A Cloud Computing Collaborative Commerce Model

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ABSTRACT
Cloud computing has the potential to be particularly suitable for collaboration commerce (c-commerce) because it generally requires less customization, development, integration, operation, and maintenance costs than other computing resources. However, upgrading c-commerce IT infrastructure, to run on cloud computing, faces a number of challenges, such as lack of effective design and implementation models. This paper presents a description and performance evaluation of a new model of c-commerce that utilizes the evolving cloud computing technologies; therefore, it is referred to as cloud collaborative commerce (cc-commerce) model. The model consists of six main components, these are: client, provider, auditor, broker, security and privacy, and communications network. The new cc-commerce model is used to develop a simple and flexible Web-based test tool, namely, the CC-Commerce Test (3CT) tool. The performance of the new model is evaluated using 3CT tool to estimate the response times for four different configurations. The obtained results demonstrate that the new model performs faster than equivalent c-commerce models.

Keywords
Cloud Computing; collaborative commerce; cloud commerce; electronic commerce; cloud collaborative commerce.

1. INTRODUCTION
One of the fastest growing applications for the Internet is the electronic commerce (e-commerce), which is the sales aspect of electronic business (e-business) [1]. Essentially, e-commerce is about performing transactions on the Web, such as purchasing and marketing products, training, supply chain management, etc. Due to the exponential growth of businesses and tremendous advancement in Information and Communications Technology (ICT), new form of commerce was emerged, which is called collaborative commerce (c-commerce). It involves online collaboration and interactions among business partners (organizations) to capitalize upon the global market and to become more profitable and competitive. Organizations realize that effective collaboration is a key to good knowledge management practices, which are essential for success; therefore, many organizations decide to go beyond private e-commerce and move towards c-commerce [2].

In c-commerce, organizations able to share information and at the same time protect their privacy as well as sensitive information. As organizations build their resource management systems (RMSs) independently, it is expected to have disparate heterogeneous RMSs, which have to be integrated to form federations and subsequently work effectively within as well as across organizations. Furthermore, organizations usually run their RMSs on individually and locally installed local area networks (LANs), which are accessed and interconnected through the Internet using Wide Area Network (WAN) protocols and infrastructures. Thus, many challenges must be addressed to meet clients (customers), organizations, and applications satisfactions and maintain satisfactory Quality-of-Service (QoS); such as: communications bandwidth, reliability, efficiency, availability, scalability, security, etc. Adding to the above challenges is the high cost of installing and operating local RMSs. Also, all local resources need to be continuously maintained and upgraded [3].

A more recent technological breakthrough is the emergent of cloud computing, which is the delivery of computing resources (hardware and software) as a service rather than a product, whereby shared resources, software, and information are provided to users by Cloud Computing Providers (CPSs) as a metered service over a communications network, typically the Internet [4]. It is very interesting to perceive how c-commerce can benefit from this tremendous cloud computing technological development and relax the many challenges that are facing wider c-commerce promotion, and meet clients, organizations, and applications satisfactions and also maintain satisfactory QoS [5, 6]. Cloud computing platforms have the potential to be particularly well-suited for applications required collaboration between different parties, such as those imposed by c-commerce applications. It generally requires less development, integration, installation, customization, operation, maintenance, and upgrading costs than other enterprise applications [7, 8].

This paper develops a new c-commerce model that utilizes cloud computing concept as a platform for running c-commerce application, which is referred to as cloud-based collaborative commerce (cc-commerce). The model and its configurations are described in details. The performance of the new model is evaluated qualitatively and quantitatively. The quantitative performance is evaluated in terms of the average response time. The benefits and advantages of the new cc-commerce model over the conventional c-commerce model are pointed-out.

This paper is developed into six sections. Section 1 introduces the main theme and concept of the paper. The rest of the paper is organized as follows. Section 2 presents a background on c-commerce, traditional computing systems and cloud computing. Section 3 reviews the most recent and related work. A detail description of the new cc-commerce model is given in Section 4.
Section 5 presents a description of four scenarios representing e-commerce and cc-commerce configurations that are performed to evaluate and compare the performance of the cc-commerce model against the performance of different e-commerce configurations. Finally, in Section 6, conclusions are drawn and a number of recommendations for future work are pointed-out.

