

PRIMJENA RAČUNA REDOVA ČEKANJA POMOĆU ERLANG DISTRIBUCIJA ZA WEB APLIKACIJE

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Zagreb, Vukovarska 37

UVOD

- Ograničeni broj uslužnih kanala (ponekad samo jedan)
- Kako procijeniti dopušteno opterećenje
- Kako odrediti potreban broj uslužnih kanala
- Kako odrediti potrebnu brzinu usluge uslužnih kanala

UVOD

- Ponekad određena aktivnost može se na jednom serveru odvijati samo za jednog korisnika
- Rješenje
 - Povećati broj servera (npr. Reports engine, cluster node itd.)
 - Skratiti vrijeme aktivnosti (promjena metode, koda itd.)

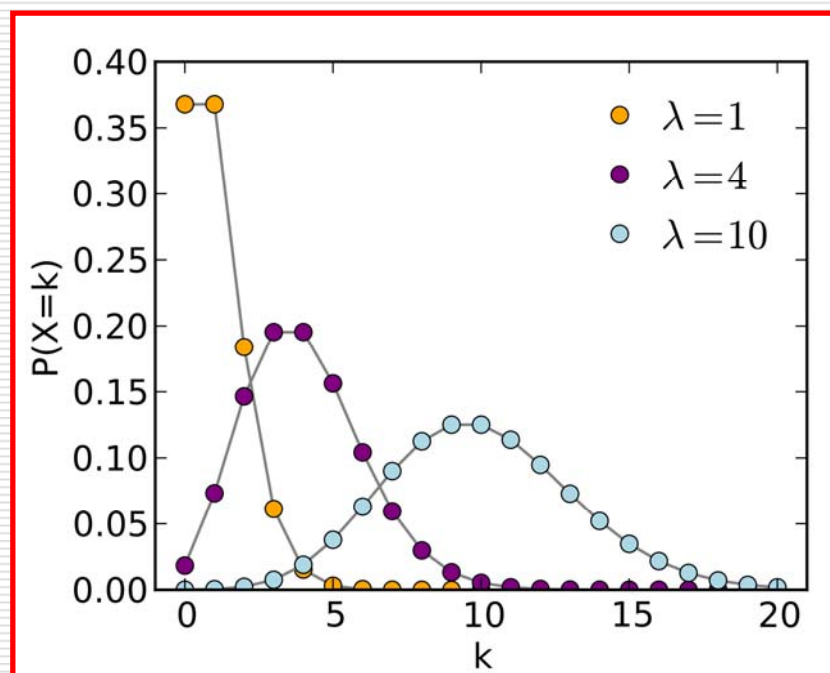
AGNER KRARUP ERLANG

- ❑ Danski matematičar, statističar i inženjer (1878 - 1929)
- ❑ Teorija redova čekanja
- ❑ Računao udio korisnika koji moraju čekati na uspostavu poziva van sela budući da su sve linije zauzete
- ❑ Vjerojatnost neuspješnog poziva je prihvaćena od British Post Office kao osnova za proračun kapaciteta telefonskih postrojenja



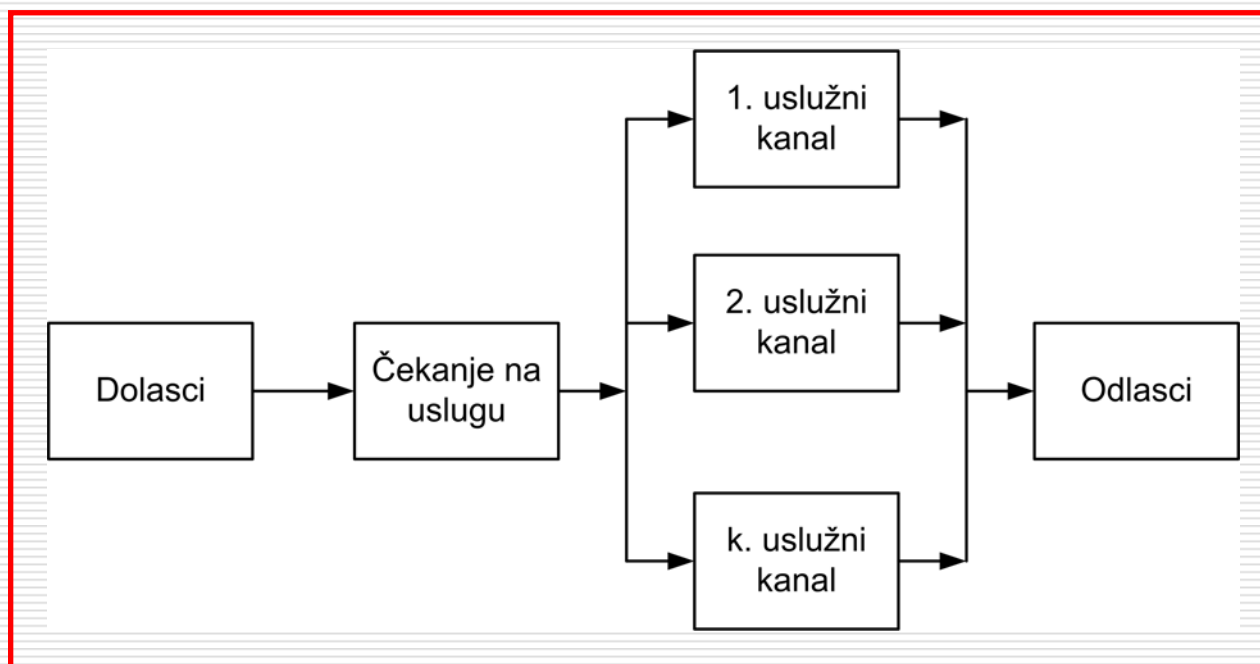
TELEKOMUNIKACIJE

- Velika primjena u telekomunikacijama
 - Telefonske centrale
 - Call centri
- Dolazak telefonskih poziva slijedi Poissonovu razdiobu
- Vrijedi i za korisnike web aplikacija



