

A Census of Tandem System Availability Between 1985 and 1990

Jim Gray
Presented by Zhijun He

Introduction

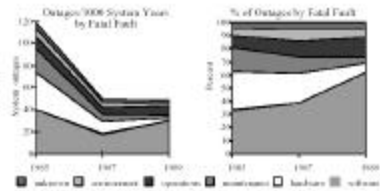
- Analyze failure reports of Tandem system from 1985 to 1989
- Fault category:
 - all: any reported fault
 - implicated fault: any fault related to an outage
 - fatal fault: the first non-tolerated fault in a fault chain

EWR Data

	1985	1987	1989
Customers	1000	1398	2668
EWR Customers	?	?	267
Outage Customers	378	216	164
Systems	2400	6993	9006
Processors	7,000	15,000	25,500
Discs	16,000	46,000	74,000
Cases	169	217	301
Reports	491	535	766
Faults	892	669	892
Outages	785	794	438
System MTBF	8 years	20 years	21 years

Faults by year and cause

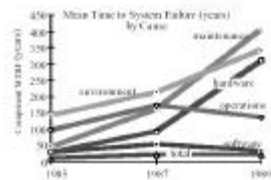
year	Outages by Fatal Fault			by implicated Fault		All Faults
	1985	1987	1989	1987	1989	
software	96	114	272	135	297	515
hardware	62	66	29	106	77	157
maintenance	53	37	22	42	28	28
operations	25	35	68	49	86	27
environment	17	28	26	37	27	100
process	?	?	0	?	9	61
unknown	12	14	23	17	23	21
total	285	294	438	386	538	892



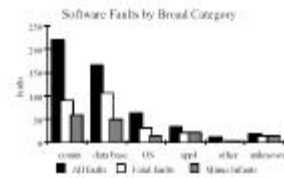
Observations

- System outages improved by a factor of 2 by 1987 and then held steady
- Hardware and maintenance shrank from 50% to 10%
- Operations grew from 9% to 15%.
- Software grew from 33% to more than 60%.

MTBF



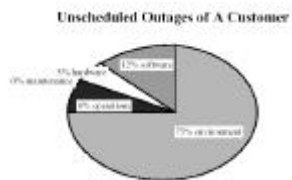
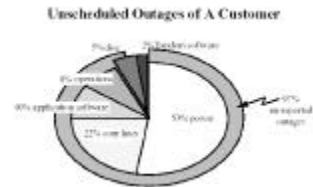
Software Faults



A Specific Customer

- Sample set
 - 937 system-weeks
 - 199 outages, 4-week MTBF
 - 26% caused by power failures
 - 22 related to data communications equipment.
 - 37% scheduled outages.
 - 99 unscheduled outages.

A Specific Customer(Cont'd)



Conclusion

- Hardware and Maintenance has improved a lot
- Software outage rates remain the same
- Operation is another significant cause.