

# Building Requirements for Real-time Critical Infrastructure



# Welcome Distinguished Members of the Open Group

## ■ Day 1 Agenda

- Historical Perspective of the Enterprise with Extrapolation
- Background on Requirements - Use Cases at the Core
- RT Requirements
  - Pervasive Computing
  - Home Office an extension of the Enterprise
  - Enterprise Computing
  - Hosting and Application Service Provider
  - Telematics

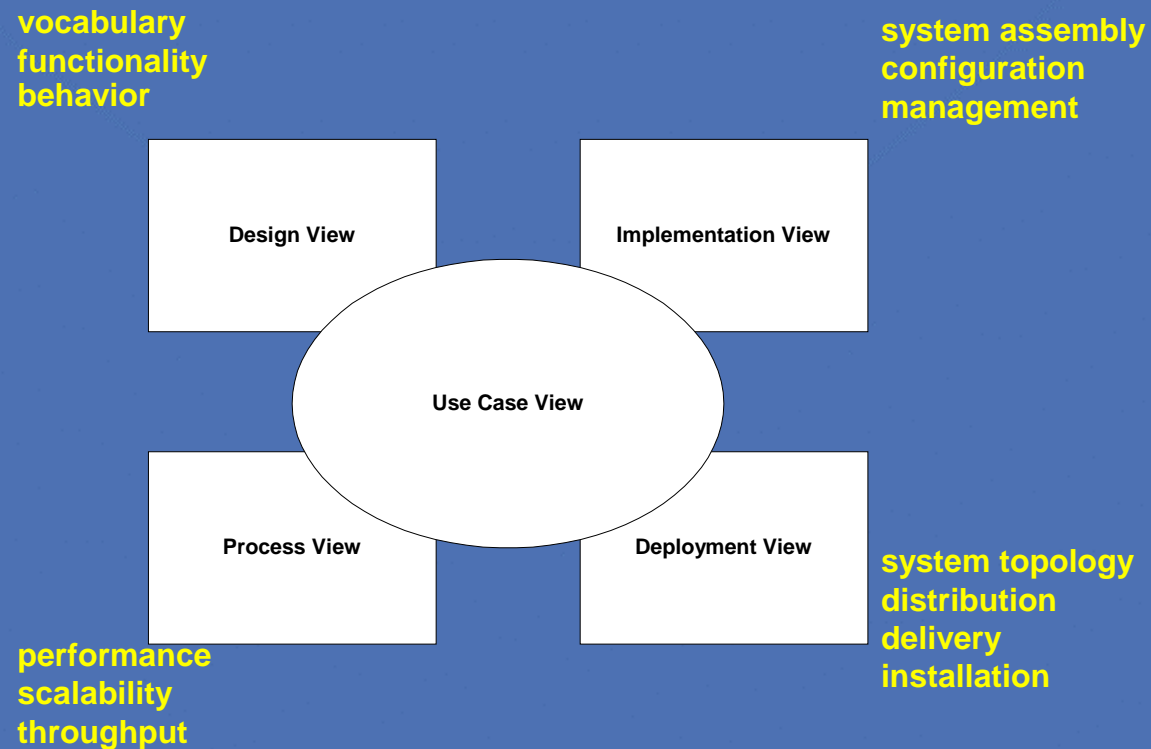
## ■ Day 2 Agenda

- Theory for Building Infrastructure and Applications
- Building RT Requirements using Simulators

