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Congestion Control Using TFC and TFR In Common Channel Signaling System#7 (SS7) At Message Transfer Part-Level 3

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Abstract--- *Signalling refers to the exchange of information between the call components required to maintain and provide the call service. The communication between telephones-switches in public telephone networks with different set of protocols are known as Signalling System Number 7 (SS7 or CCS#7). The function of SS7 are call control, maintenance capabilities based on office telephone network and network management remotely. The telephone networks are vulnerable to attacks and congestion occurring in the telecommunication. In telecommunication network(BSNL concerning) a failure of links and exchanges i.e, out of service of links and outage of exchanges. In addition, congestion situations may cause failure of single links. Therefore, to avoid such problems, "Congestion Control at MTP-L3 (Message Transfer Part-Layer3)" is used for controlling the traffic occurring at the MTP-L3 layer using Transfer Control (TFCs) and transfer restricted mechanism (TFRs). The "Secured Tracking Devices (STD)" is used for secured transmission of voice and data in the telecommunication by identifying the attackers. Hence, the "CC at MTP-L3 STD" methodology provides better results by varying Number of nodes and energy consumption of existing "STD without TFCs/TFRs. The route reliability increases with decrease in network lifetime, end-to-end delay and Congestion Control.*

Keywords--- *Congestion Control, Transfer Control, Transfer Restricted Mechanism, Signaling System Number 7, Common Chanel Signaling #7,Secured Tracking Devices.*

I INTRODUCTION

Signal System-7 (SS7) is a set of protocols for performing out-of-band signaling in support of the call-establishment, billing, routing and which describes a means of communication between telephone switches in public networks. SS7 is highly sophisticated form of common channel signalling (CCS), which is to provide remote network management, call control, and maintenance capabilities for the (inter-office) telephone network [1]. The authentication mechanism is done using mobile and base station to analyse the effectiveness of current authentication mechanism using Global System for Mobile Communication (GSM). The GSM mobile communication is to make mobile phone system secured with proper authentication methodology [2]. The digital cellular mobile network GSM (Global System Mobile) is built into the system to deactivate or break the encryption on the radio link in order to eavesdrop on mobile phone conversation [3]. The PSTN contains more number of switches in which it includes redundant hardware and extensive self-checking and recovery software. The PSTN

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designers made the coupling-interactions trade-off in favour of loose coupling, in which it allows human operators to intervene in the event of failure than relying entirely on computer control [4].

The security flaws of the GSM network and its transport channels has influenced revolutionized different aspects of the human life. GSM uses radio communications for its mobile subscribers for the persons who are unauthorized users via. Different base station [5].

The IP backbone network topology is synthesized based on various qualitative and quantitative criteria for environment. IP network design process and network designs are typically characterized by a trade-off of cost versus performance and availability [6]. Traffic delay is one of the important metrics used for performing network functions. The main function is to examine the optimal range of quanties used for estimating the IP packet variation in the Next generation networks [7]. Telecommunication next generation network NGN is a converged network, which aims to provide a multitude of services over a signal integrated network infrastructure. An optimal method for planning, designing and capacity dimensioning for the next generation network is used for increasing the subscription ratio of the service and guarantee the service of the network [8]. The network of VoIP involves sending voice information in digital from using packet based switching rather than using the traditional protocols of public switched telephone network (PSTN) [9]. The three broad techniques currently being employed in performance analysis of computer networks based on analytical Modeling, simulation and measurements. The field of performance analysis of computer networks is highly dynamic and progressive [10]. To overcome various problems in the telecommunication, the "CC at MTP-L3 using TFCs and TFRs and secured tracking device (STD)" methodology to avoid congestion/traffic in network by reducing the unknown source entering in the telecommunication. The MTP-L3 layer with STD using TFCs/TFRs methodology performs by better results in congestion, end to end delay, route reliability, and network lifetime compared "MTP-L3 layer without STD.

