




TOTAL PROCESSING DELAY CAN BE ANALYZED AND COMPUTED

TOTAL DELAY	METHOD	FORMULA	DEFINITIONS
	Disjoint, complete	$\Delta t_{TOT} = \sum_{i=0}^N (t_{i+1} - t_i)$	Δt_{TOT} – total duration t_i – i th time at which set of active processes changes N – number of times at which set of active processes changes
	Inclusion-exclusion	$\Delta t_{TOT} = \sum_i \Delta t_{S_i} - \sum_{i < j} \Delta t_{S_i \cap S_j} + \sum_{i < j < k} \Delta t_{S_i \cap S_j \cap S_k} - \dots + (-1)^{n-1} \Delta t_{S_1 \cap S_2 \cap \dots \cap S_n}$	S_i – i th task in signal processing chain Δt_{S_i} – duration of i th signal processing task n – number of tasks in signal processing chain

If two or more tasks can be performed at the same time, the total processing delay can be less than the sum of the durations of the individual tasks that constitute the process.

INDIVIDUAL DELAYS	TASK	Acquisition	Form a network packet	Transit	Accrue received packets	Playback
	MOTION VS. PARCELIZATION	Parcelization	Parcelization	Motion	Parcelization	Parcelization
	WAITING FOR	CPU	Opportunity to send packet	Distance traveled	Packets that straggle	CPU
	CULPRIT	Competing applications	Competing traffic in home and neighborhood network	<ul style="list-style-type: none"> Speed of light in optical fiber Routing 	Fluctuations in <ul style="list-style-type: none"> sender router availability hop dwell times receiver router availability 	Competing applications
	MITIGATING TOOL	Sample buffer	Network buffer	Wormhole	Jitter buffer	Sample buffer
	SOUNDJACK UI ELEMENT*				<input type="text" value="4 bi"/> <input type="checkbox"/> auto	
	PRESCRIPTIVE RELATIONSHIP	$\Delta t_{SB} \geq \Delta t_{CPU,MAX}$	$\Delta t_{NB} \geq \Delta t_{ROUTER,MAX}$		$\Delta t_{JB} \geq \sigma_{t,NIC \rightarrow NIC}$	$\Delta t_{SB} \geq \Delta t_{CPU,MAX}$
	CONSTITUTIVE RELATIONSHIP		$\Delta t_{NB} = n_{NB} \Delta t_{SB}$	$\Delta t_{FIBER} = \frac{\ell}{(c/n_{FIBER})}$ $\Delta t_{TR} = \Delta t_{FIBER} + \Delta t_{HOPS}$	$\Delta t_{JB} = n_{JB} \Delta t_{NB}$	
	DEFINITIONS OF SYMBOLS	Δt_{SB} – sample buffer duration $\Delta t_{CPU,MAX}$ – longest duration CPU is likely to be pre-occupied with competing processes	Δt_{NB} – network buffer duration $\Delta t_{ROUTER,MAX}$ – longest time likely to be spent waiting for router to grant turn to send n_{NB} – number of sample buffers in a network buffer	Δt_{FIBER} – delay from transit in fiber ℓ – path length in fiber c – speed of light in vacuum n_{FIBER} – index of refraction of fiber Δt_{TR} – outside-homes transit delay Δt_{HOPS} – delay from re-transmissions along path	Δt_{JB} – duration of jitter buffer $\sigma_{t,NIC \rightarrow NIC}$ – typical magnitude of difference between packet inter-arrival times n_{JB} – size of jitter buffer expressed as a number of network packets	

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