# Requirements for the RT Enterprise a Historical Perspective

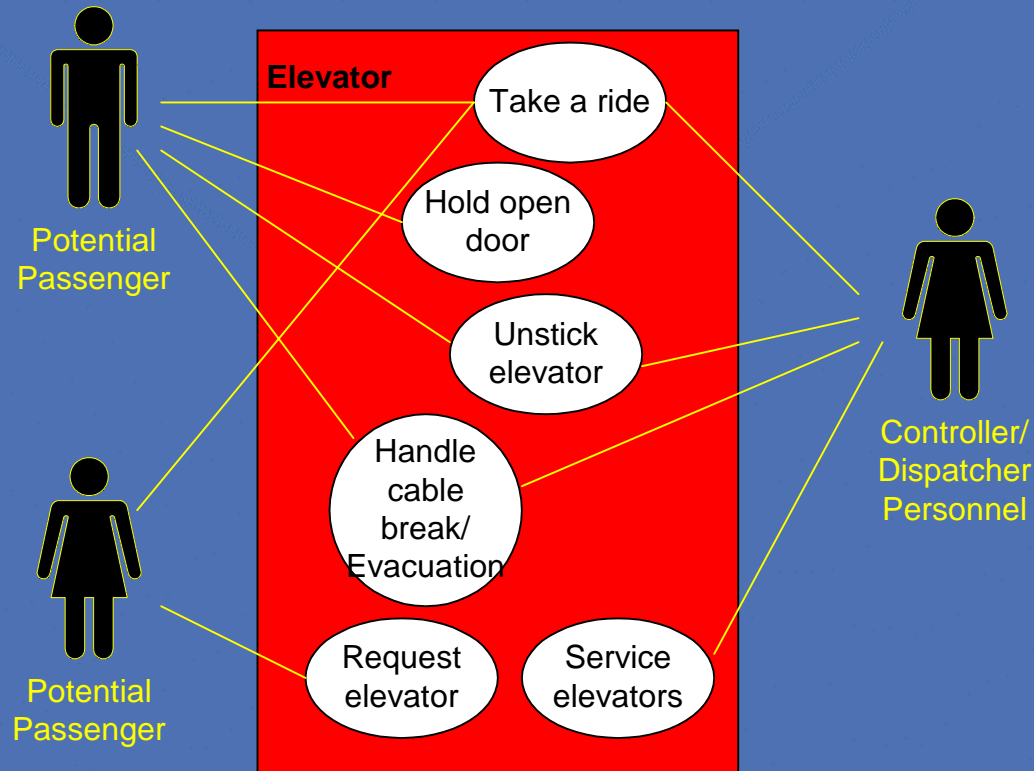


# Background on RT Requirements - Use Cases at the Core



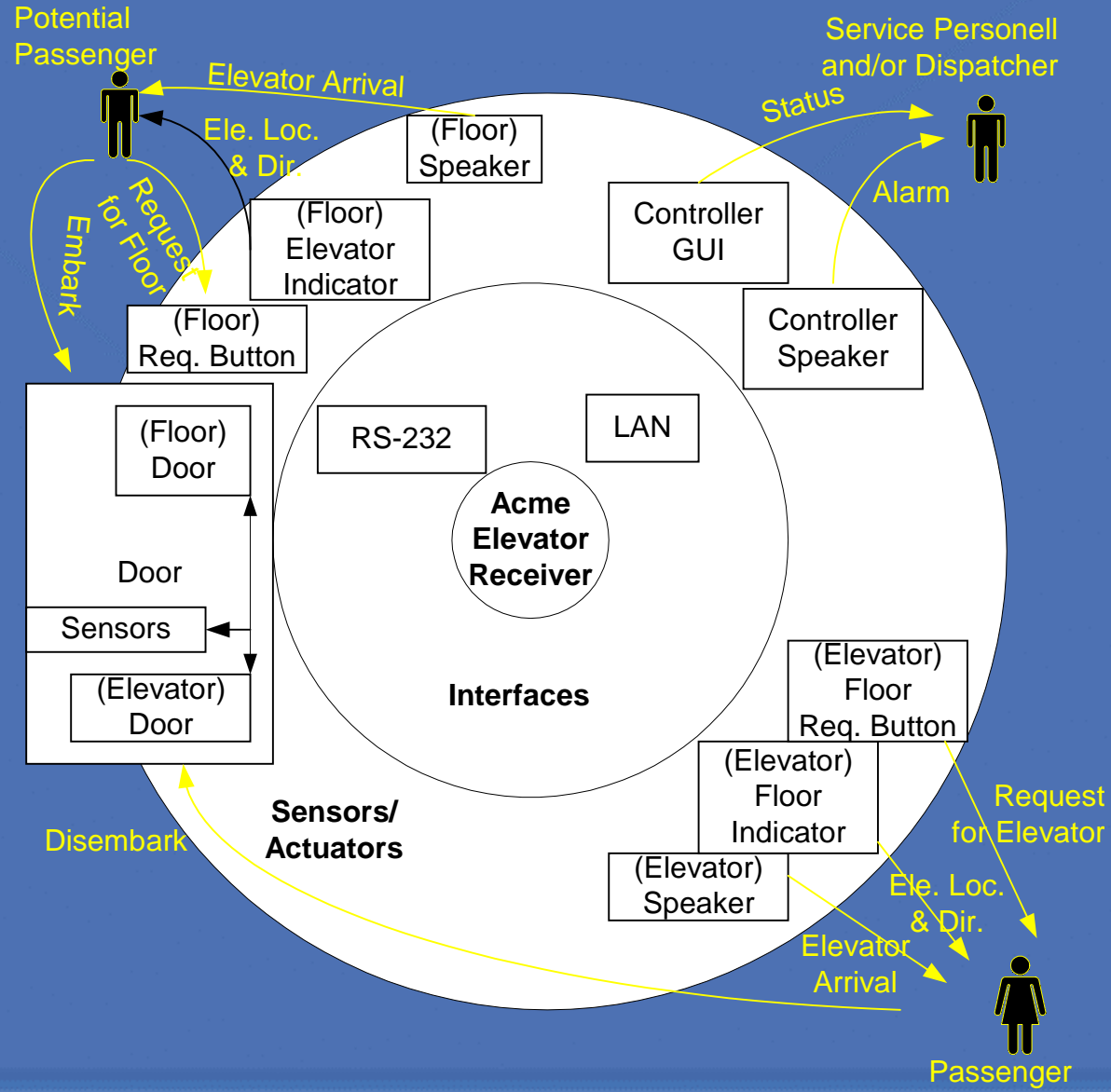
# Background on RT Requirements - Use Cases at the Core (Cont'd)