II LITERATURE SURVEY

JinooJoung et al. [11] has implemented a flow-admission-control in next generation networks with flow aggregate information exchange for calculating end-to-end delay bounds of flows aggregate. The delay-bound and admission-control scheme are evaluated with simulations in a few realistic scenarios. Rossouw von et al. [12] had addressed various types of unknowingly participating attacks in cyberspace. The ICT becomes increasingly integral part of the supporting systems in term of information security. A.A. Obiniyi et al. [13] has presented new innovations in performance analysis of computer networks with a view for intimating network users, administrators and designers with a high level of cooperation with the software-defined networks and the next-generation protocol (Ipv6).Dr.S.S.RiazAhamed [14] has addressed primary function of SS7 is to provide call control, remote network management, and maintenance capabilities for the inter-office telephone exchanges. The SS7 architecture enables communication to take place between entities within the network effectively. Garima Sharma and Dr. Harish Mittal et al. [15] had presented security on SS7 Signalling Protocol in the mobile networks, which is still long for interoperability and background compatibility in international roaming. The security method were less to handle, if new variety of attacks are added in the network.

The above illustrated paper has some limitations yet to be performed well in telecommunication such as congestion control and security. Thus “CC at MTP-L3 with STD” methodology performance efficiently than the recent related papers.

III OVERVIEW OF SIGNALING SYSTEM 7 (SS7)

The Signaling System 7 (SS7) is an architecture, which are used in the functions of billing, routing and public switched telephone network (PSTN). The exchange of information is done to maintain and provide the call service between the call components process is known as Signalling. The exchange of network elements by the user of PSTN takes place, when the user dialing the numbers, at dial tone, call waiting tone etc. happens. The important medium of exchanging information in the elements of telephone network is SS7. The SS7 network protocol are used in;

- Advanced features in calling for example. Call forwarding and information of caller.
- Personal communication services (PCS) and wireless roaming.
- Conference calling
- Authentication of mobile subscriber

Effective and secured worldwide communication

A.Signaling Points

The SS-7 messages are exchanged between networks elements over 50 or 60 kilobit per second (kbps) in which signalling links are defined as the bidirectional channels. Signalling exist out-of-band on dedicated channels in place of in-band on voice channels. The different types of Signalling Link are described below.,

- SSP (Signal Switching Point) – Telephone switch call and dial are functions
- STP (Signal Transferring Point) – Transfer Routing Messages
- SCP (Signal Control Points) – Control and monitor transmission in the network. It is also called as Intelligent Network.

The Basic PSTN Network topology is given in Figure.1. Each SSP has two links in which messages sent over either link are treated equivalently as a result of the STPs of a mated try area unit unvarying. The SCPs are often displayed in pairs. The SCPs are expected to service evenly like SCPs. SCPs don't seem to be directly connected by a try of link.

A (access) Link – “A” link joins a signalling end point to one STP. On link A only messages created from or coming to the signalling end point are channelled.

B (bridge) Link - “B” link joins one STP to another STP. A quad of “B” links joins companion STPs of another network. The contrast between a “B” link and “D” link is rather irrational. Because of which link may be referred to as B/D links.

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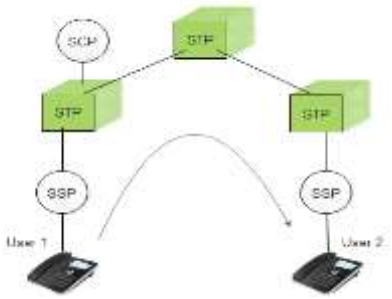

Figure.1. Basic PSTN Network Topology

B. Signaling Link Types

Signalling links are logically organized by link type("A" through "F") according to their use in the SS7 signaling network.

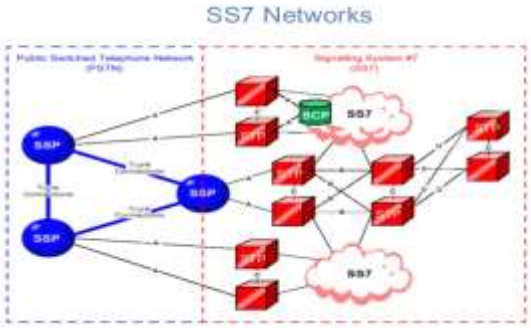

Figure.2. SS7 Signaling Link Types

- **C (Cross) Link -** "C" link joins STPs doing similar functions into a mated pair. The "C' link is used, when link failure occurs and STP has no available route to destination signaling point.
- **D (diagonal) Link -** "D" link joins a secondary like local or regional STP pair to a primary STP in a quad link manner.
- **E (Extended) Link -** "E" link joins a SSP to an equivalent STP. "E" links provide a replacement signaling path if an SSP's "home"
- **F (fully associated) Link** - "F" joins SSPs and SCPs, which are the two signaling end points. "F" links directly joins signaling points in networks without STPs.