REDOVI ČEKANJA

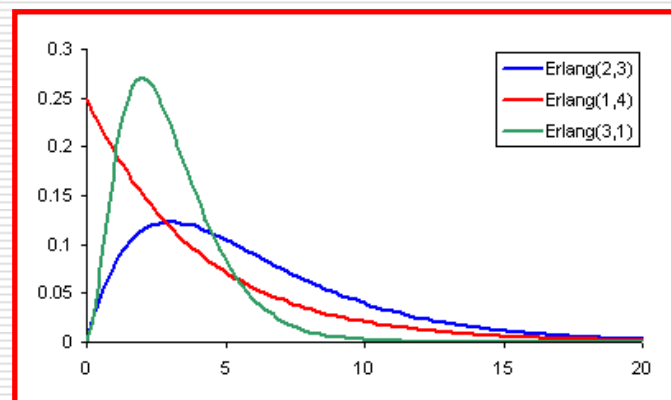
- ❑ Sustav poslužuje dolazne zahtjeve
- ❑ Sustav je konačnih mogućnosti
- ❑ Postoji red čekanja dok se ne oslobodi uslužni kanal



ERLANG DISTRIBUCIJA

- Kontinuirana distribucija, ima pozitivne vrijednosti za sve realne brojeve veće od nule
- Definirana sa dva parametra
 - shape k
 - rate λ
- Posebni slučaj Gamma distribucije
- Događaji koji se javljaju neovisno s nekom prosječnom frekvencijom modelirani su kao Poissonov proces
- Vremena čekanja između k pojava događaja su distribuirana u skladu s Erlang distribucijom

$$f(x; k, \lambda) = \frac{\lambda^k x^{k-1} e^{-\lambda x}}{(k-1)!}$$



ERLANG DISTRIBUCIJA

- ❑ Agner Krarup Erlang puno se bavio modeliranje komunikacijskog prometa
- ❑ Postoje još dvije Erlang distribucije koje se koriste za modeliranje prometa: Erlang B i Erlang C
- ❑ Odustaje se od neopsluženih zahtjeva za uslugom, "target service" (Erlang B formula)
- ❑ Neopsluženi zahtjevi za uslugom ulaze u red čekanja sve dok se ne opsluže (Erlang C formula)

WEB APLIKACIJE

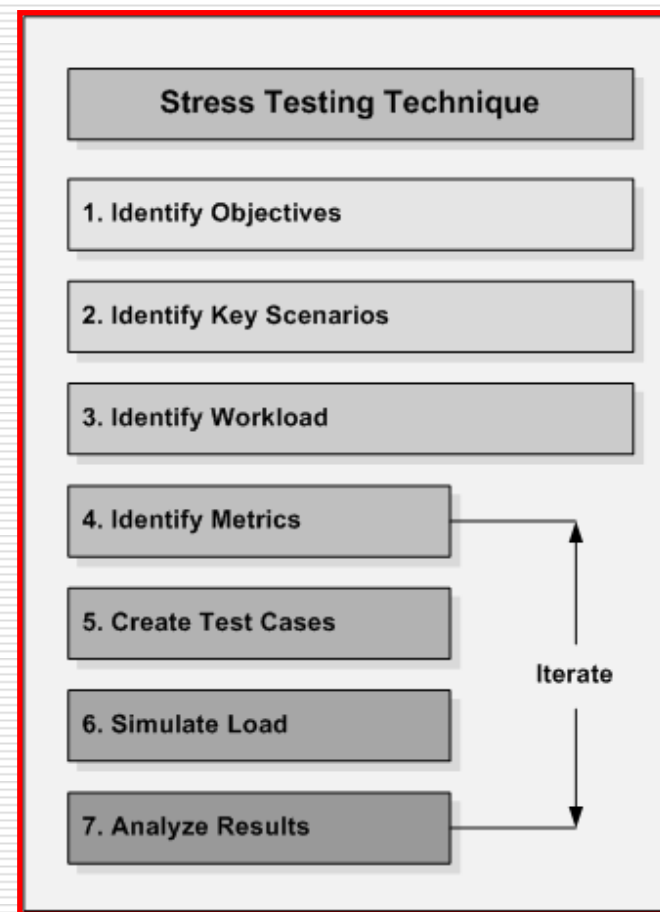
- Koriste ograničene računarske resurse
 - Forms sesije
 - Reports serveri
 - Host komande
 - Komunikacija s File server-om
 - Komunikacija s Print server-om
- Printeri
 - Print job-ovi i red čekanja
- Terminal server
 - Aplikacije koje dopuštaju pokretanje samo jedne instance
 - Licence

SYSTEM STRESS TESTING

- Testiranje performansi sustava pod opterećenjem
- Testiranje je fokusirano na robusnost aplikacije, raspoloživost i pouzdanost pod ekstremnim uvjetima
- Pronalazi odgovore na pitanja:
 - Koje vrijeme odziva će postizati korisnici?
 - Kako dugo sustav može izdržati povećanu aktivnost korisnika?
 - Kako često će se korisnici susretati s pogreškama na sustavu i trebati se rekonektirati?
 - Može li se sustav vratiti sam u normalno stanje nakon stress testa s abnormalnim opterećenjem?

PERFORMANCE/LOAD/ STRESS TESTER

- ❑ Load test pod izuzetnim opterećenjem – stress test
- ❑ Uređaj (kombinacija hardware i software) koje simulira opterećenje sustava
- ❑ Koristi se za određivanje stabilnosti sustava pod opterećenjem
- ❑ Simulira simultani dolazak korisnika sa odvojenih PC strojeva (različite IP adrese)
- ❑ Vrlo dobre procjene, ali
 - Skupi uređaji
 - Alternativa je skupi najam



ERLANG

- ❑ Bezdimenzijska jedinica koja se koristi u telefoniji kao statistički pokazatelj telekomunikacijskog prometa
- ❑ Definira se kao iskorištenost kanala u vremenu
- ❑ "Erlang" je korišten u skandinavskim zemljama i označava jedinicu telefonskog prometa
- ❑ Međunarodno priznanje slijedilo je nakon kraja drugog svjetskog rata

ERLANG

□ Primjer:

- 30 poziva po satu
- Prosječno trajanje poziva 5 min

- Minuta prometa u satu = Broj poziva x Trajanje
- Minuta prometa u satu = 30×5
- Minuta prometa u satu = 150
- Sati prometa u satu = $150 / 60$
- Sati prometa u satu = 2.5 **Erlanga**