## •Elevator Use Case



# Background on RT Requirements - Use Cases at the Core (Cont'd)

## •Elevator Onion Skin



# Background on RT Requirements - Use Cases at the Core (Cont'd)

## ■ RT apps in place of use cases

- RT in insurance
- RT in entertainment systems in home
- RT in the enterprise CRM, SCM, etc.
- RT in air traffic control
- RT in aerospace & flight simulators
- RT in medical and imaging
- RT in ship-board combat system
- RT in train switching and bus tracking
- RT in automobiles and traffic signals
- RT robots and factory automation
- RT in telecom
- RT in power, light, water
- RT in defense

## ■ Key safety requirements

- UL 1998 - Safety Related Software
- 21 CFR PART 1 - authenticity, integrity, and confidentiality of the electronic records and signatures
- RTCA-DO-178B - Depends on the failure condition, and the software's potential contribution to system failures.
- ANS 7.4.3.2 - Nuclear powerplants
- MIL-STD 882d - Weapon systems
- NEBS - Telecom systems
- IEEE 1059 - Software Validation
- IEEE 1228 - Software Safety
- ISO 14971 - Risk Management

# Requirements for Pervasive Computing in RT

## ■ Key business drivers

- Any time computing required
- Any place computing required
- Any network required

## ■ Key technology drivers

- Microkernel platforms
- Executive platforms
- Monolithic platforms
- Sensors
- Bridging software for these:
  - 196
  - 680x0
  - 683xx
  - 68HCxx
  - 8051
  - ace
  - ARM
  - basic
  - coldfire
  - cop8
  - Crusoe
  - i960
  - infineon
  - media
  - mips
  - m-core
  - MSM 5010
  - Msp430
  - PowerPC
  - scenix
  - sparc
  - st6 and st9
  - StrongARM
  - tms370
  - x86
  - x86 embedded
  - xemics
  - XScale

# Requirements for Pervasive Computing in RT

## ■ Key business drivers

- Continuous control over the environment
- Enhanced safety critical applications
- Early detection and warning
- More responsive thus more competitive
- Security enhanced

## ■ Key sensor technology drivers

- Detection and resolution of deadlock
- Termination detection
- Market fluctuation detection and arbitrage
- Theft detection w/RF tags
- Scanning bar codes, magnetic strip, etc.
- Radiation detection sensors
- Fire and smoke detection
- Water contamination detection
- Motion detection
- Sound detection
- Power surge detection
- Magnetic pulse detection
- Solar flare detection
- Nanomuscle actuator extended

# Requirements for Pervasive Computing in RT



## Retailers..

- ▶ shopping anywhere
- ▶ locate stores
- ▶ convenience
- ▶ promotions
- ▶ customer loyalty

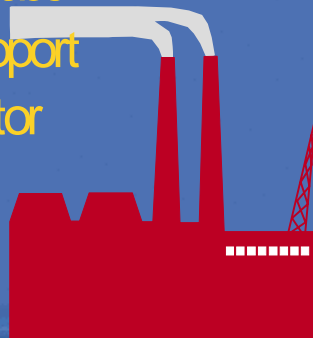
## Financial Institutions..

- ▶ banking anywhere
- ▶ stock quotes & trades
- ▶ locate ATMs
- ▶ notifications
- ▶ customer care



## Manuf./Distributers..

- ▶ Inventory anywhere
- ▶ order entry anywhere
- ▶ track and trace
- ▶ product support
- ▶ facility locator



## Travel..

- ▶ flight confirmations
- ▶ rapid check-in
- ▶ reservations anywhere
- ▶ change notifications
- ▶ frequent flyer program

# Requirements for Pervasive Computing in RT

## ■ Key RT infrastructure drivers

- Election and mutual exclusion
- Byzantine agreements
- Distributed RT
- Conventional, Object-Based, and Fault-Tolerant Task Scheduling
- Resource reclamation
- Message scheduling
- Quality of service routing
- Medium access protocols in RT networks

## ■ Key sensor technology drivers

- Altitude/Position/Navigation detection
- Collision detection
- Velocity/Acceleration detection
- Transit violation detection
- Metal stress detection
- Emotion detection
- Light detection
- Weather/humidity/temp/barometric pressure monitoring
- Weight detection
- Odor/Gas detection
- Attendance detection
- Virus detection
- Intruder detection

# Requirements for Pervasive Computing in RT -- Bridging Software (Cont'd)

## ■ Embedded Q Requirements

- Full Java, com, and c support
- Java JVM level 1.1 on appropriate device (except Palm)
- Compatible with all (EPOC, Palm, WinCe, Windows 95, 98, NT, 2000) operating systems
- Work with all the popular development environments (Visual Age Micro Edition, CodeWarrior(R), etc.)
- Implement push-style event delivery between applications
- Enable robust message delivery for mission critical applications in unreliable but cost-effective networks

## ■ Embedded DB Requirements

- Multi-column indexes
- Referential integrity
- Sub-selects (IN)
- Defaults
- Inner/outer joins
- 32 indexes per table
- One file database
- Null support
- Unicode support
- Transactions
- Support all targeted CPUs (i.e., PocketPC, H/PC, P/PC)
- Compatible with all (EPOC, Palm, WinCe, Windows 95, 98, NT, 2000, eLinux, Neutrino 2.0) operating systems

# Requirements for Pervasive Computing in RT -- Bridging Software (Cont'd)

## ■ Embedded Q Requirements

- Interrupt prone applications Intra & inter-process calls supported
- Local queue support on client devices that have JVM.
- 56-bit DES encryption.
- A very high security version is available with 128-bit encryption (at additional cost).