C. SS7 Protocol Suite and OSI Reference Model (RM)

The SS7 protocol stack is aligned with the layer in the OSI RM to provide various function in telecommunication. The important purpose of SS7 network is to convey difficult signaling information between nodes (i.e SS7 nodes) such as telephone exchanges, call control and network management and related to call control. The Figure.2, explains SS7 protocol suite and OSI RF. The three levels of the message transfer part (MTP) collectively provide a highly reliable and resilient connectionless message transport mechanism. SS7 Protocol Suite provide three level of the MTP, which functions are described below.

- **MTP Layer-1 –** Defines the physical characteristics of the data links used in the signaling network.
- **MTP Layer-2 –** Provides the functions and procedures for the reliable transfer of signaling information over a single data link.
- **MTP Layer-3 –** Elaborate routing and signaling network, which permits in-sequence and no duplicated connectionless message transfer even under adverse conditions like network congestion and failure.

SCCP – The SCCP function is covered in ITU-T recommendations Q.711 to Q.714 and Q.716 .The signaling connection control part provided addition functions to message transfer part for transfer of circuit related and non-circuit related signaling information and other type of information between exchanges and other specialized centrals in telecommunications network via SS7 networks. The overall objective of SCCP is to provide means for:

- A transfer capability for signalling data units with or without the use of logical signalling connections.
- A logical signalling connection between two SCCP users with the SS#7 network.
- Enhanced addressing capabilities.

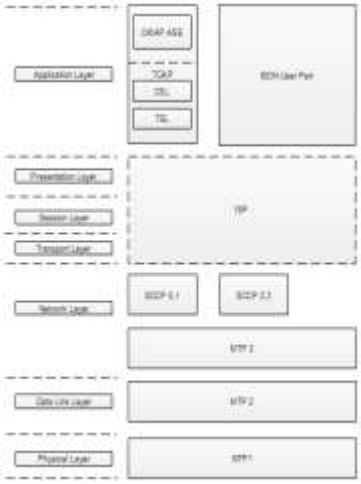

Figure.3. Relation between SS7 and OSI Reference Model

- **TCAP - Provides** application layer formatting and procedure for real-time intensive response type applications. TCAP consists of two sub layers such as component and transaction sub layers. **Component Sub layer (CSL) and Transaction sub layer (TSL)** are modeled after and aligned with the remote operations service protocol.
- **Common Management Information Protocol (CMIP) -** has same services and associated protocol.
- **ISDN User Part (ISDN-UP) –**is a message-oriented applications, which defines for providing call control (call establishing, supervising and releasing voice and data calls over a circuit-switched connections among telephone exchanges, which serves an ISDN).

It is very hard to find out how MTP reacts to congestion thereby constituting a more easily accessible information source than the standards. Hence, below explanation describes, how the congestion takes place in MTP-L3 layers and prevention and detection using Transfer Control (TFCs) and transfer restricted mechanism (TFRs).

- **TFCs –** A transfer controlled message is sent by an STP to notify SPs originating message traffic that messages of a given priority or lower should no longer be sent to the specified destination. It should be noted that no changes to the transfer controlled procedures are necessary to support an SPCS with multiple point codes. A prompt STP notification of congestion status to signalling end points through TFC messages is desirable to minimize message discard and delay in the network and to maximize message throughput under congestion conditions.
- **TFRs –** When a TFR/TCR message is received for a route in a combined link set marked allowed and the status of another route in the combined link set is allowed. The STP shall perform the controlled rerouting procedure to resume load sharing over the combined link set.