ERLANG

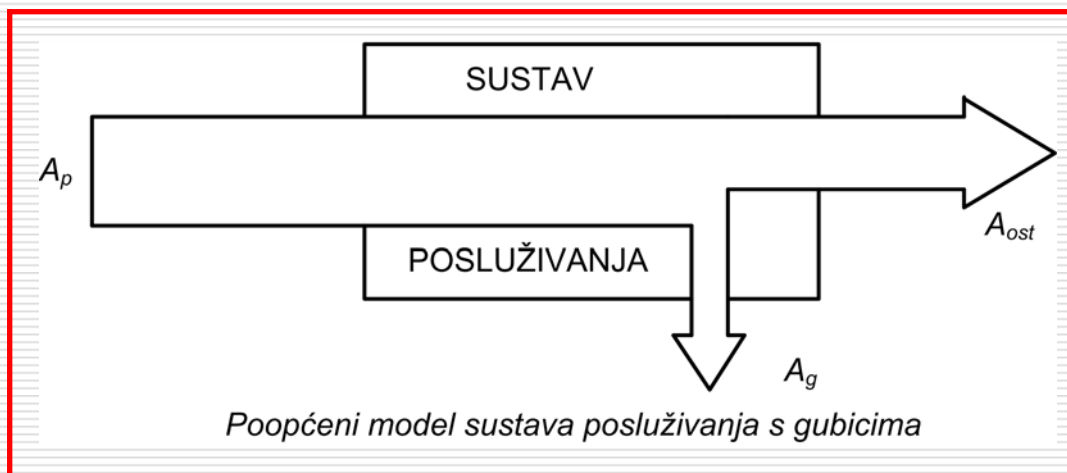
- Koliko je elemenata potrebno za pružanje usluge bez predimenzioniranja

- Potrebno definirati ciljne vrijednosti:
 - GoS - Grade of Service
 - QoS - Quality of Service

- Parametri
 - Vjerojatnost blokiranja usluge
 - $p=0.05$ prihvatljivo
 - $p=0.01$ dobro
 - Vrijeme čekanja na uslugu (npr. 80% zahtjeva ispod 10s)

- Vrijednosti potrebno je definirati za Busy Hour
 - Glavni prometni sat (sat s najvećim prometom, peak hour)
 - Najveći broj zahtjeva za uslugom (worst case analysis)
 - BHT (Busy Hour Traffic)

ERLANG B



$$p_B(A_p, m) = \frac{\frac{A_p^m}{m!}}{\sum_{i=0}^m \frac{A_p^i}{i!}}$$

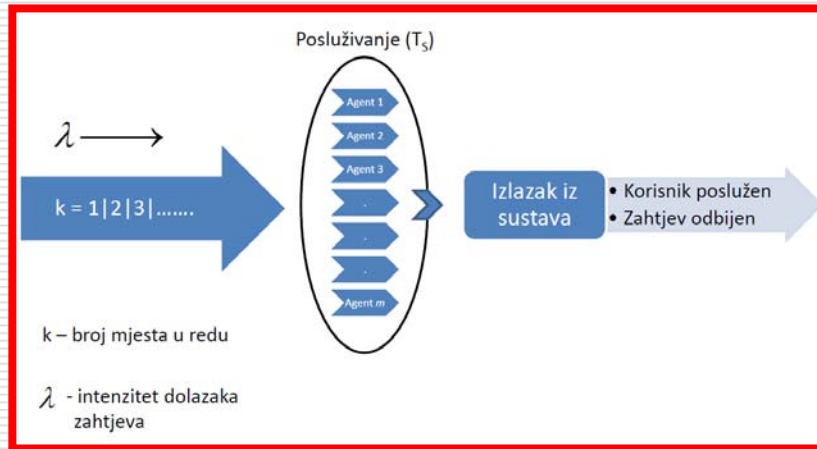
pri čemu je

p_B - vjerojatnost da će zahtjev biti odbijen
(vjerojatnost da su svi poslužitelji zauzeti)

m - broj poslužitelja

A - promet (Erlang-a)

ERLANG C



Λ - intenzitet dolazaka
(prosječan broj korisnika koji
pristižu u jedinici vremena)

pri čemu je

p_C - vjerojatnost da će zahtjev
biti odbijen
(vjerojatnost da su svi
poslužitelji zauzeti)

m - broj poslužitelja

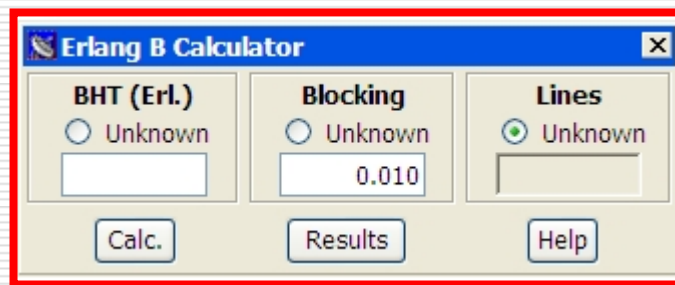
A - promet (Erlang-a)

$$p_C(A_p, m) = \frac{A_p^m}{A_p^m + m! \left(1 - \frac{A_p}{m}\right) \sum_{i=0}^{m-1} \frac{A_p^i}{i!}}$$

ERLANG KALKULATORI

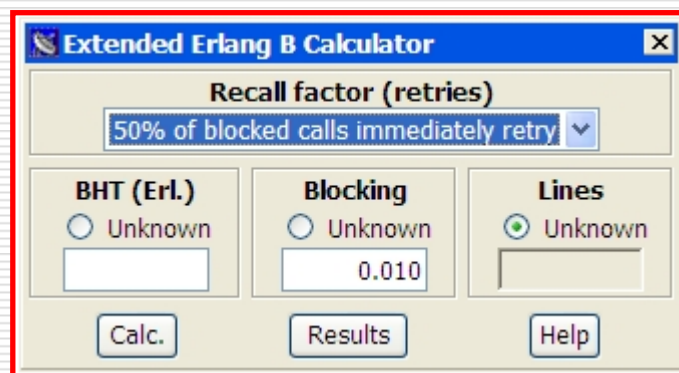
- Besplatni WEB kalkulatori
 - Jednostavni za korištenje
 - Zadovoljavaju većinu potreba
 - Ne zahtijevaju detaljno poznavanje teorije, samo operativno
 - specifikacija prometa u Erlang jedinicama kod nekih kalkulatora)
 - Erlang B
 - Extended Erlang B
 - Erlang C
- Programi
 - Erlang CC Modeler Lite – besplatan
 - Erlang CC Modeler Pro