## ■ Embedded DB Requirements

- Works with all the popular development environments (Visual Age Micro Edition, CodeWarrior(R), etc.)
- Data-types
- Real, Numeric, NVarchar, NText, Image, Integer, DateTime, VarBinary, UniqueIdentifier, Money
- Having/group by
- Seek on index
- Set functions
- Identify attribute
- Local security - DB encryption (128) and database password
- Performance (Better than the competition)

# Requirements for Pervasive Computing in RT -- Bridging Software (Cont'd)

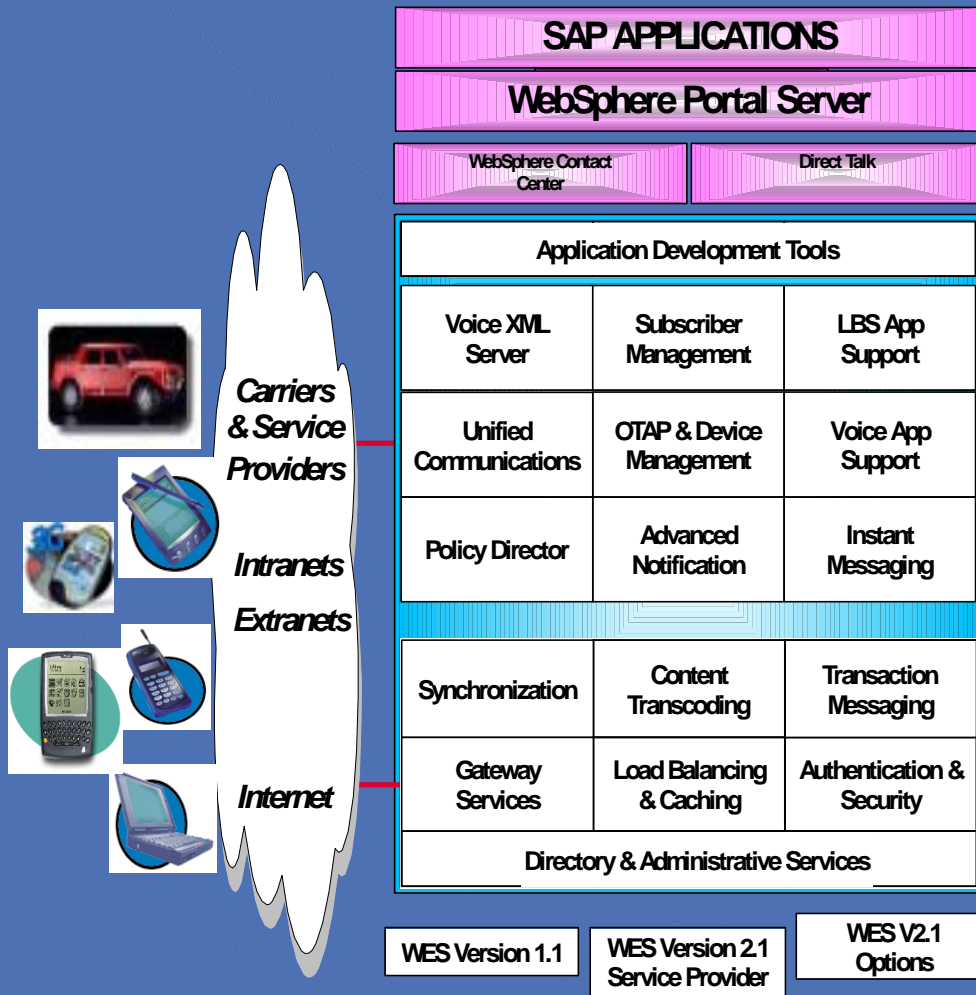
## ■ Embedded Sync Engine Requirements

- Extend the messaging and collaboration power by way of integration to Domino, etc.
- Design, deploy, synchronize and administer Mobile Notes™ applications
- Create applications using Domino Designer for PDAs
- Create WAP based interfaces
- Mobile Notes client for PDAs (i.e. Palm, Windows CE/Pocket PC and EPOC platform PDAs)
- XML and SyncML-based application structure
- Central administration

## ■ Embedded MicroBrowser Requirements

- Webserver
- Servlet Engine
- MicroITS
- JSP
- Offline Browsing
- SyncLayer APIs
  - Data Exchange
  - XML
  - Personalization
  - Installation
  - Local DB

# Requirements for Pervasive Computing in RT (Cont'd)



## Key technology drivers

- Embedded Transaction Queue Software
- Embedded DB(s)
- Embedded Personalization Engines
- Embedded Web Servers
- Portals
- Transcoding
- TUIs
- NUIs
- GUIs
- Speech Recognition
- Text to Speech Software