IV CONGESTION CONTROL AT MTP-L3 USING TFCS AND TFRS

MTP-L3 assumes equal sharing of the traffic load among the routes in the route set. When a link in a link set is congested, the whole link-set is considered as congested. Similarly, when a route is congested, the corresponding route is considered as congested. As of whole, the route set towards the signaling point is considered as congested. MTP-L3 differentiates between congested and failed links. When a link failure and traffic take place the signaling link is re-routed to an alternate link. Traffic routed to a congested signaling link is placed in the level 2 transmission buffer irrespective of the congestion status of the link. The MSUs are simply discarded, when the transmission buffer becomes full. Figure.3, explains congestion signaling on MTP-L3.Links D-F and D-E are assumed to have priorities 1 and 2 respectively, which forms routing towards F. A UP at A is communicating with a UP at F, when a link in the link set D-E becomes congested by the way the whole network is considered as congested.

Hence, the adjacent STPs B and C suggest not touse D for routing of traffic to F.However, the B and C omits the path based on the Transfer Restriction (TRs) and transfer to another path. It is slight difficult to continuously monitor the traffic/congestion status of the traffic route set.

The signaling route set congestion-test procedure is used to find out congestion priority, which can be sent on a particular route set. The signaling route set-congestion test procedure is repeated until the congestion status comes to Zero (i.e. until the congestion has ceased).

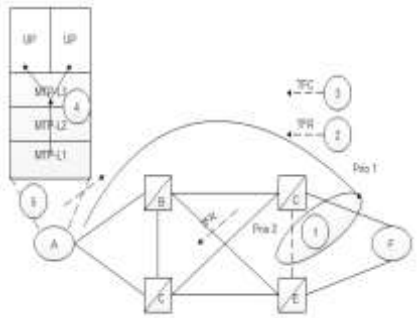

Figure 4.Congestion Signaling on MTP-L3

Hence, the route set congestion test procedure is repeated until the congestion reduces using TFRs and TFCs (Controlled and restricted). Therefore, there are many possible new attacks in SS7, which affects the security in telecommunication. To overcome the attacks, below mentioned techniques are developed.

V SECURED TRACKING DEVICES (STD)

FOR AVOIDING VULNERABILITIES

The mobile networks are the most dynamic part of critical communication infrastructure and the key instrument used to perform regular activities varying from voice and text messaging to providing signaling for emergency services and critical infrastructure. The “Secured tracking devices” is an independent location for finding solution for Universal Mobile Telecommunication Service (UMTS).The secured tracking devices helps in finding capabilities based on the ability to send and handle standard signaling messages via. SS7 network. This device does not require any special hardware or software installation neither in the cellular network in the mobile phone. Hence, tracking devices can track virtually in the world even if the subscriber's mobile phones is not GPS enabled. In telecommunication, subscribers are identified by the international mobile Equipment identity (IMEI). The SMS delivery protocol allows the source network to receive information about the subscriber's location for further routing of the message. The Figure.5.a and 5.b shows with and without STD in the telecommunication. When subscriber “A” makes a call, the request along with the number of destination subscriber are sent to the attacker's equipment. Then, attacker can then redirect the call and create a three-way such as., i) Destination Subscriber ii) Calling Subscriber and iii) Attackers. The STD used to track the attacker and send acknowledgment to the Subscriber “A” by sending SMS.