ERLANG B



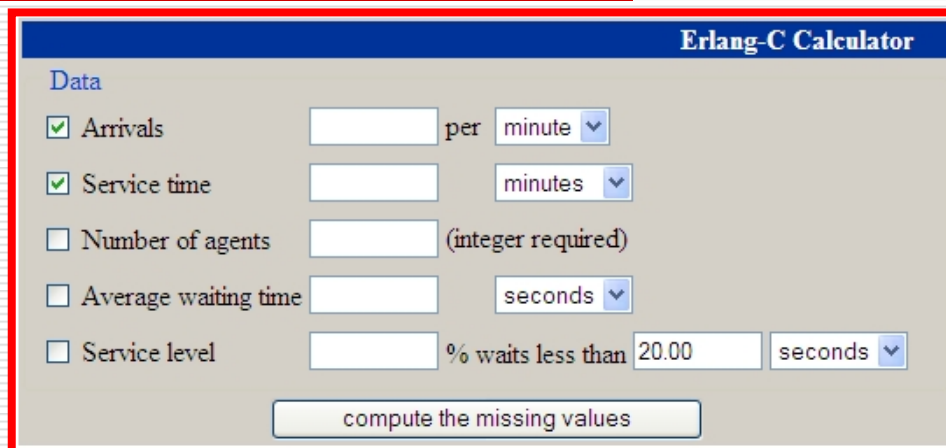
- WEB Erlang B kalkulator
 - Busy Hour Traffic (Promet glavnog sata)
 - Vjerojatnost blokiranje prometa ovisno o opterećenju
 - Broj uslužnih agenata za prihvatljivu vjerojatnosti blokiranja

EXTENDED ERLANG B



- WEB Extended Erlang B kalkulator
 - Dodatna mogućnost specificiranja Recall Factor-a
 - Korisnici koji nakon neuspjeha odmah pokušavaju ponovo (immediate retry attempt)
 - Aplikacija sa ugrađenom petljom za retry

ERLANG C



The screenshot shows a web-based 'Erlang-C Calculator' interface. It features a blue header with the title 'Erlang-C Calculator'. Below the header, there is a section titled 'Data' containing five input fields, each with a checkbox and a unit dropdown menu. The first three fields are checked: 'Arrivals' (per minute), 'Service time' (minutes), and 'Number of agents' (integer required). The last two fields are unchecked: 'Average waiting time' (seconds) and 'Service level' (% waits less than 20.00 seconds). A 'compute the missing values' button is located at the bottom of the form.

- WEB Erlang C kalkulator
 - Treba specificirati barem tri parametra
 - Pri tome specificirati barem dva od prva tri polja unosa

ERLANG CC MODELER LITE

- Za detaljniju analizu postoje posebni programi
- Grafički prikaz
- Očekivani boravak u redu čekanja
- Prosječno čekanje ovisno o broju uslužnih agenata

Here's how it works !

1 Calculate
The number of agents you need. What the average speed to answer will be.

2 Model

- How many extra calls could be handled with a certain number of agents.
- The effect of reducing talk times or wrapup time.
- The productivity of your staff.

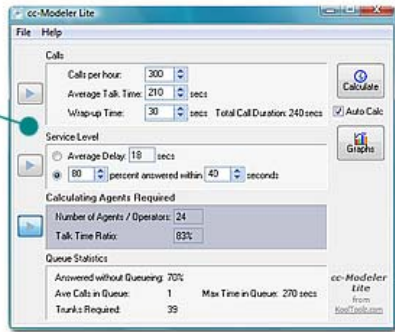

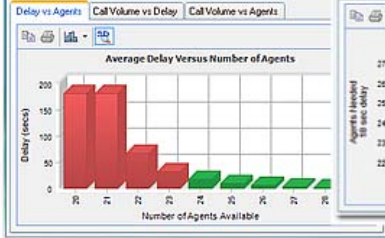

3 Show

- How many calls will be queued.
- The longest time that a caller will wait.
- The number of incoming lines you need.

4 Auto Calculate
vary any of the parameters and instantly see the effect on others.

5 Forecast
See the impact of variations or growth in call volumes on:

- The number of agents needed.
- The average speed to answer.

VARIJACIJE PROMETA

- Promet nije konstantan
- Varira tijekom dana i noći
- Analiza moguća uz pomoć naprednijeg Erlang software-a (Erlang CC Modeler Pro)

ERLANG CC MODELER PRO

- Uključuje dnevne varijacije prometa
- Broj potrebnih agenata tijekom dana

Here's how it works !

- 1 Multiple Projects**
Each with one or more days.
- 2 Service Levels**
Define your service level goals for each project or forecast.
- 3 Daily Calls**
 - Import your data from other applications or reports.
 - Time intervals can be either 15 or 30 minutes.
- 4 Agents Required**
cc-Modeler calculates the agents required throughout the day.
- 5 Multiple shifts**
Plan your shifts to optimize your coverage throughout the day. cc-Modeler shows you how efficient your shift schedule is.
- 6 Breaks & Planned Activities**
Define meal breaks and off-phone activities for one or more agents on each shift.
- 7 Coverage Gaps**
cc-Modeler shows you the actual versus required agents at each time throughout the day. All color coded for instant visibility of weaknesses in your shift coverage.

KADA KORISTITI ERLANG B, A KADA ERLANG C

□ ERLANG B

- Usluga je blokirana, ali korisnik ne ulazi u red čekanja

□ ERLANG C

- Usluga je blokirana, korisnik ulazi u red čekanja dok se ne oslobodi uslužni kanal (agent)

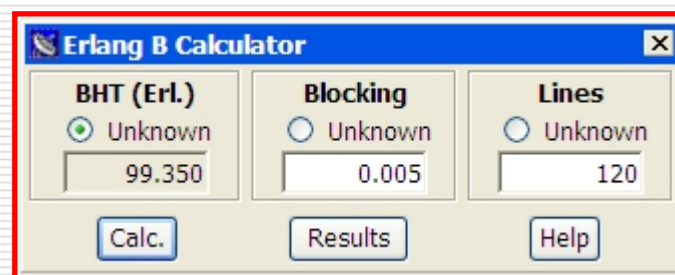
DIMENZIONIRANJE iAS SERVERA – FORMS SESIJE