# Requirements for the RT Home Office

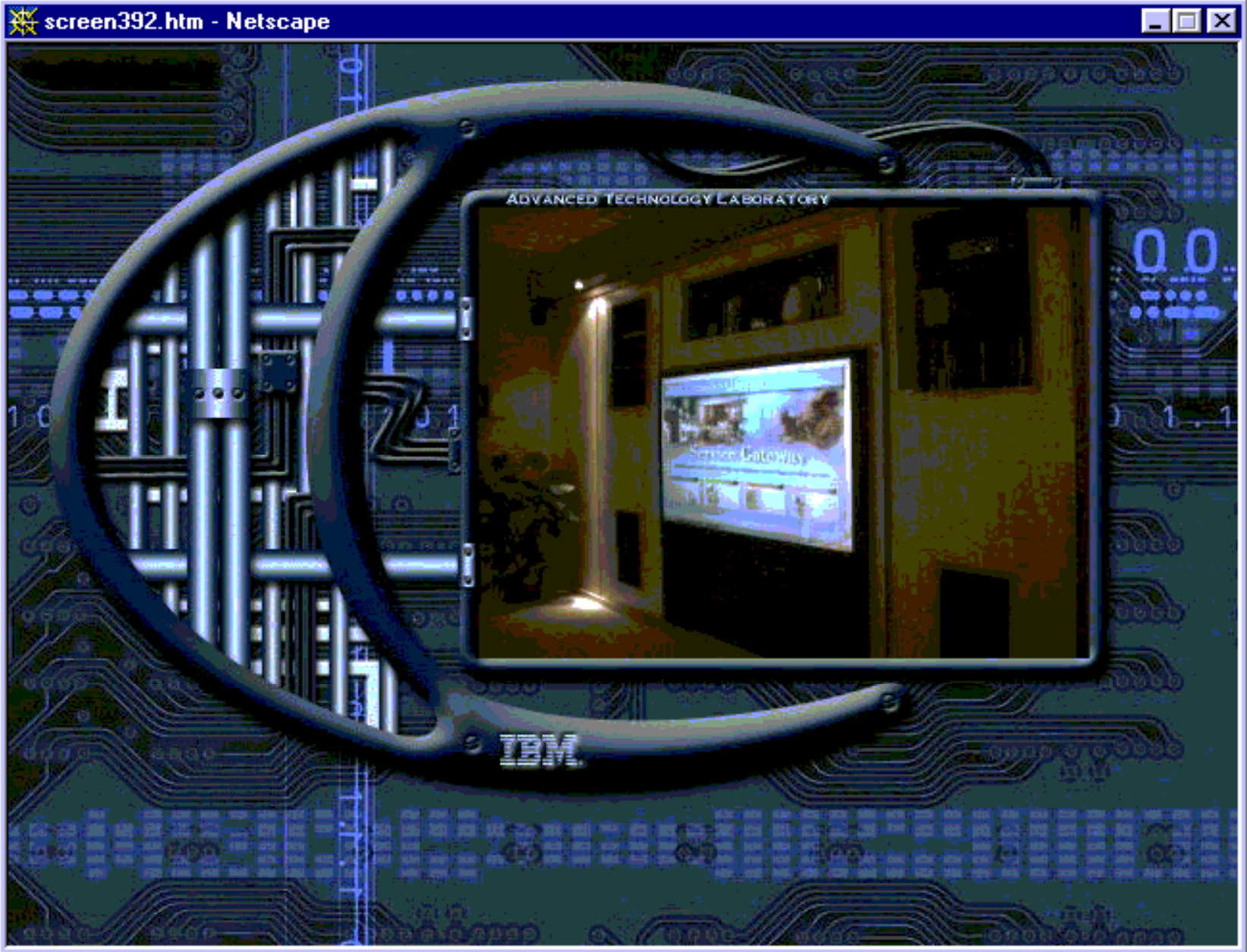
## ■ Key business drivers

- Home automation for controlling devices in the home locally and remotely
- Secure connections to the Internet for secure telecommuting
- Sharing of broadband Internet access
- Security and safety for remote monitoring of intrusion and fire alarms
- Seamless connectivity for ALL in-home devices
- Easy to setup and use

## ■ Key technology drivers

- Broadband Cable
- DSL/ADSL
- Wireless GPRS/CDPD/3G/ WiFi
- Residential Gateways
- VPN
- Firewalls
- 802.11b -> i
- WebPADs, PC, Palm, Media Jukebox
- OSGi - Automatic configuration, remote feature management, and automatic updates