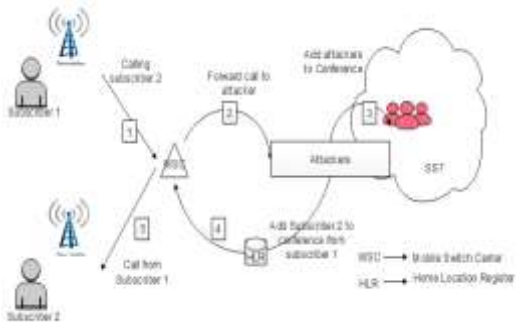

Figure 5a.Without STD in SS7 telecommunication

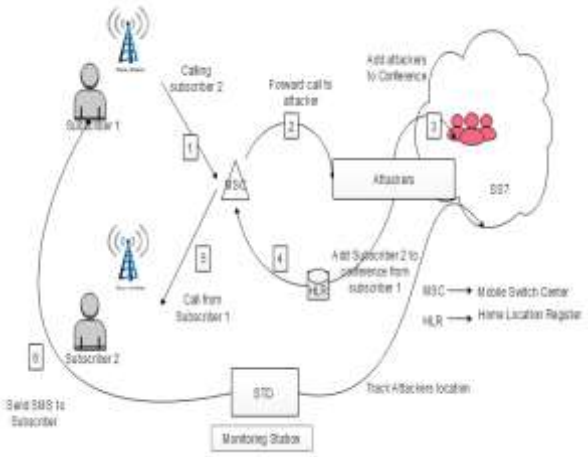

Figure 5. b. With STD in SS7 telecommunication

VI RESULT AND DISCUSSION

The "Congestion Control at MTP-L3 and STD" techniques is implemented using NS2 are used for avoiding traffic using TFCs and TFRs techniques. The complete work is done using I7 system with 8 GB RAM. The trace files generated using AWK scripts various parametric values are collected and graphs are plotted using GNU plot. The simulation starts and end time is denoted as 0.0001-50.000 respectively by varying number of static nodes as 20, 40, 60, 80 and 100. The MAC type is 802_11 with Omni Antenna model. The proposed algorithm control congestion at "MTP-L3 and STP" techniques using TFCs and TFRs. This section gives a detailed view of the results that are obtained using "CC at MTP-L3 with STD using TFCs/TFRs method. The performance metrics are given below

A. Reliability of routes

It is the maximum packets successfully received at the destination with higher reliability of routes. Based on a total amount of packets established in a ratio by a total number of destination packet send by the source node, which is given below.,

B. Lifetime of network

Energy exhaust time of First Node

C. Delay

It is total seconds of the packet received by the receiver and packets send by sender. Difference between sending time of packets and receiving time of packets is known as delay, which is given in equation 3.

D. Consumption of energy

The ratio of energy utilized by node to process one packets is known as energy consumption. The huge number of nodes is equivalent to the huge amount of received energy consumption. A huge number of nodes is equivalent to the huge amount of received energy consumption. A node drops a specific amount of energy for every packet transmission and received, which is given in equation (4)

Table.1shows the network lifetime vs. route reliability by changing different fixed nodes. Hence, STD with TFCs/TFRs shows better results than that of STD without TFCs/TFRs. shows better results than that of STD without TFCs/TFRs.

Table.1. Network lifetime vs. Route Reliability

QoS	STD with TFCs/TFRs	STD without TFCs/TFRs
50	3.0	2.60
55	3.0	2.60
60	3.10	2.60
70	3.10	2.90
75	3.50	3.0
80	4.0	3.40
85	4.30	3.60
90	5.00	4.80
95	5.50	5.0

Figure.6, explains a comparison between reliability of routes and energy consumption of "CC at MTP-L3 with STD" with existing "MTP-L3 without STD". Hence, CC at MTP-L3 with STD performs better results just because of limited number of transmission attempts on the energy cost of routes, when host to host system is considered with increase the reliability of routes.

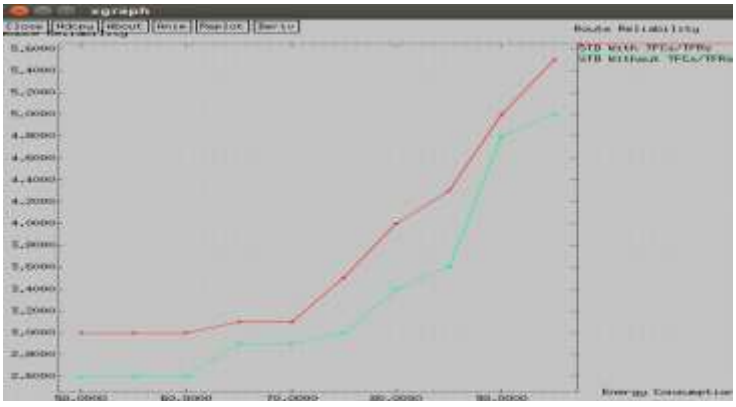

Figure. 6 Network Lifetime vs. Route reliability

Table.2 shows the network lifetime vs. energy consumption by changing different fixed nodes. Hence, STD with TFCs/TFRs shows better results than that of STD without TFCs/TFRs