- ❑ Ukupan broj uspostava Forms sesija (Busy Hour)
- ❑ Prosječno trajanje Forms sesije
- ❑ Najveći istovremeni broj korisnika Forms sesija
- ❑ Dopuštena vjerojatnost blokiranja kod uspostave sesije
- ❑ Erlang B

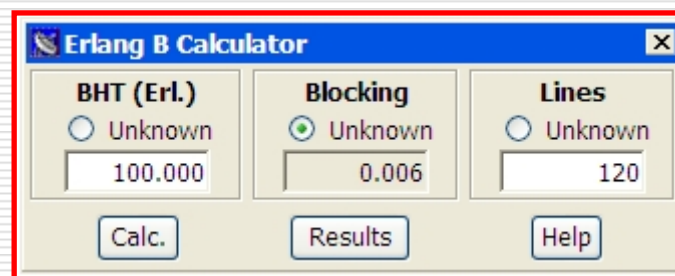
Određivanje ukupnog broja uspostava sesija tijekom Bussy hour-a

BHT – produkt broja uspostava sesija i prosječnog trajanja sesije

Određivanje vjerojatnosti blokiranja kod uspostave sesije za zadani promet



BHT (Erl.)	Blocking	Lines
<input checked="" type="radio"/> Unknown 99.350	<input type="radio"/> Unknown 0.005	<input type="radio"/> Unknown 120
Calc.	Results	Help



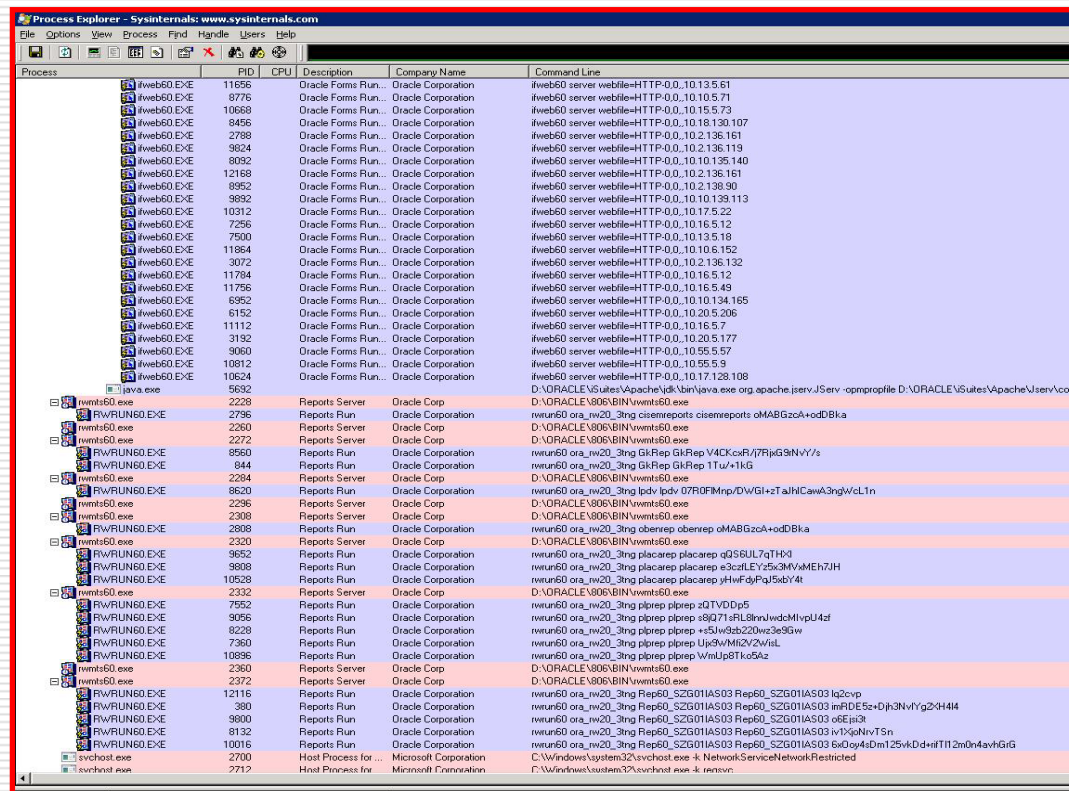
BHT (Erl.)	Blocking	Lines
<input type="radio"/> Unknown 100.000	<input checked="" type="radio"/> Unknown 0.006	<input type="radio"/> Unknown 120
Calc.	Results	Help

REPORTS SERVERI

- In-process reports server
 - Na starim iAS-ima 1.0.2 Forms 6 in-process reports server može opsluživat istovremeno samo jedan job (ekvivalent jedne reports engine)
- Stand alone reports server
 - Kako odrediti broj reports engine-a
 - Premalo engines uzrokuje formiranje repova
 - Previše engines nepotrebno zauzima memoriju instance iAS-a (smanjuje broj mogućih Forms sesija)

REPORTS SERVERI

- Procjena vremena trajanja report-a uz pomoć Task manager-a (Sysinternals)
- Ulazni podataka za Erlang kalkulator