2. BACKGROUND

This section provides a background on the main topics that represent the core of this research, namely: c-commerce, traditional computing systems and cloud computing systems.

2.1 Collaborative Commerce (C-Commerce)

C-commerce is a form of e-business that conducts business on the Internet, not only purchasing and marketing but also servicing customers and collaborating with business partners [1]. C-commerce is conducted via inter-enterprise Internet connections and enables multiple enterprises to work interactively online to find ways to serve their customers and to solve business problems. It is also defined as enterprise capable Web-based solutions that use the Internet to allow employees, customers, and suppliers to collaboratively develop, build, manage, market, and support products throughout their life cycle [6, 7].

2.1.1 C-Commerce Models

In order for organizations to carry-out c-commerce, suitable business models are required [3, 7]. Supplier to customer relationships in c-commerce can be classified into two forms; these are: Tightly-coupled and Loosely-coupled. In tightly-coupled, one party dominates the business practices and the others conform to them. Because the dominating party is so large, it is either the dominant supplier or the dominant customer in the market. Therefore, it has the power to dictate what system will be used to conduct the transaction. Tight relationships can take the form of a one-to-one, a many-to-one, or one-to-many relationship.

In loosely-coupled, no business has the power to dictate the system used to conduct transactions, instead it may deal with whichever business it pleases, taking into account such things as price, value, and reputation. In order to complete the transaction, the business must either constantly change their business practices to adapt to new partners or there must be some sort of mitigation system which can resolve differences between partners. This would allow a business to form a relationship with another with minimal effort or changes to their infrastructure. However, the forming of such a mitigation system is not trivial and may require serious investment.

2.1.2 The Vision of C-Commerce

The ultimate objectives of c-commerce initiatives are to maximize return on IT investment, increase business agility and QoS, and enhance supply chain integration. Integration of supply chain enables business partners to coordinate complex transactions, share latest information, collaborate on product planning, communicate product design ideas, and integrate their workflows. C-commerce can help businesses gain competitive advantages, such as: connect and automate processes among business partners; reduce processing latencies; develop new capabilities that improve service levels while reducing costs; and make dynamic planning, design, and operational based on real-time information [9, 10, 11].

2.2 Traditional Computing Services

Traditionally, two broad approaches can be identified to providing computing services: On-premises IT services and Data center IT services [2]. On-premises IT is where the business purchases, installs and maintains all servers, software licenses, backup devices and telephony equipment which are housed on-site in the business office. Of course, technology is complicated so IT experts are always required to maintain the system operation at business or company site. Companies either hire on-staff IT employees or hire local IT services firms to perform this maintenance. Maintaining the variety of systems needed to run a business is no easy task and very often the IT staff is overworked and subsequently the business has to wait for IT support.

On-premises IT services have many advantages, such as: higher level of internal control, ability to customize services, data is on-site, and can operate without Internet. On the other hand, they have many disadvantages, such as: requires specialized IT support staff, initial and operation capital cost intensive, difficult to upgrade and patch, unpredictable additional costs, difficult to maintain compliancy, and high availability [4].

The data center option is very often confused with cloud computing, where it is not cloud computing. This option does allow companies to move their systems to a dedicated managed data center, and it has many advantages over traditional on-premises installations, such as: higher level of internal control, ability to customize services, and leverages facilities of professionally managed data center. On the other hand, they have many disadvantages, such as: requires IT staff, capital cost intensive, difficult to upgrade and patch, unpredictable costs, high costs for managed services, and redundant cost if some systems that are still required on premises [4, 8].

2.3 Cloud Computing

2.3.1 Definition and Features

Cloud computing can be defined as the delivery of computing resources (hardware and software) as a service rather than a product, whereby shared resources, software, and information are provided to computers and other devices as a metered service over a network, typically the Internet [4]. It can help businesses by reducing initial investment on hardware and software purchase as well as reducing operation and management costs, which, in turn, help them to allocate more money to spend on the core business. Other benefits include: employees work anywhere, lower capital expenditures, focus on business not technology, no upgrades worries, fast implementations, lower upfront and ongoing costs, pay only for services business required, guaranteed service-level agreements (SLAs), and predictable spending [4].

