CPU	2 x Intel® Xeon® Gold 6248 CPU @ 2.50GHz	2 x Intel® Xeon® Gold 6248 CPU @ 2.50GHz	2 x Intel® Xeon® Gold 6248 CPU @ 2.50GHz
内存	DDR4 2666 192GB (12 x 16GB)	DDR4 2666 192GB (12 x 16GB)	DDR4 2666 192GB (12 x 16GB)
PMEM	无	PMEM 1.5TB (12 x 128GB)	PMEM 1.5TB (12 x 128GB)
磁盘	4 x 1.6TB NVMe SSD + 1 x 960GB SATA SSD	4 x 1.6TB NVMe SSD + 1 x 960GB SATA SSD	4 x 1.6TB NVMe SSD + 1 x 960GB SATA SSD
OS	CentOS 7.6	CentOS 7.6	CentOS 7.6
AIMDB	Aimdb 3.1	Aimdb 3.1	Aimdb 3.1
测试负载	Sysbench	Sysbench	Sysbench
数据集	120GB	1.2 TB	600 GB

表 2：主机配置

亚信科技 AIMDB Benchmark 的性能压力测试数据如图 1 所示。数据显示，在使用英特尔® 傲腾™数据中心持久内存的情况下，能够保持物理内存 94%以上的性能，在实际生产过程符合高性能的要求。

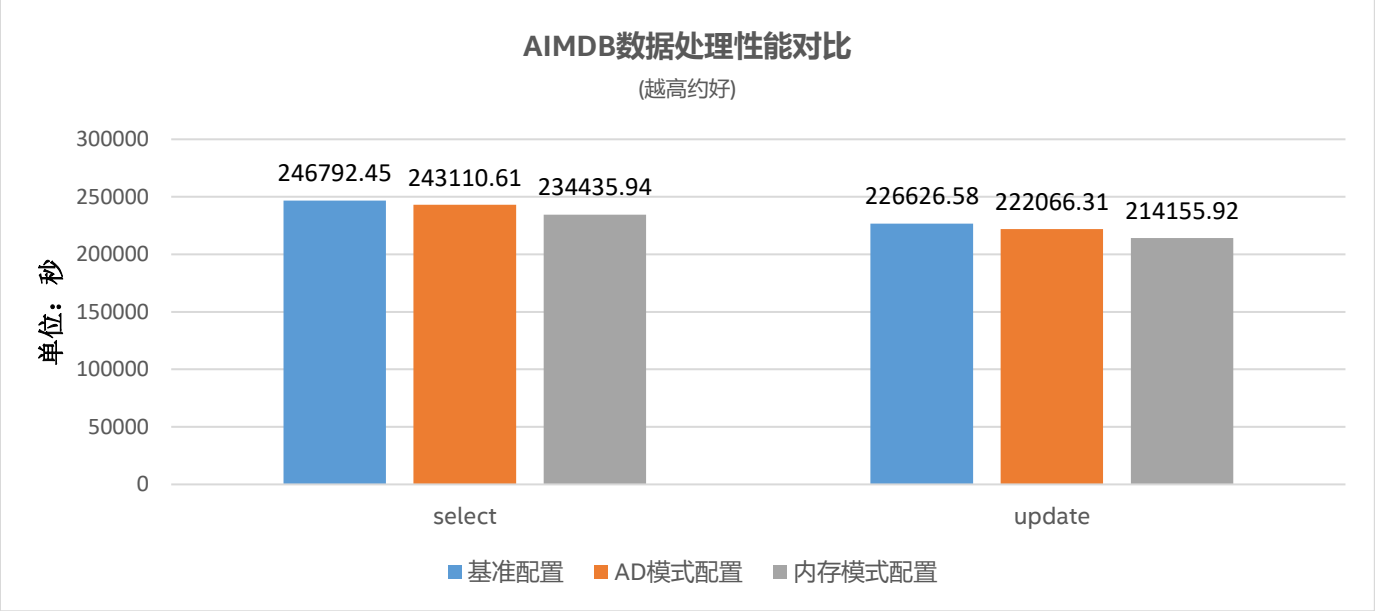


图 1：AIMDB 数据处理性能对比

测试数据还显示，在保证服务质量的前提下，英特尔® 傲腾™ 数据中心持久内存的内存模式和应用直接访问模式可处理的数据集规模相对基准配置分别有 10 倍和 5 倍的提升。（测试数据如图 2 所示）

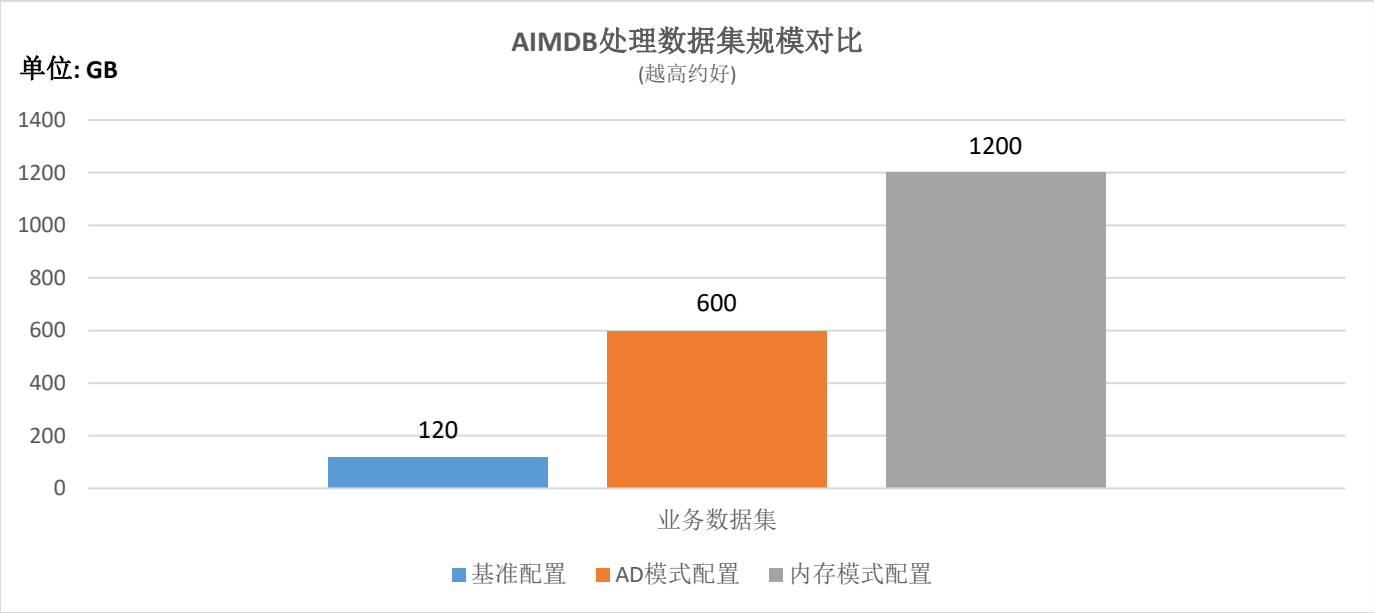


图 2：AIMDB 处理数据集规模对比

在 AIMDB 启停和故障恢复的测试场景中，测试人员使用英特尔® 傲腾™数据中心持久内存启动一个 120G 大小的 dump 备份，数据加载到服务可用，并测试了所耗费的时间（测试数据如图 3 所示）。数据显示，磁盘加载完毕时间从 285s 缩短到 19s 完成，性能提升了 15 倍。英特尔® 傲腾™数据中心持久内存停止时间也从使用 SSD 磁盘的 315s 缩短到 54s，提升了 5.8 倍。