# RT Home Office Portal Example

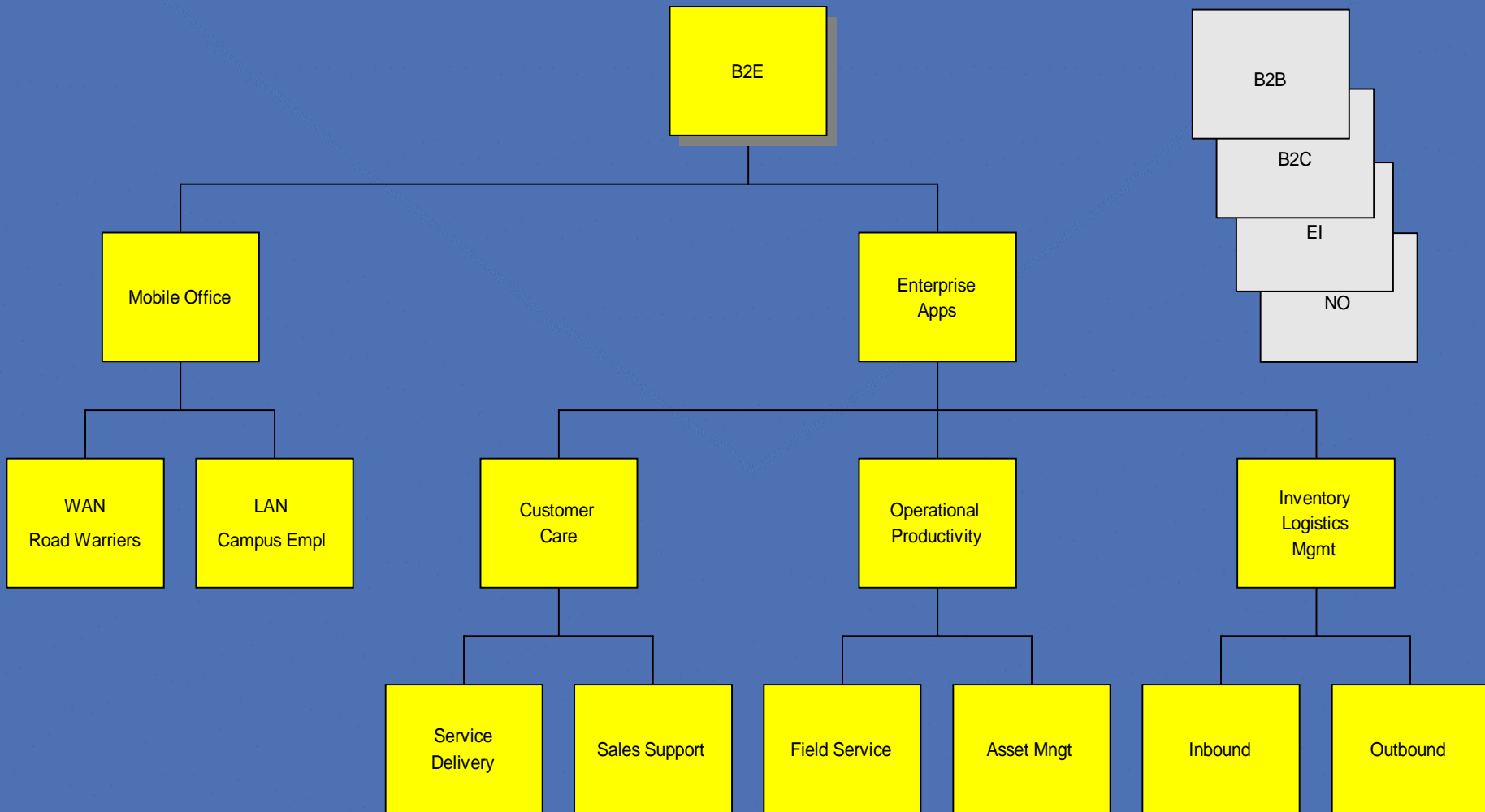


# RT Enterprise Portal Example



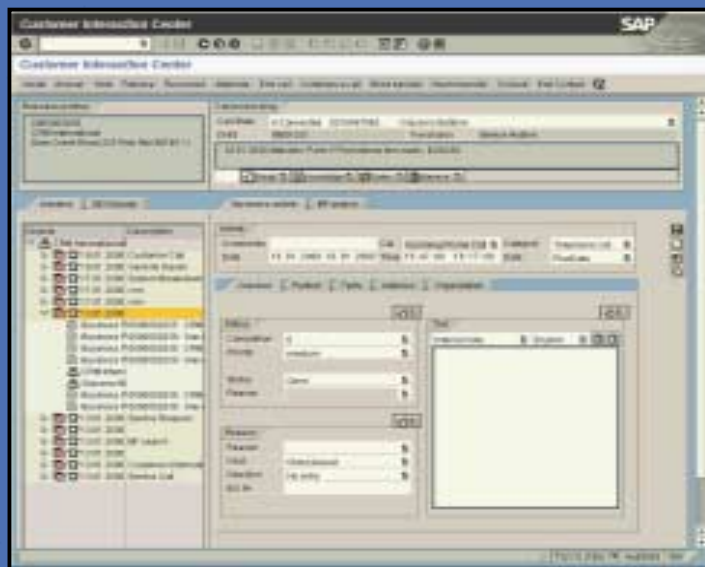


# Requirements for the RT Enterprise Client

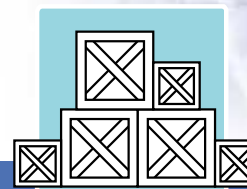


# CRM Requirements - Marketing w/RT Twist

- Time-to-market
- Marketing, planning, and campaign management
- Telemarketing and lead generation
- Opportunity management



- Sales activity and contact management
- Customer segmentation, product and service profiling
- Collaborative content management



## Warehouse reports

Inventories are high. Let's launch a marketing campaign on these products.



## Customer reports

These customers show a proven record of positive profit for us. Let's give them a benefit.