However, more experienced (large) businesses look far beyond costs as a sole consideration. Larger organizations, particularly those operating in industries with strict legislation and compliance regulations factor in: third-parties are handling confidential data (i.e., information security), requires reliable Internet connection, redundancy, a subscription service could be expensive over time and as business grows, customization and integration with custom systems could be an issue, and lack of full control over data and processes. Unlike Web hosting solutions, there is only limited numbers of CSPs. But the good news is that all major hardware and software brands of the world including Google, Microsoft, HP, DELL, Amazon and IBM are already providing cloud solutions [11].
2.3.2 Types of Cloud Computing Services

CSPs provide three types of services; these are [4]:

1. Cloud infrastructure as a service (IaaS): All required hardware to run a business is provided by CSPs and customers manage their application software.
2. Cloud platform as a service (PaaS): A customer pays to the CSP to use their platform as their IT solution. For example, for E-mail system or database software.
3. Application software as a service (SaaS): If you only need to use a specific kind of software to get an output or to perform an analysis, then it is much cheaper to use that software service from a CSP rather than buying, installing and maintaining it.

Figure 1 shows the cloud computing services, which is divided between two main layers, users and cloud computing.

Figure 1. Types of cloud computing services.

2.3.3 Cloud Collaboration

Cloud collaboration is a newly emerging way of sharing resources (applications and information) through the use of cloud, whereby files containing these resources are uploaded to a central cloud for storage, where they can then be accessed by others. Users are allowed to upload, comment and collaborate on documents and even amend the document itself, evolving the document within the cloud. Businesses in the last few years have increasingly been switching to use cloud collaboration to achieve business objectives that are enabled by collaboration solutions [6, 9, 11].

Collaboration in the cloud immediately opens options for access to new and cost-effective ways to address company goals and objectives. For example being able to get communications and collaboration services up and running quickly, lower upfront deployment costs, ease of access, pay for software solutions you need and when you need them, and access to automatically updated software and security. If used effectively, collaboration in the cloud enables companies to capitalize on needed technology without the extensive, upfront capital expense that comes with the time-consuming installation and configuration of IT systems.

CSPs need to determine the applications they must own and control, and which ones are prime targets for the cloud. In essence, companies must decide how much control over certain aspects of IT they truly need. Then they must compare how much economic value that control offers by being in-house compared to the economies of scale available in the cloud.

When considering cloud, companies need to know that the partners, or vendors, they work with are credible. They should have proven processes to support an organization’s needs. It’s equally important to identify companies with a track record of on-premise solutions. Those companies should also have a clear cloud vision, strategy and offerings that demonstrate stability and long-term viability. If personal data is put into the cloud, legal requirements for transferring, storing and using data must be addressed carefully in advance.

3. PREVIOUS WORK

This section reviews some of the most recent and related work to e-commerce and applications of cloud computing in e-commerce. However, it has been realized that very little efforts being focused on cloud computing performance evaluation for e-commerce. Huang & Fan [7] proposed an integrated solution for e-commerce including the collaborative strategy, model and platform. They developed service oriented architecture (SOA) and model-driven architecture (MDA) based-platform for e-commerce to enable value-added collaboration between partners by providing new technical solutions, best practices, and collaboration tools.

Chen, Zhang, & Zhou [9] presented an in-depth analysis of business process management (BPM) and Web services in the context of e-commerce. They proposed architecture for Web services enabled BPM in e-commerce and provided technical insights into why Web services can enhance business process coordination. Also, they presented an implementation of a dynamic e-procurement. They concluded that with the advent of Web service standards and business process integration tools, BPM systems enabled by Web services are empowering the development of more flexible and dynamic e-commerce.

Zhang, Chen, & Lai [10] developed a c-commerce model based on multi-agent system (MAS) technology that is characterized with the features of autonomy, easy adaptation, flexibility and dynamic of agent technology. The model describes the interaction relationship with partners and run on the cooperation among the different MAS layers. Many useful functions, including automated learning, data analysis and mining, and best solution selection can be realized in this unified e-commerce system.

Buyya et al [5] provided the architecture for creating clouds with market-oriented resource allocation (MORA) by leveraging technologies such as Virtual Machines. They presented some representative cloud platforms, especially those developed in industries, along with their current work towards realizing MORA as realized in Aneka enterprise cloud technology. They highlighted the difference between high performance computing (HPC) workload and Internet-based services workload. They also described a meta-negotiation infrastructure to establish global cloud exchanges and markets, and illustrated a case study of harnessing storage clouds for high performance content delivery.