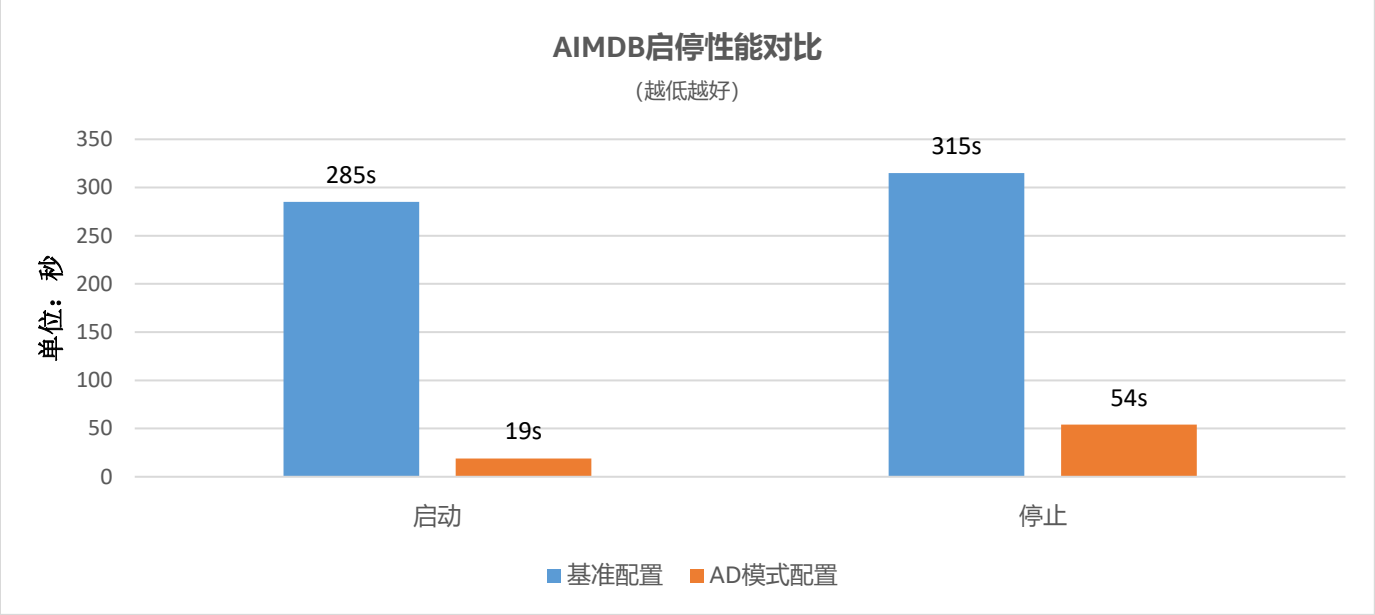


图 3：AIMDB 启停性能对比

在话单处理性能的测试场景中，测试人员使用英特尔® 傲腾™数据中心持久内存与物理内存在大批量处理话单的场景下，观察统计话单处理吞吐能力（测试数据如图 4 显示）。数据显示，经过综合加权平均后，英特尔® 傲腾™数据中心持久内存的话单处理能力为 254.6 条/秒，物理内存为单线程 262.4 条/秒，处理速度比为 97%，非常接近物理内存的处理能力。

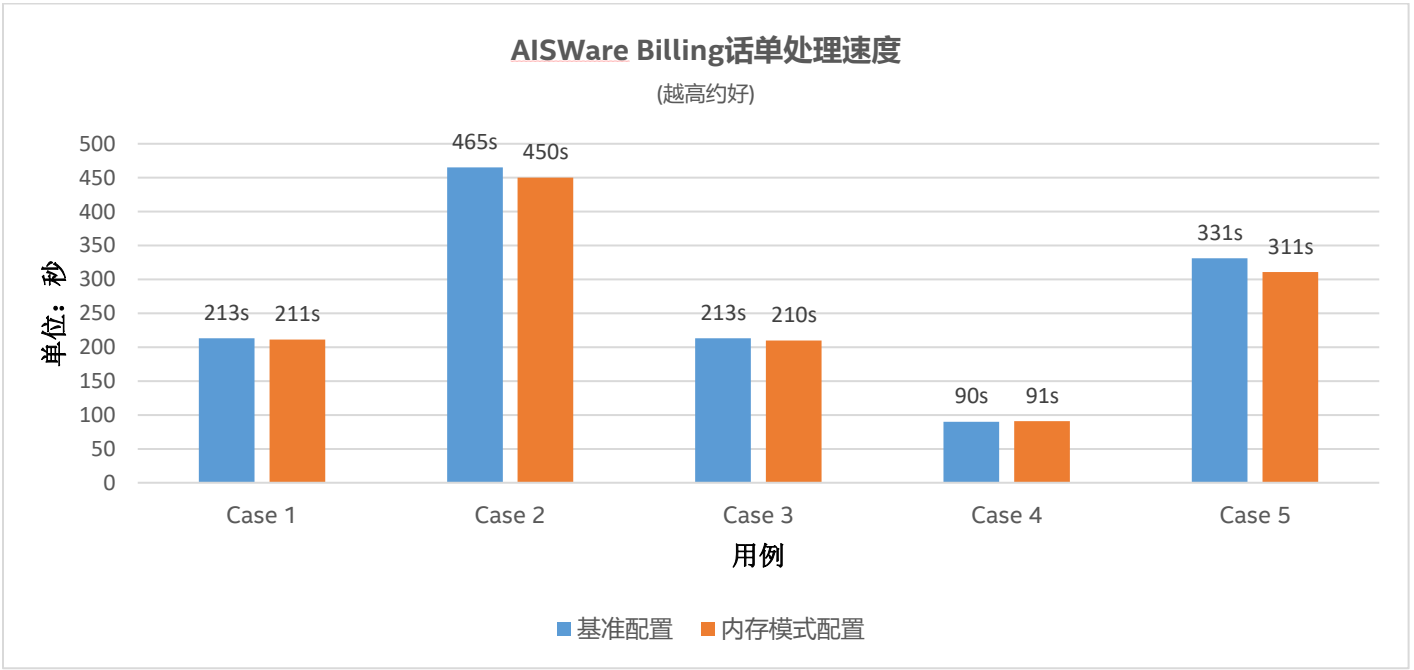


图 4：**AISWare 5G Billing 话单处理速度**

此外，测试人员还测试了英特尔® 傲腾™数据中心持久内存处于应用直接访问模式下的话单处理测试（测试数据如图 5 所示）。数据显示，经过综合加权平均后，话单处理速度在普通模式下为 262.4 条/秒，在英特尔® 傲腾™数据中心持久内存的内存模式下为 254.6 条/秒，应用直接访问模式下为 323 条/秒，相比普通模式带来了 23%的性能提升。