Table.2. Network Lifetime vs. energy consumption

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QoS	STD with TFCs/TFRs	STD without TFCs/TFRs
50	4.5	5.5
55	4.5	5.5
60	4.5	5.5
65	3.0	4.0
70	2.5	3.5
75	2	3
80	2.5	2.3
85	1.5	2.3
90	1	2
95	1	2

There is a reduction in unnecessary packet transmission and reception in retransmission algorithm.Table.3 shows the end to end delay vs. number of nodes by changing different fixed nodes. Hence, STD with TFCs/TFRs shows better results than that of STD without TFCs/TFRs

Table.3. End-to-end delay vs. number of nodes

QoS	STD with TFCs/TFRs	STD without TFCs/TFRs
20	10.5	11.5
40	12.5	13.5
60	13.00	14.5
80	14.5	15.50
100	16.5	17.5

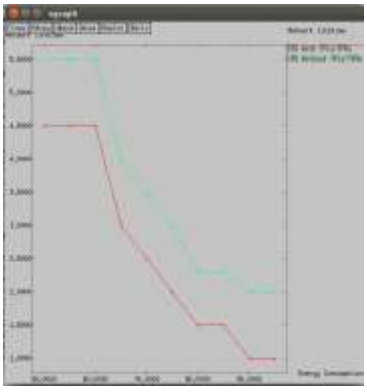

Figure. 7 Network lifetime vs. Energy Consumption

Table.4 shows the Congestion vs. number of nodes by changing different fixed nodes. Hence, STD with TFCs/TFRs shows better results than that of STD without TFCs/TFRs

Table.4. Congestion vs. Energy Consumption

QoS	STD with TFCs/TFRs	STD without TFCs/TFRs
20	143203	152136
40	133513	141327
60	120213	131213
80	117312	121312
100	101312	113629

Figure.8 explains a comparison between End to end delay vs. No of nodes of "CC at MTP-L3 with STD" with existing "MTP-L3 without STD". Hence, CC at MTP-L3 with STD performs better results than existing methodology.

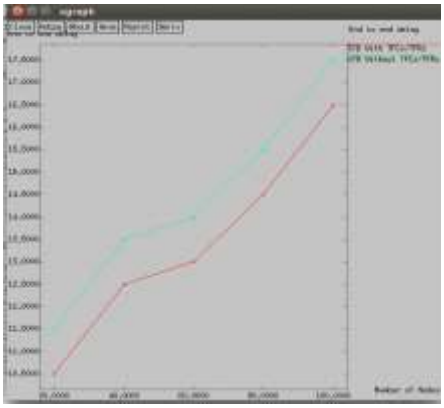

Figure. 8 End to end delay vs. No of nodes

Figure.9 explains a comparison between Congestion vs. No of nodes of "CC at MTP-L3 with STD" with existing "MTP-L3 without STD". Hence, CC at MTP-L3 with STD performs better results than existing methodology.

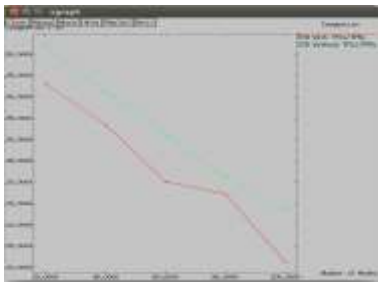

Figure. 9Congestion vs. No of nodes

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Performance Metrics

Simulation parameters	Value
Simulator	NS2(2.34)
Topology area	350*350
Packet size	512bytes
Nodes	200
Pause time Simulation	0sec 200sec
Maximum connection	10flows
Packet rate Traffic type	1packet/sec CBR(constant bit rate)
Initial energy	100 joules
Transmission range	70mts
Tx energy	0.1
Rx energy	0.1

VII CONCLUSION

The SS7/CCS7 network has emerged as a standard, extremely secure, low-delay and reliable infrastructure designed to support voice transport and services over the circuit-switched network. The “CC at MTP-L3 STD” methodology control congestion using Transfer Control (TFCs) and Transfer Restricted Mechanism (TFRs) with 'Secured Transmission Device” for monitoring telephone communication. Hence, “CC at MTP-L3 STD” methodology provides better results by varying Number of nodes and energy consumption of existing “STD without TFCs/TFRs with increase in route reliability with decrease in network lifetime, end-to-end delay and Congestion Control.

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