Li & Xia [11] made a preliminary study on how cloud computing can be applied in the e-commerce chain and presents the principles, ideas and analysis of the architecture of cloud-computing-based e-commerce chain to provide references for its construction. They showed that the chain has five layers: structural, basic resource, middleware, logic, and collaborative application layers. When the architecture of the chain is being designed, it should consider that the different characteristics of collaboration chains have different focuses. They did not discuss any implementation or performance evaluation to their model.
4. THE NEW CC-COMMERCE MODEL

The new cc-commerce model is assumed to consist of six main components and it is depicted in Figure 2. Each component is an entity (a person or an organization) that participates in a transaction or process and/or performs tasks in cc-commerce. A brief definition for each of these components is given below and further details can be found in [12]:

1. Client. An entity that maintains a business relationship, and uses service provided by providers or brokers.
2. Provider. An entity responsible for making a service available to interested parties.
3. Auditor. An entity that can conduct independent assessment of cc-commerce services, information system operations, performance and security of the cloud implementation.
4. Broker. An entity that manages the use, performance and delivery of cc-commerce services, and negotiates relationships between providers and cc-commerce clients.
5. Security and privacy. An entity that is responsible for providing security and privacy across the system using standard and/or specially developed protocols.
6. Communications network. An intermediary that provides connectivity and transport of cc-commerce services between cc-commerce clients to providers/brokers.

The model can be configured and used in three different configurations; these are:

**Configuration#1** (Figure 4): A cc-commerce may request service from a cc-commerce broker instead of contacting a cc-commerce provider directly. The broker may create a new service by combining multiple services or by enhancing an existing service. In this example, the actual providers are invisible to the client and the client interacts directly with the broker.

**Configuration#2** (Figure 5): Communications network provides the connectivity and transport of cc-commerce services from providers to clients. As in Figure 5, a provider participates in and arranges for two unique SLAs, one with a communications network (SLA2) and one with a client (SLA1). A provider arranges SLAs with a communications network and may request dedicated and encrypted connections to ensure the services are consumed at a consistent level according to the contractual obligations with the clients. In this case, the provider may specify its requirements on capability, flexibility and functionality in SLA2 in order to provide essential requirements in SLA1.

**Configuration#3** (Figure 6): For a cc-commerce service, a cc-commerce auditor conducts independent assessments of the operation and security and privacy of the service implementation. The audit may involve interactions with both client and provider.

4.1 CC-Commerce Deployment Models

The cc-commerce model developed in this work can be deployed using one of the following configurations [12]: (1) Provider-access configuration, and (2) Broker-access configuration. In provider-access, a client directly accesses a provider, where the infrastructure and computing resources are made available to the general clients over a public network. The configuration can be owned by an organization selling cloud services or by an organization hiring cloud services and deploy its technology on top of it to serve a diverse pool of clients.
In broker-access, a client accesses a broker to accomplish a certain mission or query, the broker, in turn, analyze the query and choose the best path to accomplish the mission, which could be through intra-connection with local recourses (cc-1) or through interconnection with other cc-commerce sites (cc-2, cc-3, .., cc-n). In this case, the broker either outsources the query to one or more sites or collaborates with other sites. The interconnection with other sites can be done through dedicated links or through existing Internet infrastructure. A special case of the broker-access configuration is that when collaborating sites host resources only for one enterprise or organization, then it can be considered as a cc-commerce configuration.

For more efficient implementation, we highly recommend to host the cc-commerce auditor at the same site of the cc-commerce provider/broker. Furthermore, it is always recommended to host a cc-commerce broker and at least one provider at the same site. The security and privacy components must be installed at all sites. However, it is necessary to realize that installation of security and privacy components and interconnection through WAN links increase query processing time or response time. In other words, it is expected that provider-access configuration always performs faster than the broker access configuration, specially, if the broker outsources part or the entire requested query.

4.2. Implementation & Performance Measures

In cc-commerce, a client accesses a specific Website, which is called the main Website, for the sake of performing a certain task, for example, retrieving data stored at one or more hosts located at various locations that are internetworked using different WAN technologies and protocols, and having various IP addresses on the Internet. The host of the main Website is called the Main Host.