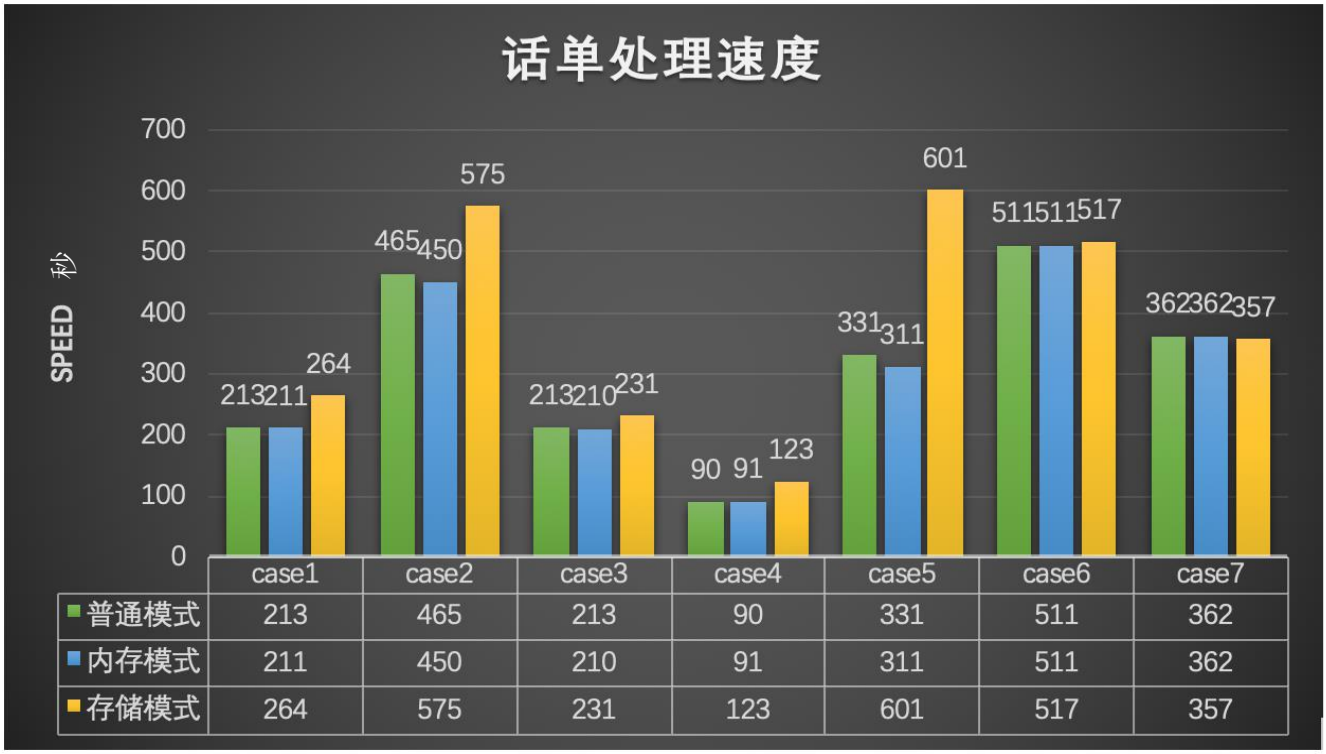
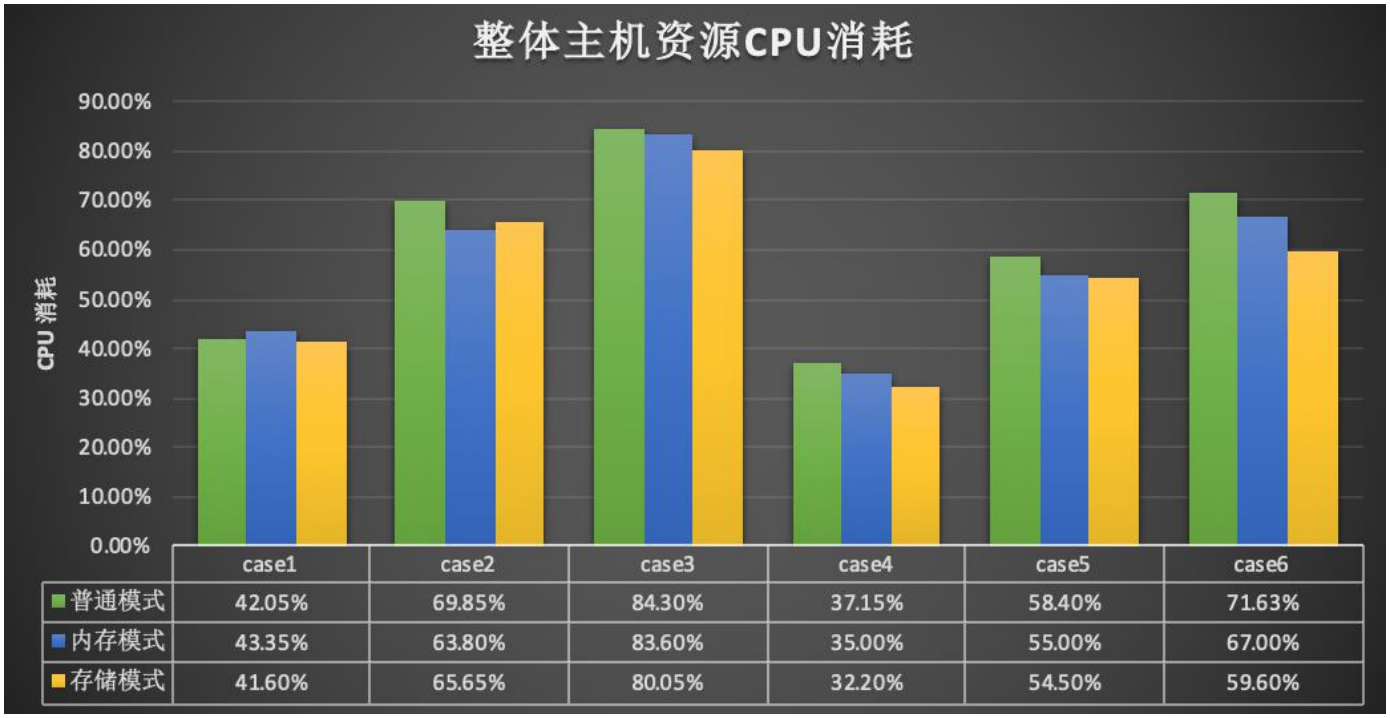


图 5：话单处理速度

上述场景整体主机 CPU 开销情况如图 6 所示。普通模式加权平均：CPU 开销 60.56%，英特尔® 傲腾™数据中心持久内存的内存模式加权平均：CPU 开销 57.56%，应用直接访问模式加权平均：55.60%。CPU 同比带来 5～10%的下降。



	case1	case2	case3	case4	case5	case6
普通模式	42.05%	69.85%	84.30%	37.15%	58.40%	71.63%
内存模式	43.35%	63.80%	83.60%	35.00%	55.00%	67.00%
存储模式	41.60%	65.65%	80.05%	32.20%	54.50%	59.60%

图 6：整体主机资源 CPU 消耗

测试结果显示，通过使用英特尔® 傲腾™数据中心持久内存，亚信科技 AIMDB 可以在不牺牲性能的前提下（>94%），使单个服务器上保存更大数据集 (10 倍)，从而得到更优的部署成本。此外，亚信科技 AIMDB 还可以大幅提升启动（15 倍）和停止（5.8 倍）性能，从而显著提高系统的运维能力和可靠性。

在英特尔® 傲腾™数据中心持久内存作为内存使用时，能够基本保持物理内存的处理速度。低 CPU 消耗的场景可以通过大内存模式部署更多的应用，或者在大的高速缓存和内存数据库使用的场景使用，带来更多的收益比。

作为应用直接访问模式使用时，英特尔® 傲腾™数据中心持久内存具有非常高的 IO 能力，整体话单处理性能，系统吞吐量可以带来较大的性能提升，同时在主机 CPU 消耗上也实现了一定程度的下降。

英特尔® 傲腾™ 数据中心级持久内存具有大容量、低成本、和持久性存储的特点，能够为大数据分析、内存数据库等应用带来巨大的性能提升，同时能够为用户降低 IT 成本，简化基础设施，英特尔® 傲腾™ 数据中心级持久内存(PMEM)正在成为构建新一代数据中心和数据分析平台的最佳解决方案。我们看到亚信科技 5G 场景计费系统采用英特尔® 傲腾™ 数据中心级持久内存和浪潮 NF5280M5 服务器在大幅节省部署成本的同时，也获得了巨大的性能提升。

魏健
方案与测试部副总经理
浪潮电子信息产业股份有限公司

效果：为面向未来的计费系统奠定基础

5G 技术带来了人与人、人与物、物与物的广泛连接，推动了物联网、边缘计算等概念走向落地，对于电信计费系统而言，电信费用涉及到的设备类型、种类、数量都将大幅增长，这意味着巨大的挑战，同时也是一个重要的商业契机。在正在高速发展的 5G 时代，亚信科技希望在技术上做运营商网络和业务的编排者，在商业模式上做运营商和垂直行业的赋能者，正在面向 5G 时代对于计费系统进行创新。

通过搭载英特尔® 傲腾™ 数据中心级持久内存，亚信科技得以在快速增长的计费系统负载中，帮助运营商在控制计费系统服务器成本的前提下，快速处理计费业务。在大量的场景下，语音、流量等费用的计算能够实现快速处理，1 天之内可以完成整个系统出账，解决了业务爆发式发展与 IT 基础设施承载能力不足的矛盾。