Process	PID	CPU	Description	Company Name	Command Line
iweb60.exe	11856		Oracle Forms Run...	Oracle Corporation	iweb60 server webfile=HTTP-0.0.10.13.5.61
iweb60.exe	9776		Oracle Forms Run...	Oracle Corporation	iweb60 server webfile=HTTP-0.0.10.10.5.71
iweb60.exe	10660		Oracle Forms Run...	Oracle Corporation	iweb60 server webfile=HTTP-0.0.10.15.5.73
iweb60.exe	8456		Oracle Forms Run...	Oracle Corporation	iweb60 server webfile=HTTP-0.0.10.18.130.107
iweb60.exe	2788		Oracle Forms Run...	Oracle Corporation	iweb60 server webfile=HTTP-0.0.10.2.136.161
iweb60.exe	9824		Oracle Forms Run...	Oracle Corporation	iweb60 server webfile=HTTP-0.0.10.2.136.119
iweb60.exe	8092		Oracle Forms Run...	Oracle Corporation	iweb60 server webfile=HTTP-0.0.10.10.135.140
iweb60.exe	12169		Oracle Forms Run...	Oracle Corporation	iweb60 server webfile=HTTP-0.0.10.2.136.161
iweb60.exe	8952		Oracle Forms Run...	Oracle Corporation	iweb60 server webfile=HTTP-0.0.10.2.138.90
iweb60.exe	8992		Oracle Forms Run...	Oracle Corporation	iweb60 server webfile=HTTP-0.0.10.10.139.113
iweb60.exe	10312		Oracle Forms Run...	Oracle Corporation	iweb60 server webfile=HTTP-0.0.10.17.5.22
iweb60.exe	7256		Oracle Forms Run...	Oracle Corporation	iweb60 server webfile=HTTP-0.0.10.16.5.12
iweb60.exe	8352		Oracle Forms Run...	Oracle Corporation	iweb60 server webfile=HTTP-0.0.10.13.5.18
iweb60.exe	11854		Oracle Forms Run...	Oracle Corporation	iweb60 server webfile=HTTP-0.0.10.10.6.152
iweb60.exe	3072		Oracle Forms Run...	Oracle Corporation	iweb60 server webfile=HTTP-0.0.10.2.136.132
iweb60.exe	11784		Oracle Forms Run...	Oracle Corporation	iweb60 server webfile=HTTP-0.0.10.16.5.12
iweb60.exe	11796		Oracle Forms Run...	Oracle Corporation	iweb60 server webfile=HTTP-0.0.10.16.5.49
iweb60.exe	8352		Oracle Forms Run...	Oracle Corporation	iweb60 server webfile=HTTP-0.0.10.10.134.165
iweb60.exe	6152		Oracle Forms Run...	Oracle Corporation	iweb60 server webfile=HTTP-0.0.10.20.5.206
iweb60.exe	11152		Oracle Forms Run...	Oracle Corporation	iweb60 server webfile=HTTP-0.0.10.16.5.7
iweb60.exe	3192		Oracle Forms Run...	Oracle Corporation	iweb60 server webfile=HTTP-0.0.10.20.5.177
iweb60.exe	9080		Oracle Forms Run...	Oracle Corporation	iweb60 server webfile=HTTP-0.0.10.55.5.7
iweb60.exe	10012		Oracle Forms Run...	Oracle Corporation	iweb60 server webfile=HTTP-0.0.10.55.5.9
iweb60.exe	10624		Oracle Forms Run...	Oracle Corporation	iweb60 server webfile=HTTP-0.0.10.17.128.108
java.exe	5692				D:\ORACLE\Servlets\Apache\bin\java.exe org.apache.jserv.JServ -oprompile D:\ORACLE\Servlets\Apache\serv\conf
nwmst60.exe	2228		Reports Server	Oracle Corp	D:\ORACLE\B06\BIN\Nwmst60.exe
FWRLN60.exe	2796		Reports Run	Oracle Corporation	rwrn60 ora_rw20_3rng cisemreports cisemreports oMABGzca+odBkA
nwmst60.exe	2280		Reports Server	Oracle Corp	D:\ORACLE\B06\BIN\Nwmst60.exe
nwmst60.exe	2272		Reports Server	Oracle Corp	D:\ORACLE\B06\BIN\Nwmst60.exe
FWRLN60.exe	8560		Reports Run	Oracle Corporation	rwrn60 ora_rw20_3rng GkRep GkRep V4CkxR\776j69NvY/s
FWRLN60.exe	844		Reports Run	Oracle Corporation	rwrn60 ora_rw20_3rng GkRep GkRep 1Tt/\+1kG
nwmst60.exe	2284		Reports Server	Oracle Corp	D:\ORACLE\B06\BIN\Nwmst60.exe
FWRLN60.exe	8520		Reports Run	Oracle Corporation	rwrn60 ora_rw20_3rng lscdy lscdy 07R0FMmp/DWGI+zTajHCawA3ngWcL1n
nwmst60.exe	2296		Reports Server	Oracle Corp	D:\ORACLE\B06\BIN\Nwmst60.exe
nwmst60.exe	2308		Reports Server	Oracle Corp	D:\ORACLE\B06\BIN\Nwmst60.exe
FWRLN60.exe	2808		Reports Run	Oracle Corporation	rwrn60 ora_rw20_3rng obenrep obenrep oMABGzca+odBkA
nwmst60.exe	2320		Reports Server	Oracle Corp	D:\ORACLE\B06\BIN\Nwmst60.exe
FWRLN60.exe	9682		Reports Run	Oracle Corporation	rwrn60 ora_rw20_3rng placarep placarep qdSUL7qTHD
FWRLN60.exe	9808		Reports Run	Oracle Corporation	rwrn60 ora_rw20_3rng placarep placarep q3cZLEy25x3MvAMEN7JH
FWRLN60.exe	10528		Reports Run	Oracle Corporation	rwrn60 ora_rw20_3rng placarep placarep jhwFdyPaJ5xbY4t
nwmst60.exe	2332		Reports Server	Oracle Corp	D:\ORACLE\B06\BIN\Nwmst60.exe
FWRLN60.exe	7552		Reports Run	Oracle Corporation	rwrn60 ora_rw20_3rng plprep plprep q0TVD0p5
FWRLN60.exe	9056		Reports Run	Oracle Corporation	rwrn60 ora_rw20_3rng plprep plprep +92714PL8mUvdcM1vpU4t
FWRLN60.exe	8228		Reports Run	Oracle Corporation	rwrn60 ora_rw20_3rng plprep plprep +55Jw3bz20vc3e9Uw
FWRLN60.exe	7360		Reports Run	Oracle Corporation	rwrn60 ora_rw20_3rng plprep plprep Up9vM6Zv2vial
FWRLN60.exe	10896		Reports Run	Oracle Corporation	rwrn60 ora_rw20_3rng plprep plprep WmJ88tko5Az
nwmst60.exe	2360		Reports Server	Oracle Corp	D:\ORACLE\B06\BIN\Nwmst60.exe
nwmst60.exe	2372		Reports Server	Oracle Corp	D:\ORACLE\B06\BIN\Nwmst60.exe
FWRLN60.exe	12116		Reports Run	Oracle Corporation	rwrn60 ora_rw20_3rng Rep60_SZG01AS03 Rep60_SZG01AS03 kqzcvp
FWRLN60.exe	380		Reports Run	Oracle Corporation	rwrn60 ora_rw20_3rng Rep60_SZG01AS03 Rep60_SZG01AS03 mRDE5z+Djh3NvYg2+H44
FWRLN60.exe	9800		Reports Run	Oracle Corporation	rwrn60 ora_rw20_3rng Rep60_SZG01AS03 Rep60_SZG01AS03 o6Ej3
FWRLN60.exe	6132		Reports Run	Oracle Corporation	rwrn60 ora_rw20_3rng Rep60_SZG01AS03 Rep60_SZG01AS03 vYx8NvT5n
FWRLN60.exe	10016		Reports Run	Oracle Corporation	rwrn60 ora_rw20_3rng Rep60_SZG01AS03 Rep60_SZG01AS03 5x0ay4Dm125kDd+Ht112m0n4svHGG
svchost.exe	2700		Host Process for ...	Microsoft Corporation	C:\Windows\System32\svchost.exe -k NetworkService\NetworkRestricted
svchost.exe	2712		Host Process for ...	Microsoft Corporation	D:\Windows\System32\svchost.exe -k ransvc