In the new cc-commerce model, the Main Host and all collaborating hosts are located at the same location under the same IP address interconnected using LAN technologies and protocols. Thus, it is expected to reduce the response time because of replacing the WAN links between the Main Host and other collaborating hosts by the high bandwidth LAN links.

In order to evaluate the performance of the new cc-commerce model, and compare its performance against cc-commerce applications, we developed a test tool that is referred to as 3CT tool for CC-Commerce Test tool. The 3CT tool is programmed using ASP.NET (C#), LINQ to SQL Class, Microsoft Visual Studio 2008, C# Web application, and MS SQL Express 2008 Server. In this work, we subscribe for three hosts at three different providers as given in Table 1.

Table 1. Names, URLs, and IPs of collaborating sites.

<table>
<thead>
<tr>
<th>Host 1 DC1</th>
<th>Host Name</th>
<th>URL</th>
<th>IP Address</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Host 2 CD2</td>
<td>Host Name</td>
<td>WebsitePanel</td>
</tr>
<tr>
<td></td>
<td>Host 3 CD3</td>
<td>Host Name</td>
<td>networksolutions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Host Name</td>
<td></td>
</tr>
</tbody>
</table>

The 3CT tool is hosted at the www.ixwebhosting Web hosting, and it can be used in provider or broker access configurations. It consists of a single Webpage through which we can initiate a request (query) for retrieving data from the NorthWind.MDF database. The Webpage can be accessed at http://www.awad.text.com/default.aspx.

In order to numerically evaluate the performance, we calculate the response time \( T_i \), which is defined as the CPU time required retrieving the requested data from the various hosts. Due to network instability, the response time for equivalent data retrieval tasks are usually measured more than once at different times during the day, and the average response time \( T_{avg} \) and the associated standard deviation \( \sigma \) are calculated, in particular in this work, \( T_i \) is estimated for 19 equivalent retrieving processes. The calculated \( T_{avg} \) depends on: amount of retrieved data, number of collaborating hosts including main Website server, network configuration, and bandwidth and delay of the data communication links between client and main server and between the main server and other collaborating servers. To evaluate the performance of the provider-access configuration, the tool retrieves data from the same hosting server; i.e., it represents a cc-commerce model. For broker-access configuration, the tool retrieves data from various hosts. Since each host is assumed to host data for a single enterprise, it can be considered as a cc-commerce evaluation.

5. RESULTS AND DISCUSSIONS

The 3CT tool is used to evaluate and compare the performance of the new cc-commerce model against the performance of cc-commerce models having different number of collaborating parties. In particular, four scenarios are considered, three of them represent different cc-commerce configurations (broker-access configuration with one enterprise per site) and one of them represents a cc-commerce configuration (provider-access configuration). In all scenarios the response time for equivalent data retrieval tasks from the NorthWind.MDF database are estimated more than once and \( T_{avg} \) and \( \sigma \) are calculated.

In all scenarios, a client accesses the Webpage at Site 1 requesting some data. Then, Site 1 server retrieves these data from its local data storage or from one or more other servers at other sites. In particular, in this work, to demonstrate and investigate the effect of the size of the retrieved data on the performance of the cc-commerce system, we perform two queries requesting two different data sizes. The sizes of the requested data are 850 KB and 1958 KB. For the 850 KB, three entities from NorthWind.MDF are retrieved, namely, Customers (48 KB), Employees (268 KB), and Orders (534 KB). While for the 1958 KB, five entities from the NorthWind.MDF database are retrieved, namely, Customers, Employees, Orders (twice from two different sites), and Orders Details (574 KB).

Scenario #1 simulates a cc-commerce system that consists of three sites, which are hosted under three different IP addresses. Site 1 hosts the main Web server, which acts as a cc-commerce broker, and the other two sites act as collaborating sites. In other words, the Webpage is acting as a broker outsourcing the execution of the received query to other sites. All three sites stores the NorthWind.MDF database. The IP addresses of these sites are given in Table 1. Table 2 shows the details of the retrieved data (names of entities, sizes, and number of records (rows) per entity), and the IP addresses of the sites from which data is retrieved.
The main recommendations for future work may include using broker-access configuration with more than one enterprise per site against the performance of provider-access configuration, considering equal retrieved data and collaborating enterprises.