由于亚信科技计费服务器性能的提升，计费效率得到了保证，可以为客户提供全方位的、及时的、友好的服务能力和服务渠道，保证良好的客户体验。同时，亚信科技计费服务器可以有效支撑各类传统业务及流量类业务的及时上线，保证电信运营商在竞争激烈的市场中处于有利地位。

展望未来，亚信科技与英特尔携手合作，以进一步提高其计费系统的性能优势。该公司于 2018 年 12 月开始在香港证券交易所公开交易，首次公开募股筹集的资金使亚信科技能够增强其研发能力，帮助该公司持续保证其计费系统能够充分利用新兴技术。

结论

人工智能、物联网和增强型云服务等因素提高了电信网络上的数据量及其多样性，特别是随着 5G 时代的加速到来，电信运营商业务支撑系统也在面临严峻的考验。亚信科技、浪潮、英特尔等企业正在加速业务合作与技术创新，帮助电信运营商对于网络和业务进行编排，满足 5G 落地的迫切需求。

亚信科技 5G 场景计费系统采用了重新设计，并利用了英特尔® 傲腾™ 数据中心级持久内存技术提供的内存架构，以跟上发展的步伐。该内存的系统延迟更低，能够更快响应针对这些新数据集的复杂计费查询，这些进步将帮助运营商和其他服务提供商在变革中蜕变。

采取下一步行动

联系亚信科技销售人员或注册免费试用：
5G@asiainfo.com

了解更多关于英特尔® 傲腾™ 数据中心级持久内存的信息：
www.intel.com/optanedcersistentmemory

了解更多关于英特尔® 至强® 处理器的信息，请访问：
www.intel.com/xeon

[1] 标准普尔《全球市场情报》，《中国电信提供商亚信科技在 IPO 前为 5G 做准备》，https://www.spglobal.com/marketintelligence/en/news-insights/trending/kioj0lviutcjws6aj0stja2.

[2] 美通社，《全球数字业务支撑系统 (BILLING)市场规模将以 15.2%的复合年增长率增长》，https://www.prnewswire.com/news-releases/global-digital-business-support-system-Billing-market-size-to-grow-at-a-cagr-of-15-2-300763635.html.

[3] RadhikaAnand 提出的总体拥有成本索赔免责声明。

SOLUTION BRIEF
AsiaInfo AISWare 5G Billing
2nd Generation Intel® Xeon® Scalable processors
Intel® Optane™ persistent memory
Telecommunications

Intel® Optane™ persistent memory Accelerates AsiaInfo Technologies' AISWare 5G Billing System and Drives Network Transformation for 5G

Intel® Optane™ persistent memory is integral to AsiaInfo Technologies' leadership in 5G billing system for next-generation telecommunications services.

Compared with 3G/4G networks, 5G network has features such as high speed, low latency, and wide connectivity. Not only does it bring billions of IoT devices, but the 5G network also supports new applications such as augmented reality/virtual reality, fully connected self-driving cars, greatly expanding the scale of network services, and providing unprecedented terminal and data types. As the 5G network is gradually commercialized, the global telecom industry needs to make major changes to adapt to the fundamental shift in telecom services.

Another set of factors in the shifting market outlook is that business adoption of cloud and edge computing will continue to expand, putting further demands on the network. The founder of AsiaInfo Technologies, Tian Suning, says: "With the advent of the 5G era, we are transitioning from tens of billions to an era of trillions of connections, creating intelligent scenarios for connectivity. Operator networks need to be further innovated to help companies achieve rapid innovation and agile production."[1]

This massive expansion of data and new usage models will place new demands on billing systems, as reflected in market expectations that the global digital business supporting system market will grow from USD 2.8 billion in 2018 to USD 5.8 million by 2023, at a Compound Annual Growth Rate (CAGR) of 15.2 percent.[2]

AsiaInfo is helping drive that growth and rising to future challenges through billing system innovation that spans both software and hardware. AsiaInfo is China's leading business supporting system provider, offering IT solutions and services to Chinese telecom operators to help them respond quickly to market changes, reduce operating costs and increase profitability. At present, AsiaInfo Technologies' software solutions and services cover IP, VoIP, broadband, wireless, 4G and other technical areas, including business supporting systems, telecom value-added applications and carrier-grade network solutions.

AsiaInfo Technologies' integrated telecom billing products cover all major billing functions including billing, accounting, charging, settlement, etc. These products enable real-time management of billing-related activities for all end users, provide flexible pricing mechanism and memory database technology and support complex pricing and accounting services, enabling customers to offer innovative, personalized service packages to attract new end users and enhance the stickiness of existing end users. For the 5G billing scenario, AsiaInfo Technologies has launched the AISWare 5G Billing System, which enables multi-dimensional billing, equity sharing, SLA pricing, open capability realization, and multiple billing mode combinations. The billing and settlement object also shift from the traditional thinking of people and things to the scene-centric billing object, thereby enabling the realization of 5G value through scene billing.

AsiaInfo has optimized its AISWare 5G Billing system for Intel® Optane™ persistent memory to reduce latency for better customer experience.

AsiaInfo
Business Support System

Customer pain points:

- High DRAM cost for large-capacity (768 GB+) deployments
- Long execution time for complex queries

Why Intel® Optane™ persistent memory:

- Store more data close to the processor
- Reduce frequent accesses to disk

Value proposition:

- Lower latency/faster response times on complex queries

Tailoring Billing Operation to Meet Emerging Challenges

As the telecom industry continues to become more competitive, carriers must be judicious in their use of resources, including cost consciousness with regard to technology and equipment. This factor plays a significant role as carriers roll out or expand support for trends such as 5G, IoT, cloud, and edge computing. Particularly in the realm of billing server hardware, the increasing cost of DRAM complicates carrier efforts to balance cost and performance requirements.

Telecom billing servers are typically configured with large amounts of memory. The speed and capacity of the memory are critical to the efficiency of the billing servers. If the memory capacity is insufficient, the system delay and response time will increase, especially during complex queries for the billing system.

Enterprise-class high-capacity DRAM memory is expensive. To achieve the desired memory pool capacity, it will cost a lot of money, so it is difficult to achieve the total cost of ownership (TCO) control goal of the billing server. As a result, AsiaInfo is responding to this challenge by optimizing its AISWare 5G Billing system for Intel® Optane™ persistent memory.

> "The combination of AsiaInfo AISWare 5G Billing and Intel® Optane™ persistent memory technology further enhances the system architecture of the next-generation billing system for 5G. In this PoC process, the system performance improvement and system resource saving brought by persistent memory have been well verified. We hope that in the follow-up exchanges and cooperation, we can further explore the application potential of the new scenarios, and jointly provide a cost-effective system solution for China Mobile's 5G business support and new business development."
>
> Ying Lijing
> Chief Engineer of Mobile Billing R&D Solutions
> Billing R&D of AsiaInfo Technologies

With lower cost and similar performance to DRAM, Intel® Optane™ persistent memory enables billing servers to be provisioned with a larger amount of total memory, without increasing system cost. Those expanded resources enable the server to store more data in memory, close to the processor, where it can be rapidly accessed for use in queries and computations. Greater capacity reduces the incidence of data spilling over and having to be written to and read from the disk, protecting those fast access times.

AsiaInfo AISWare 5G Billing system runs customer-facing business operations, for both traditional telecom services and modern digital ones such as over-the-top (OTT) content. It provides flexible, high-performance services that help providers manage customers, products, orders, and revenue effectively across operational categories, which include:

- **Customer types:** consumer and business
- **Payment methods:** prepaid, postpaid, and hybrid
- **Network connections:** mobile, fixed premise, and IP
- **Service types:** voice, data, messaging, and video

AsiaInfo collaborated with Intel during the development of Intel® Optane™ persistent memory to optimize the AISWare 5G Billing system for the new memory architecture. That work included the redesign of key aspects of the software framework. It also required development of benchmarking and testing techniques tailored to both hardware and software for accurate and flexible measurement of key performance indicators (KPIs) on systems equipped with Intel® Optane™ persistent memory.