DIMENZIONIRANJE REPORTS SERVERA

- Primjer 1
 - 1000 reporta po satu
 - vrijeme izvođenja reporta 10s
 - 1 reports engine

Erlang-C Calculator

Data

Arrivals 1000 per hour ▾

Service time 10 seconds ▾

Number of agents 1 (integer required)

Average waiting time infinity seconds ▾

Service level 0.00 % waits less than infinity seconds ▾

DIMENZIONIRANJE REPORTS SERVERA

- Primjer 2
 - 1000 reporta po satu
 - vrijeme izvođenja reporta 10s
 - 3 reports engine

Erlang-C Calculator

Data

<input checked="" type="checkbox"/> Arrivals	<input type="text" value="1000"/>	per	<input type="text" value="hour"/>	<input type="button" value="v"/>	
<input checked="" type="checkbox"/> Service time	<input type="text" value="10"/>		<input type="text" value="seconds"/>	<input type="button" value="v"/>	
<input checked="" type="checkbox"/> Number of agents	<input type="text" value="3"/>	<small>(integer required)</small>			
<input type="checkbox"/> Average waiting time	<input type="text" value="38.85"/>		<input type="text" value="seconds"/>	<input type="button" value="v"/>	
<input type="checkbox"/> Service level	<input type="text" value="22.75"/>	% waits less than	<input type="text" value="5.00"/>	<input type="text" value="seconds"/>	<input type="button" value="v"/>

DIMENZIONIRANJE REPORTS SERVERA

- Primjer 3
 - 1000 reporta po satu
 - vrijeme izvođenja reporta 10s
 - 7 reports engine

Erlang-C Calculator

Data

Arrivals per

Service time

Number of agents (integer required)

Average waiting time

Service level % waits less than

DIMENZIONIRANJE REPORTS SERVERA

- Primjer 4
 - 1000 reporta po satu
 - vrijeme izvođenja reporta 10s
 - Service level: 98% čeka manje od 5s
 - Potrebno 6 agenata (reports engines)

Erlang-C Calculator

Data

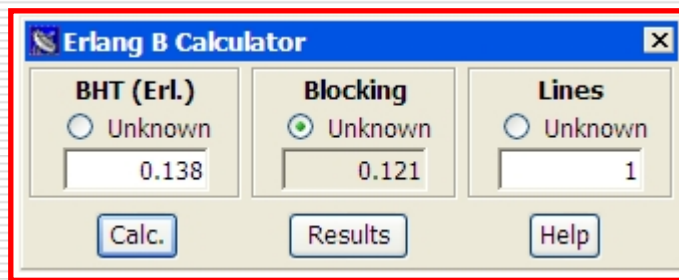
<input checked="" type="checkbox"/> Arrivals	<input type="text" value="1000"/>	per	<input type="text" value="hour"/>	<input type="button" value="v"/>	
<input checked="" type="checkbox"/> Service time	<input type="text" value="10"/>		<input type="text" value="seconds"/>	<input type="button" value="v"/>	
<input type="checkbox"/> Number of agents	<input type="text" value="6"/>	(integer required)			
<input type="checkbox"/> Average waiting time	<input type="text" value="0.23"/>		<input type="text" value="seconds"/>	<input type="button" value="v"/>	
<input checked="" type="checkbox"/> Service level	<input type="text" value="98"/>	% waits less than	<input type="text" value="5.00"/>	<input type="text" value="seconds"/>	<input type="button" value="v"/>

HOST COMMAND

- ❑ Istovremeno pokretanje instanci programa pomoću HOST komande
- ❑ Drugo pokretanje ne uspijeva
- ❑ Run-as (?), Sysinternals utilities
- ❑ Ponekad pomaže RENAME trik
 - 1st instance -> run original App.exe
 - 2nd instance -> run coppied App_1stCopy.exe
 - 3rd instance -> run 2nd coppied App_2ndCopy.exe

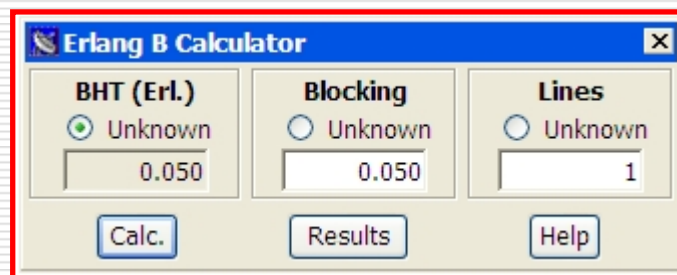
HOST COMMAND

- Ponekad nije moguće istovremeno pokrenuti više istih HOST komandi na istom serveru
 - Najveći broj korisnika aplikacije na nodu uz prihvatljivo blokiranje zahtjeva
 - Preostaje nam smanjivanje vremena koje zauzima dotična HOST komanda
- Npr. 100 zahtjeva po satu, trajanje zahtjeva 5 sekundi
 - Vjerojatnost blokiranja uz 1 uslužni kanal čak 12% (u praksi previše!)
 - Rješenje: skratiti vrijeme komande ili raspršiti korisnike po nodovima NLB clustera



FILE SERVER

- ❑ Jedan korisnik s istog iAS-a može pristupiti na file server
- ❑ Ne mogu dva korisnika istovremeno s istog iAS-a
- ❑ Može i više njih, ali ne sa istog iAS-a (NLB)
- ❑ Programi za PDF pretraživanje instalirani na File Serveru mogu dodati problematiku HOST komande
- ❑ Npr. Dopuštena vjerojatnost blokiranja $p=0.05$
 - BHT 0.05
 - Ekvivalentno 200 zahtjeva u trajanju 0.9 s ili 100 zahtjeva od 1.8 s