6. CONCLUSIONS

This paper presents a description and performance analysis of a new cc-commerce. Based on the obtained results, the main conclusions of this work can be summarized as: (1) Cloud computing can play a big role in providing cost-effective computing resources for businesses, especially small and medium businesses who cannot afford the cost of installing on-premises computing resources. (2) The new model can be used in porting any c-commerce applications to a cost-effective cc-commerce application. (3) The cc-commerce application is always runs faster than its equivalent c-commerce application; for example for equivalent tasks a speedup factor of more than 2 can be achieved.

The main recommendations for future work may include using 3CT tool to perform further investigations, in particular, retrieve more data from more sites, and also evaluate the performance of broker-access configuration with more than one enterprise per site against the performance of provider-access configuration, considering equal retrieved data and collaborating enterprises.

Table 2. Details of retrieved data.

<table>
<thead>
<tr>
<th>Entity</th>
<th>Size</th>
<th>Row</th>
<th>S #1</th>
<th>S #2</th>
<th>S #3</th>
<th>S #4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customers</td>
<td>48</td>
<td>91</td>
<td>DC3</td>
<td>DC1</td>
<td>DC2</td>
<td>DC1</td>
</tr>
<tr>
<td>Employees</td>
<td>268</td>
<td>9</td>
<td>DC2</td>
<td>DC2</td>
<td>DC2</td>
<td>DC1</td>
</tr>
<tr>
<td>Orders</td>
<td>534</td>
<td>830</td>
<td>DC3</td>
<td>DC3</td>
<td>DC2</td>
<td>DC1</td>
</tr>
</tbody>
</table>

850 KB

<table>
<thead>
<tr>
<th>Entity</th>
<th>1958 KB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customers</td>
<td>48</td>
</tr>
<tr>
<td>Employees</td>
<td>268</td>
</tr>
<tr>
<td>Orders</td>
<td>534</td>
</tr>
<tr>
<td>Order Details</td>
<td>574</td>
</tr>
</tbody>
</table>

Scenario #1 except some data is retrieved from the data storage hosted at Site 1. The data for the entity Customers (48 KB) is retrieved from Site 1 (DC1), while the rest of the data is retrieved from the other sites as detailed in Table 2. Scenario #3 simulates a c-commerce system in which the Main Web Server retrieves all data from Site 2 at IP address 204.93.174.60. Scenario #4 simulates a client accesses the Main Web Server to retrieve all from its local storage. In this case, the Webpage is acting as a cc-commerce provider. In this Scenario, the client requesting data from the Main Web Server at DC1 (IP address 98.130.174.2), which realizes that all data is available locally so it does not need to collaborate with other sites in response for this query.

The results for $T_{avg}$ and $\sigma_S$ are given in Table 3. The table also shows another parameter which is the speedup factor ($S$). It represents by how much a cc-commerce runs faster than an equivalent c-commerce process. It is calculated by dividing the response time of the cc-commerce configuration by the response time of the cc-commerce configuration.

Table 3. Results for $T_{avg}$, $\sigma_S$, and $S$.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Size</th>
<th>S #1</th>
<th>S #2</th>
<th>S #3</th>
<th>S #4</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_{avg}$</td>
<td>850 KB</td>
<td>599.52</td>
<td>464.65</td>
<td>350.34</td>
<td>157.90</td>
</tr>
<tr>
<td>$\sigma_S$</td>
<td>207.75</td>
<td>160.68</td>
<td>242.29</td>
<td>138.29</td>
<td></td>
</tr>
<tr>
<td>$S$</td>
<td>3.80</td>
<td>2.94</td>
<td>2.22</td>
<td>1.00</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Size</th>
<th>S #1</th>
<th>S #2</th>
<th>S #3</th>
<th>S #4</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_{avg}$</td>
<td>1958 KB</td>
<td>953.96</td>
<td>921.07</td>
<td>520.57</td>
<td>218.77</td>
</tr>
<tr>
<td>$\sigma_S$</td>
<td>188.55</td>
<td>294.10</td>
<td>274.62</td>
<td>170.94</td>
<td></td>
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<tr>
<td>$S$</td>
<td>4.36</td>
<td>4.21</td>
<td>2.38</td>
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