Driving Up Responsiveness for Business Operations

Because the performance of AsiaInfo AISWare 5G Billing system is primarily bound by memory, it shows outstanding results with Intel® Optane™ persistent memory. Compared to a typical five-year-old billing server, a new system based on the 2nd Generation Intel® Xeon® Scalable processor equipped with Intel® Optane™ persistent memory enables great reduction in response time for complex queries. For new servers based on the 2nd Generation Intel® Xeon® Scalable processor, the addition of Intel® Optane™ persistent memory greatly reduces response time for AsiaInfo AISWare 5G Billing system compared to the same server with DRAM alone.

Intel® Optane™ persistent memory delivers industry-leading high throughput, low latency, high quality of service and exceptional durability, and provides near-memory latency, fast cache, fast storage and application acceleration. It performs well in accelerating applications.

In addition, Intel® Optane™ persistent memory has a maximum capacity of 512GB for a single device, far exceeding 128GB for DRAM memory, making it easier to achieve a larger total amount of memory on a single server. Moreover, Intel® Optane™ persistent memory costs far less than DRAM memory, which enables AsiaInfo to build higher capacity memory pools at lower cost and provide higher data throughput and lower latency.

By providing faster queries, AsiaInfo enables service providers to process more business data in less time, driving greater value from it. For example, by accelerating business intelligence operations, telecom operators can perform a larger number of more sophisticated analyses based on user data. That leads to a higher degree of insight that can direct day-to-day business operations with better decision making and helps carriers achieve a competitive advantage.

The increased performance sets the stage for additional features and capabilities, such as real-time monitoring of KPIs, personalized reporting, and value-added service analysis and push.

Ultimately, implementing AsiaInfo AISWare 5G Billing system on servers equipped with Intel® Optane™ Persistent memory can help deliver a better user experience as well as significant cost savings.

> "The conclusion drawn from the comprehensive laboratory test of Intel® Optane™ Persistent memory technology and AsiaInfo AISWare 5G Billing system service scenario shows that Intel® Optane™ Persistent memory technology can break the bottleneck of billing service support system for large memory and high-performance storage scenarios, thus improving the overall throughput of the system. As a new hardware solution, Intel® Optane™ Ersistent memory is possible to become a cost-effective system solution through the optimization of more application scenarios and the improvement of business integration solutions in the future."
>
> Business Support Department

Redefining the Enterprise Memory Tier

Beyond its cost advantages over DRAM, Intel® Optane™ persistent memory provides profound changes to the architecture of the memory subsystem, making it the primary data tier for both working data and long-term storage. That is, it combines byte-addressability similar to DRAM with persistence similar to storage. That combination means that it can be mapped directly into application address space, eliminating the bottleneck associated with reads and writes to conventional storage.

Intel® Optane™ persistent memory offers two distinct operating modes: Memory Mode and App Direct Mode. In Memory Mode, it behaves exactly like ordinary, volatile (non-persistent) system memory but with lower cost, enabling higher capacities within a constant system budget. Modules are available in capacities of 128 GB, 256 GB, and 512 GB.

AsiaInfo unlocks even greater value from Intel® Optane™ persistent memory by enabling App Direct Mode. This approach makes separate volatile and persistent memory stores available to the billing application. The software can place large data structures and data that must be retained long-term on Intel® Optane™ persistent memory, accelerating operations using a data caching structure based on conventional DRAM. This arrangement enables AsiaInfo AISWare 5G Billing system to tailor the memory subsystem to the individual needs of the workload, further enhancing performance.

The performance advantages of Intel® Optane™ persistent memory is complemented by those delivered by the 2nd Generation Intel® Xeon® Scalable processor. With up to 28 cores and six memory channels, the processor provides pervasive performance in the data center and can be equipped with as much as 6 TB of total system memory. This combination of hardware components represents engineering across the hardware stack that delivers higher performance than predecessors, both for AsiaInfo and across the enterprise.

In the actual test, the testing personnel adopted Inspur NF5280M5 high-performance server, which is a 2U 2-way rack server designed based on the 2nd Gen Intel® Xeon® scalable processor to meet the needs of internet, IDC (Internet Data Center), cloud computing and telecom business applications. In business scenarios of higher security requirements, Inspur 5280M5 uses the security protection capability of embedded hardware encryption chip (algorithm selected according to user requirements) to implement security features such as root key system and secure storage of data. It supports the security protection of operating systems, middleware and upper-layer applications, protecting root keys, software, firmware and configuration information from malicious tampering.

In this test, Inspur NF5280M5 high-performance server is based on Intel® Optane™ persistent memory (the test configuration is shown in Table 1 and the host configuration is shown in Table 2), and the data processing performance, startup and shutdown, fault recovery capability and call detail record processing performance of the AsiaInfo Memory Database (AIMDB) under different configurations were tested.

Host model	Pcs	IP address	CPU	Memory (G)	AEP(G)	Remarks
InspurNF5280M5 server	6	10.10.12.150～10.10.12.155	2*20 Intel® Xeon®	12*16	12*128	Network adapter: Intel Corporation Ethernet Controller 10-Gigabit X540-AT2

			Gold 6248			

Table 1: Configuration for test

	Configuration 1: standard configuration	Configuration 2: Intel® Optane™ persistent memory in Memory Mode	Configuration 3: Intel® Optane™ persistent memory in App Direct Mode
CPU	2 x Intel® Xeon® Gold 6248 CPU @ 2.50GHz	2 x Intel® Xeon® Gold 6248 CPU @ 2.50GHz	2 x Intel® Xeon® Gold 6248 CPU @ 2.50GHz
Memory	DDR4 2666 192GB (12 x 16GB)	DDR4 2666 192GB (12 x 16GB)	DDR4 2666 192GB (12 x 16GB)
Intel® Optane™ persistent memory	None	1.5TB (12 x 128GB)	1.5TB (12 x 128GB)
Disk	4 x 1.6TB NVMe SSD + 1 x 960GB SATA SSD	4 x 1.6TB NVMe SSD + 1 x 960GB SATA SSD	4 x 1.6TB NVMe SSD + 1 x 960GB SATA SSD
OS	CentOS 7.6	CentOS 7.6	CentOS 7.6
AIMDB	Aimdb 3.1	Aimdb 3.1	Aimdb 3.1
Test load	Sysbench	Sysbench	Sysbench
Dataset	120GB	1.2 TB	600 GB

Table 2: Host configuration

The performance stress test data of AIMDB Benchmark is shown in figure 1. The data shows that, when the Intel® Optane™ persistent memory is used, it can maintain more than 94% of the physical memory performance and meet high performance requirements in the actual production process.