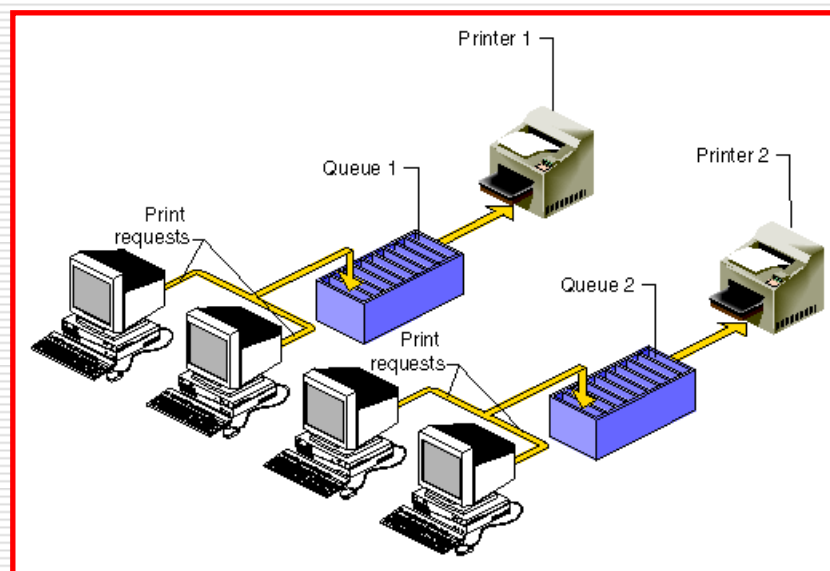


PRINT SERVER

- ❑ Jedan korisnik sa istog iAS-a može pristupiti na print server
- ❑ Ne mogu dva korisnika istovremeno s istog iAS-a
- ❑ Može i više njih, ali ne sa istog iAS-a (NLB)
- ❑ Koliko dugo smije trajati komunikacija s Print Serverom za dati promet i prihvatljivu vjerojatnost blokiranja zahtjeva za komunikacijom
- ❑ Erlang B

PRINTANJE

- Ispis na jedan ili više (linijski?) štampača
- Formiranje redova čekanja
 - Koliko štampača trebamo
 - Koliko čekamo u redu za ispis



PRINTANJE

- Broj print job-ova po satu (busy hour)
- Prosječno trajanje print job-a
- Broj raspoloživih printera
- Erlang C (postojanje reda čekanja - queue)

Erlang-C Calculator

Data

Arrivals per

Service time

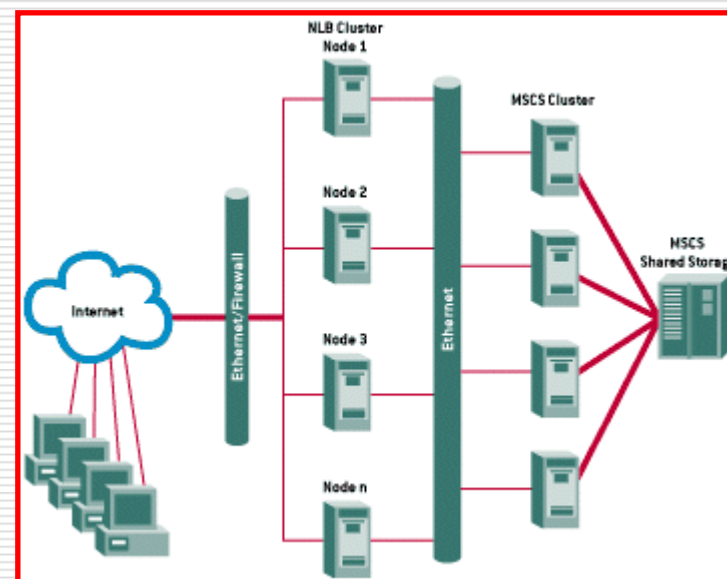
Number of agents (integer required)

Average waiting time

Service level % waits less than

NLB CLUSTER

- Više kanala usluge možemo postići i formiranjem NLB clustera
- Kad iscrpimo mogućnost smanjivanja vremena usluge po kanalu možemo dodati novi kanal dodavanjem novog noda u NLB cluster

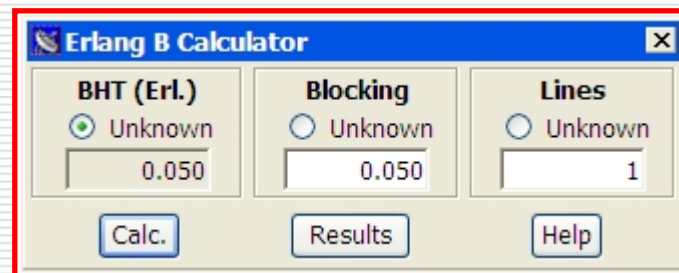


TERMINAL SERVER

- ❑ Pokušaj istovremenog pokretanje instance programa koji za to nije predviđen
- ❑ Određivanje mogućnosti kolizije
- ❑ Uporaba clustera s više nodova
- ❑ Erlang B



Npr.
 Dopuštena vjerojatnost blokiranja 0.05
 BHT 0.05
 Ekvivalentno 5 zahtjeva u trajanju 36s



TERMINAL SERVER

- ❑ Uporaba terminal servera s ograničenim brojem licenci
 - ❑ Prosječno trajanje sesije
 - ❑ Broj licenci (concurrent)
 - ❑ Vjerojatnost blokiranja usluge (log-in)
 - ❑ Erlang B (nema reda čekanja)
-
- ❑ Primjenjivo i na neke druge klijent-server programske pakete s ograničenim brojem concurrent licenci

ZAKLJUČAK

- ❑ Omogućuje inicijalno dimenzioniranje sustava koje se kasnije fino podesi
- ❑ Primjena Erlang B i Erlang C kalkulatora
- ❑ Procjena broja korisnika za prihvatljivo vrijeme čekanja
- ❑ Procjena vremena čekanja korisnika pod opterećenjem
- ❑ Procjena potrebnog broja uslužnih kanala
- ❑ Procjena vjerojatnosti blokiranja usluge

HVALA!