# CRM Requirements - Sales w/RT Twist

- Globalization
- Mass customization
- Order acquisition
- Internet pricing and w/Configuration
- E-selling
- Telesales & field sales
- Profitability analysis

- One step buying and selling
- Complete order life cycle process
- Real-time availability checks
- Contract, billing and financials management
- Fulfillment visibility and order tracking

Order ID	Date	Status	Amount
100	2007-11-01	Completed	1000
101	2007-11-02	Completed	1000
102	2007-11-03	Completed	1000
103	2007-11-04	Completed	1000
104	2007-11-05	Completed	1000
105	2007-11-06	Completed	1000
106	2007-11-07	Completed	1000
107	2007-11-08	Completed	1000
108	2007-11-09	Completed	1000
109	2007-11-10	Completed	1000
110	2007-11-11	Completed	1000



## Sales automation

My customer interactions are maintained and scheduled automatically with integrated reporting and tracking tools.



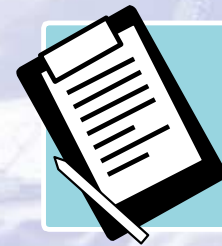
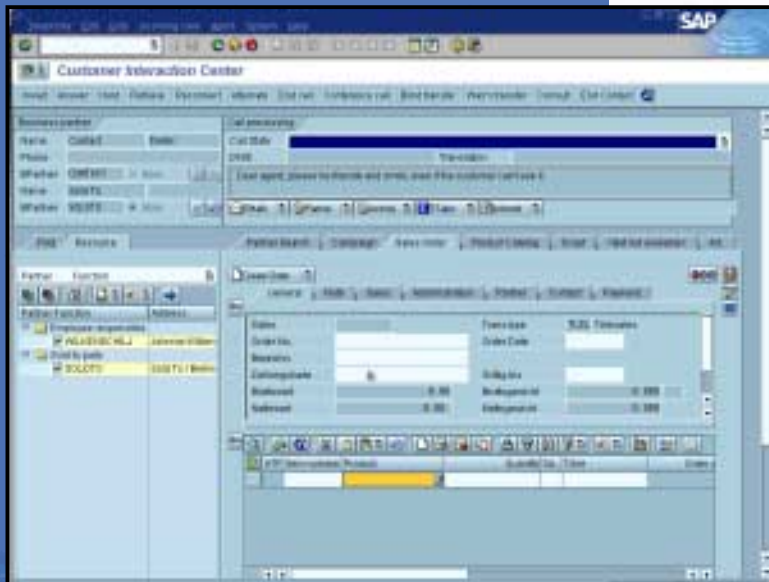
## Customer management

We have on-line visibility to complete customer interaction history.

# CRM Requirements - Service w/RT Twist

- Interaction center
- Internet customer w/Self-service
- Service management
- Claims management

- Field service (mobile service)
- Field service (dispatch)
- Integration of marketplace services



## Service log

We have access to previous customer contacts. Maybe the problem is the same as last time.

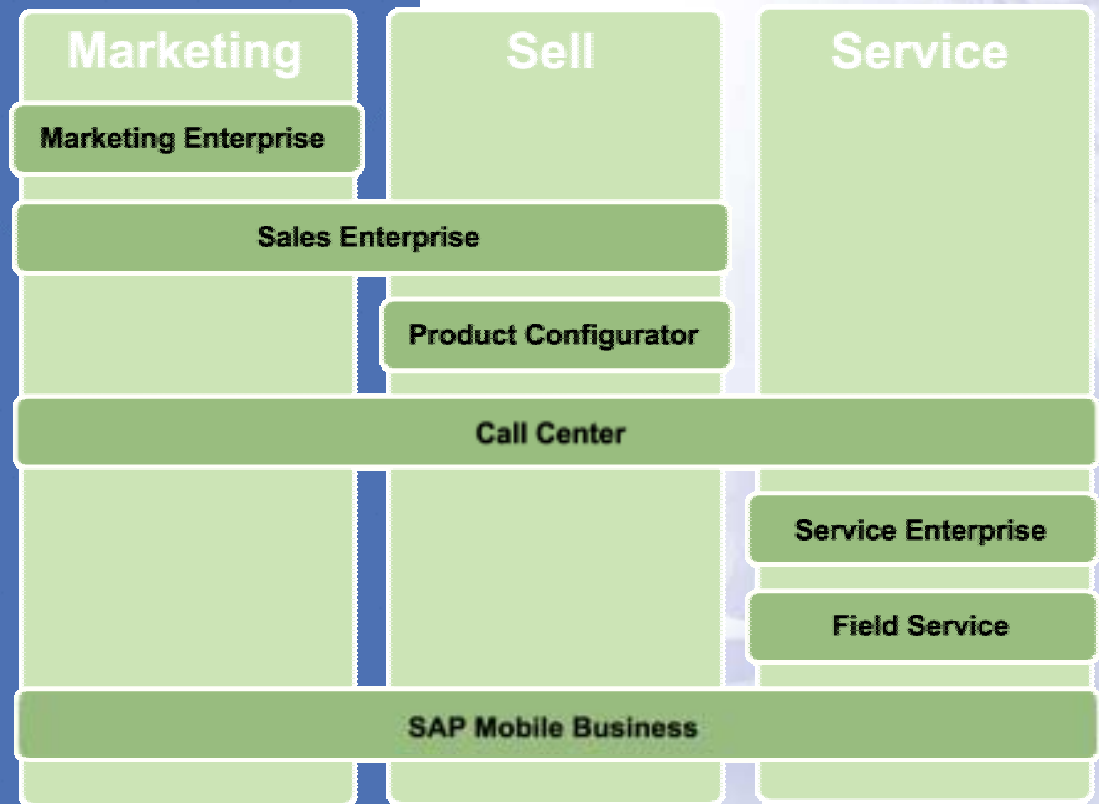


## Online support

My machine has broken down. I will download the current repairment checklist.