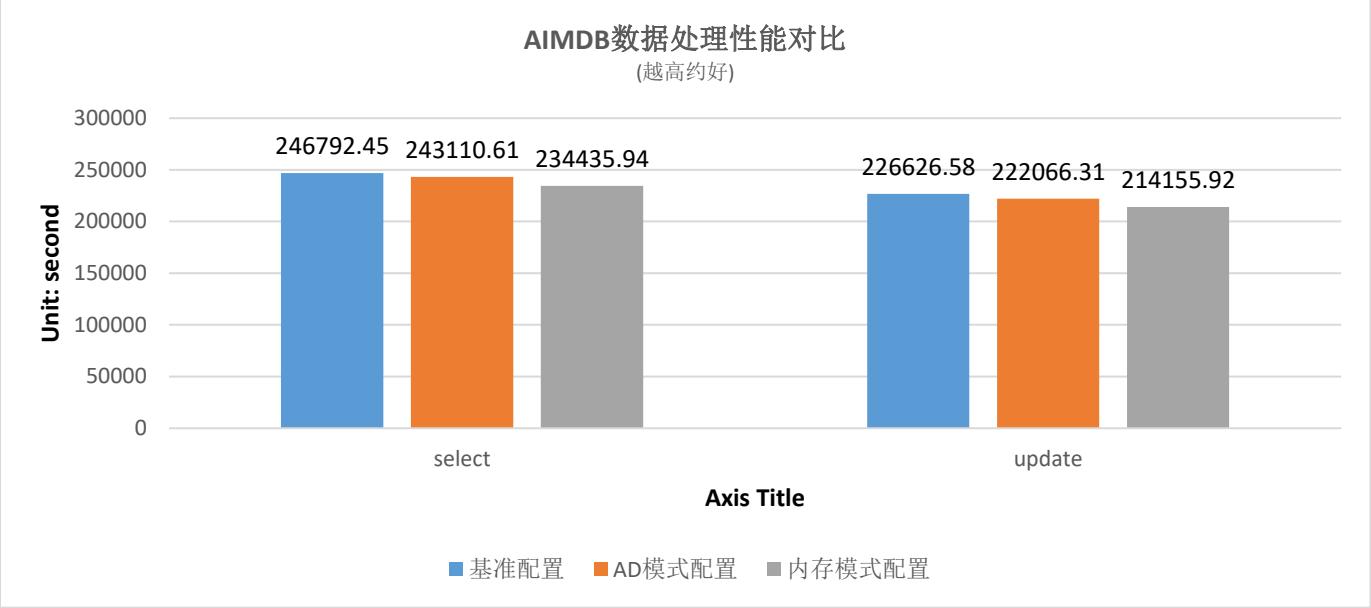


Figure 1: Comparison of data processing performance of AIMDB

AIMDB 数据处理性能对比 （越快越好）	Comparison of Data Processing Performance of AIMDB (The faster, the better)
基准配置	Benchmark Configuration (DRAM-only configuration)
AD 模式配置	Configuration for App Direct Mode
内存模式配置	Configuration for Memory Mode

The test data shows that if quality of service is guaranteed, the size of data sets processed under the memory mode and the App Direct mode of Intel® Optane™ persistent Memory is improved by 10 times and 5 times respectively (the test data is shown in Figure 2).

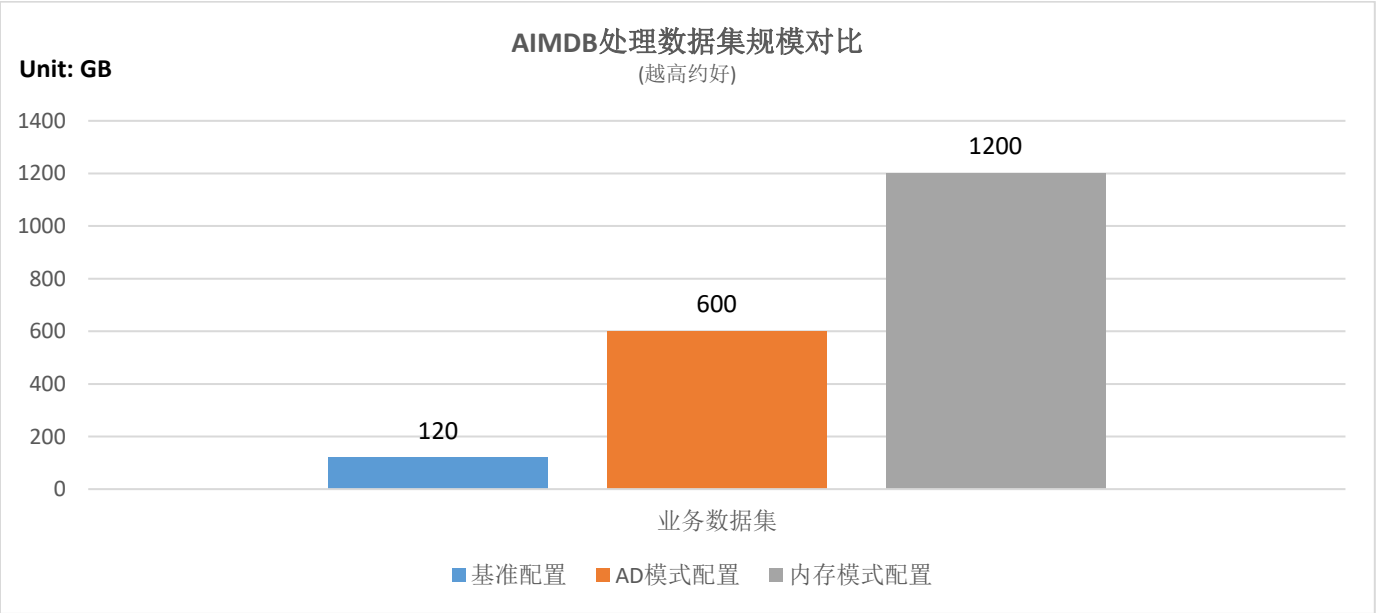


Figure 2: Comparison of AIMDB data sets size

AIMDB 处理数据集规模对比(越高越好)	Comparison of AIMDB data sets size (the hjgher, the better)
基准配置	Benchmark Configuration (DRAM-only configuration)
AD 模式配置	Configuration for App Direct Mode
内存模式配置	Configuration for Memory Mode

In the test scenario for AIMDB start-up and fault recovery, the testing personnel used Intel® Optane™ persistent memory to start an 120G dump backup, load the data into the service available, and tested the time needed (the test data is shown in Figure 3). Data shows that the disk loading completion time was shortened from 285s to 19s, which means 15 times of performance improvement. The stop time of Intel® Optane™ persistent memory has also been reduced from 315s using SSD disks to 54s, which means an improvement time of 5.8 times.

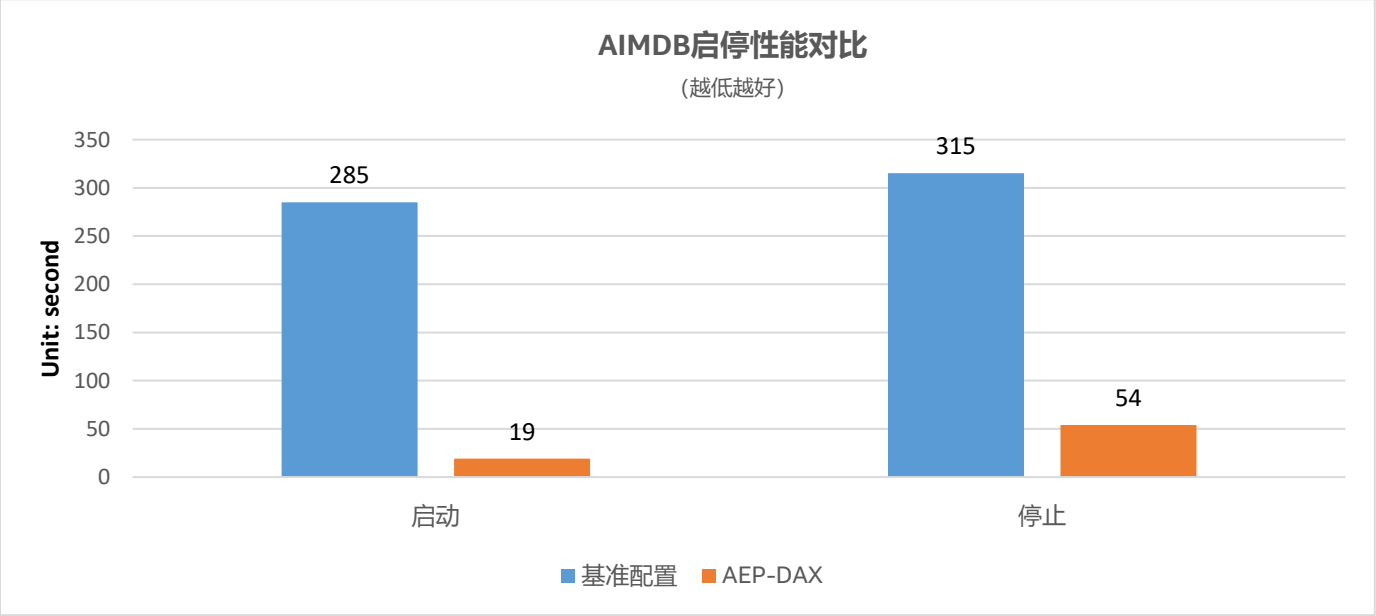


Figure 3: Comparison of AIMDB start-up and stop performance

AIMDB 启停性能对比 (越低越好)	Comparison of AIMDB Start-up and Stop Performance (the lower, the better)
启动	Start-up
停止	Stop
基准配置	Benchmark Configuration

In the test scenario for call detail recording performance, the testing personnel used Intel® Optane™ persistent memory and physical memory for batch processing of call detail records, to observe and summarize the call detail record processing capacity (the test data is shown in Figure 4). The test shows that the call detail record processing capacity of Intel® Optane™ persistent memory after comprehensive weighted average value is 254.6 records/second, and the single thread processing capacity of physical memory is 262.4 records/second. The processing capacity ratio is 97%, so they are very close in processing capacity.

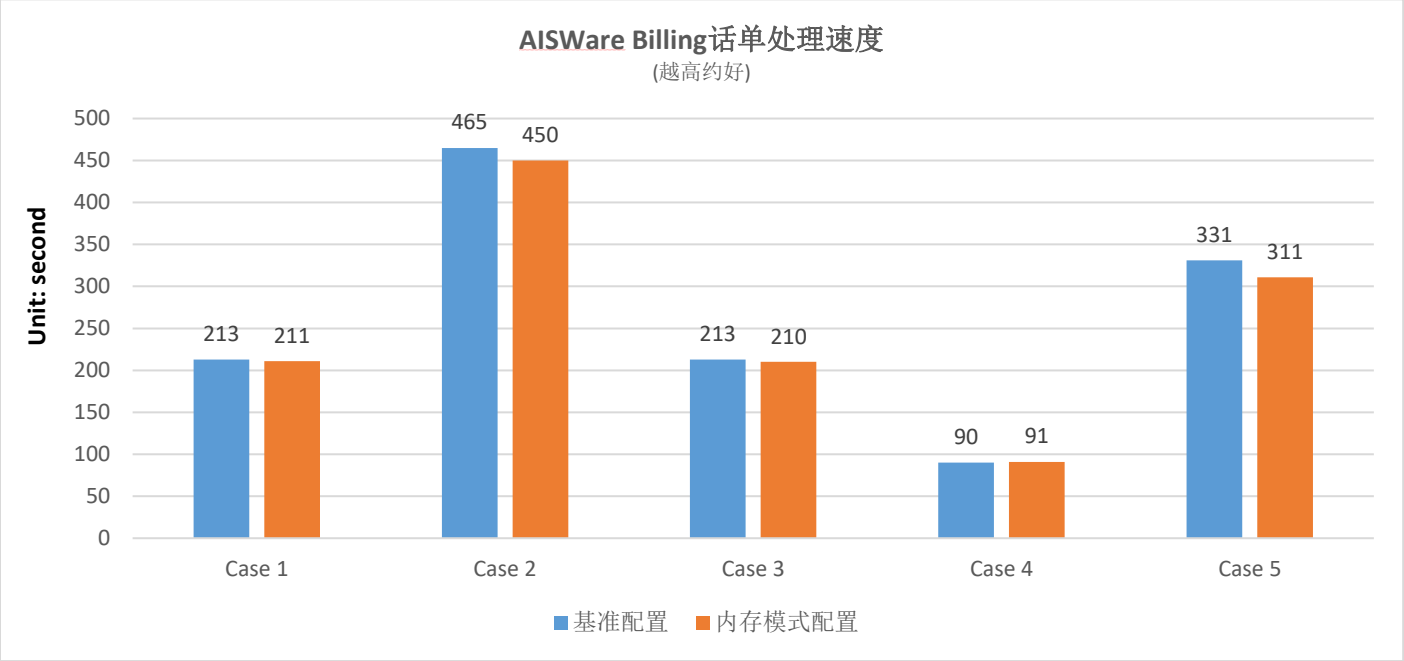


Figure 4: **AISWare 5G Billing call detail record processing speed**

AISWare 5G Billing 话单处理速度 (越高越好)	AISWare 5G Billing Call Detail Record Processing Speed (the higher, the better)
基准配置	Benchmark Configuration (DRAM-only configuration)
内存模式配置	Configuration for Memory Mode

In addition, the testing personnel also conducted call detail record processing tests on Intel® Optane™ persistent memory in Storage over App Direct Mode (the test data is shown in Figure 5). The test shows that the call detail record processing speed after comprehensive weighted average value is 262.4 records/second under the normal mode (DRAM-only configuration), and it is 254.6 records/second under Memory Mode of Intel® Optane™ persistent memory and 323 records/second under Storage over App Direct Mode. Compared with the normal mode (DRAM-only configuration), the performance has been improved by 23%.

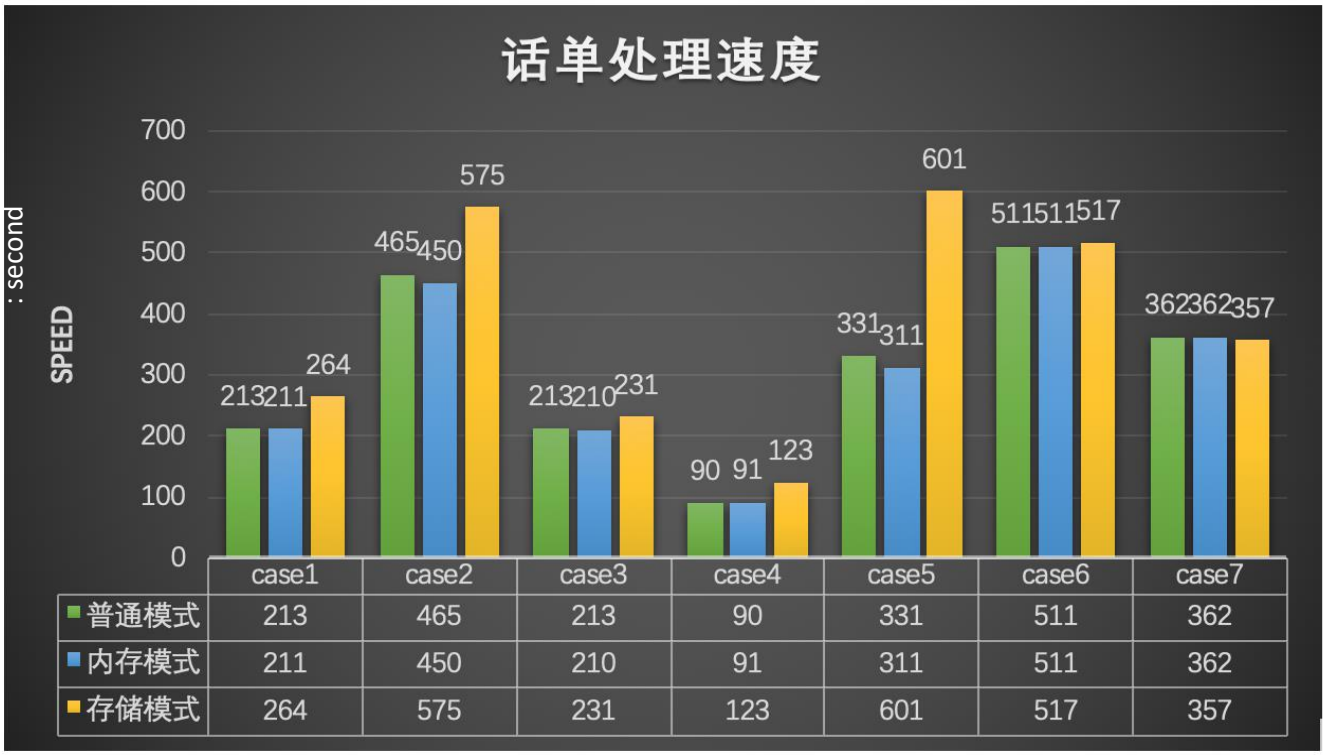


Figure 5: Call detail record processing speed

话单处理速度	Call Detail Record Processing Speed
普通模式	Normal Mode (DRAM-only configuration)
内存模式	Memory Mode
存储模式	Storage Mode

The overall host CPU consumption conditions in the above scenarios are shown in Figure 6. Weighted average value under normal mode (DRAM-only configuration): CPU consumption rate is 60.56%; weighted average value of Intel® Optane™ persistent memory in Memory Mode: CPU consumption rate is 57.56%; weighted average value under storage mode: 55.60%. The CPU consumption rate has reduced by 5~10%.

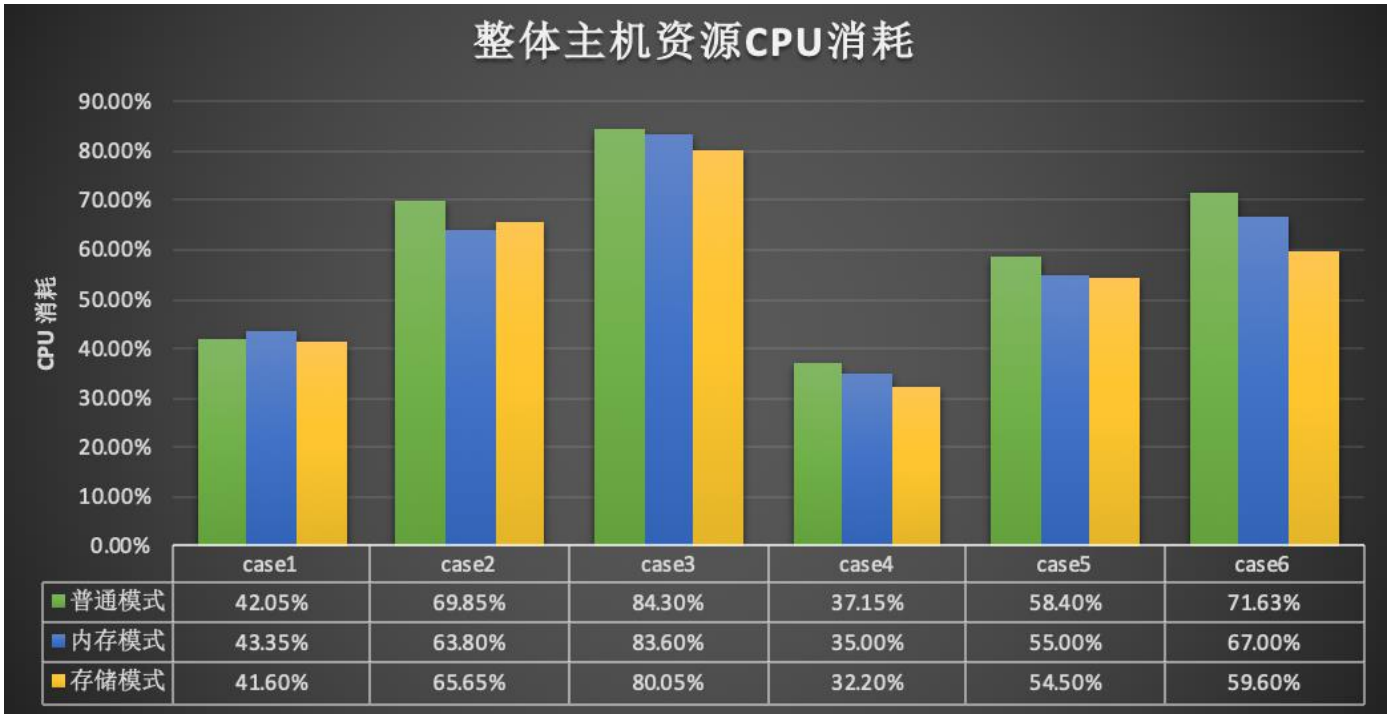


Figure 6: CPU consumption of overall host resource

整体主机资源 CPU 消耗	CPU Consumption of Overall Host Resource
普通模式	Normal Mode (DRAM-only configuration)
内存模式	Memory Mode
存储模式	Storage Mode
CPU 消耗	CPU Consumption

Test results show that when Intel® Optane™ persistent memory is used, a single server of AIMDB can save a larger data set (10 times) without sacrificing performance (> 94%). As a result, the deployment cost can be reduced. In addition, AIMDB can also greatly improve the startup (15 times) and stop (5.8 times) performance, thus significantly improving the operation capability and reliability of the system.

When Intel® Optane™ persistent memory is used in Memory Mode, it can maintain the processing speed of physical memory. For scenarios requiring low CPU consumption, more applications can be deployed under large memory mode. When it is used for big cache and memory database scenarios, it will result in higher benefit ratio.

When Intel® Optane™ persistent memory is used under the Storage over App Direct Mode, it has remarkably high IO capability, overall call detail record processing performance, and system throughput, and therefore can result in significant performance improvement. At the same time, it also can reduce CPU consumption to a certain extent.

"With high capacity, low cost, and persistent storage, Intel® Optane™ persistent memory delivers significant performance gains for applications such as big data analytics and in-memory databases. It can reduce IT costs and simplify infrastructure for users. Intel® Optane™ persistent memory is becoming the best solution for building next-generation data centers and data analytics platforms. We see the AsiaInfo AISWare 5G Billing system with Intel® Optane™ Persistent Memory and Inspur NF5280M5 server have achieved significant performance gains while significantly reducing deployment costs."

Wei Jian
Deputy General Manager, Solutions and Testing
Inspur Electronic Information Industry Co., Ltd.

Effect: laying the foundation for future-oriented billing system

5G technology brings about the wide connection between people, people and things, things and things, and promotes the implementation of Internet of Things and edge computing. For telecom billing systems, the types, categories and quantity of equipment involved in telecommunications costs will increase substantially, which means huge challenges and an important business opportunity. In the fast-developing 5G era, AsiaInfo hopes to be able to orchestrate the operator network and services in terms of technology and empower operators and vertical industries in terms of business model. It is innovating in billing systems for the 5G era.

With Intel® Optane™ persistent memory, AsiaInfo can help operators quickly process billing services while controlling the cost of the billing system servers in the rapidly growing billing system load. In a large number of scenarios, the calculation of voice, traffic and other expenses can be quickly processed, and the entire system can be accounted for within one day, which resolves the contradiction between the explosive development of the business and the insufficient carrying capacity of the IT infrastructure.

Due to the improved performance of AsiaInfo's AISWare 5G Billing servers, billing efficiency is guaranteed, providing customers with comprehensive, timely and friendly service capabilities and service channels to ensure a good customer experience. At the same time, AsiaInfo's AISWare 5G Billing servers can effectively support the timely launch of various traditional businesses and traffic services, ensuring that telecom operators are in a favorable position in the highly competitive market.

Looking ahead to the future, AsiaInfo is working with Intel to extend its billing performance advantages even further. The company began trading publicly on the Hong Kong stock exchange in December 2018. The capital raised from the IPO allows AsiaInfo to enhance its research and development capabilities, helping the company continually ensure that its billing system takes optimal advantage of emerging technologies.

Conclusion

With the acceleration of the 5G era, telecom service providers are facing tremendous development opportunities, and their information support systems are also facing severe challenges. Companies such as AsiaInfo, Inspur, and Intel are accelerating business cooperation and technological innovation, helping telecom operators to organize their networks and services to meet the urgent needs of 5G.

AsiaInfo AISWare 5G Billing system uses the redesigned memory architecture provided by Intel® Optane™ persistent memory technology to keep pace. Lower system latency provides faster response times on complex billing queries against these novel data sets. These advances will help carriers and other service providers thrive on change instead of struggling to accommodate it.

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[1] Standard & Poor's Global Market Intelligence, "Chinese telecom provider AsiaInfo Technologies preps for 5G ahead of IPO,"https://www.spglobal.com/marketintelligence/en/news-insights/trending/kioj0lviutcjws6aj0stja2.

[2] PR Newswire, "Global Digital Business Support System (Billing) market size to grow at a CAGR of 15.2%," https://www.prnewswire.com/news-releases/global-digital-business-support-system-Billing-market-size-to-grow-at-a-cagr-of-15-2-300763635.html.

[3] All information provided here is subject to change without notice.