# mySAP CRM in RT Review of Requirements

- Full integration with other mySAP.com solutions
- Mass customization
- Operational CRM
- Analytical CRM
- Collaborative CRM
- State-of-the-art suite of CRM capabilities
- Use of mySAP Workplace
- Internet pricing and configuration
- Extensive mobile sales and service support



# Requirements for the RT Enterprise Client (Cont'd)

## ■ Key business drivers

- All inclusive of the consumer perspective (ie. Bus. automation for controlling devices in the Bus. locally and remotely)
- Smart Mobs & Collaboration on control of Partnership or Alliance
- Disaster recovery in RT
- Intellectual capital capture in RT
- Gateways provide service differentiates that encourage customer loyalty and grow revenue while providing near real-time experiences
- Reduce churn rate
- Federal information processing standard
- Biometrics

## ■ Key technology drivers

- RTOS
- Portals
- Telematics
- Telemetry & guidance systems
- Instant messaging
- Dataware housing & quickplace
- Virus protection
- Retinal scans.
- Wearable embedded

# Requirements for the RT Enterprise Host or Hosting Service (ie. mySAP)

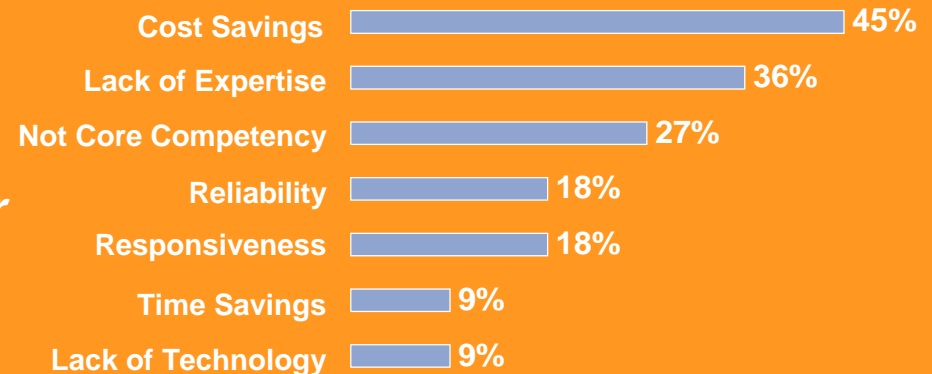
## ■ Key business drivers

- Freedom to focus on running your business in RT
- Faster time-to-market
- Maximize ROI potential
- Flexibility to respond quickly to market changes

## ■ Key technology drivers

- Access to specialized skills
- Performance optimization
- High-bandwidth Internet connectivity
- Enhanced security
- Enhanced reliability
- Reduced risk

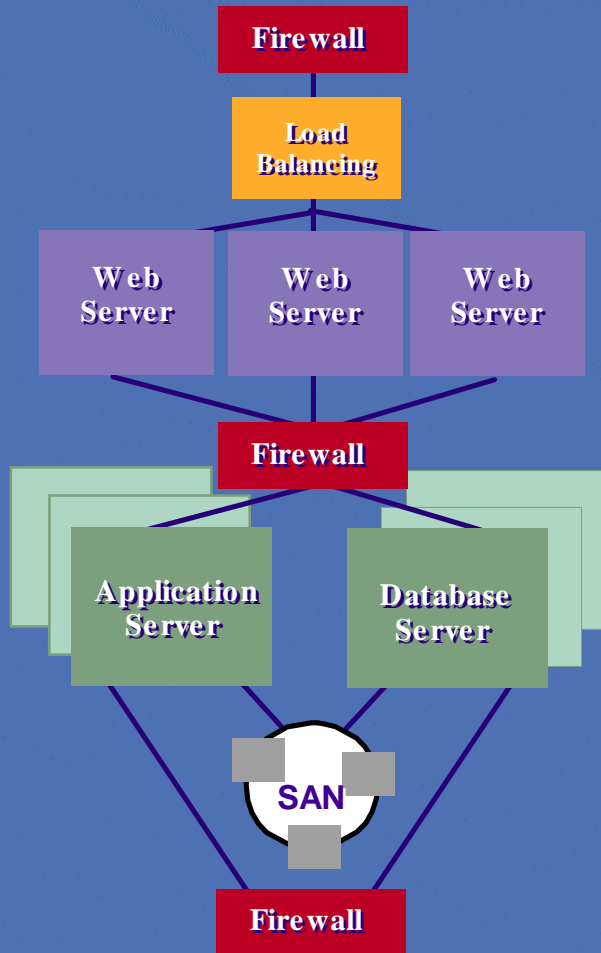
### *Why Companies Choose Hosting Over In-House*



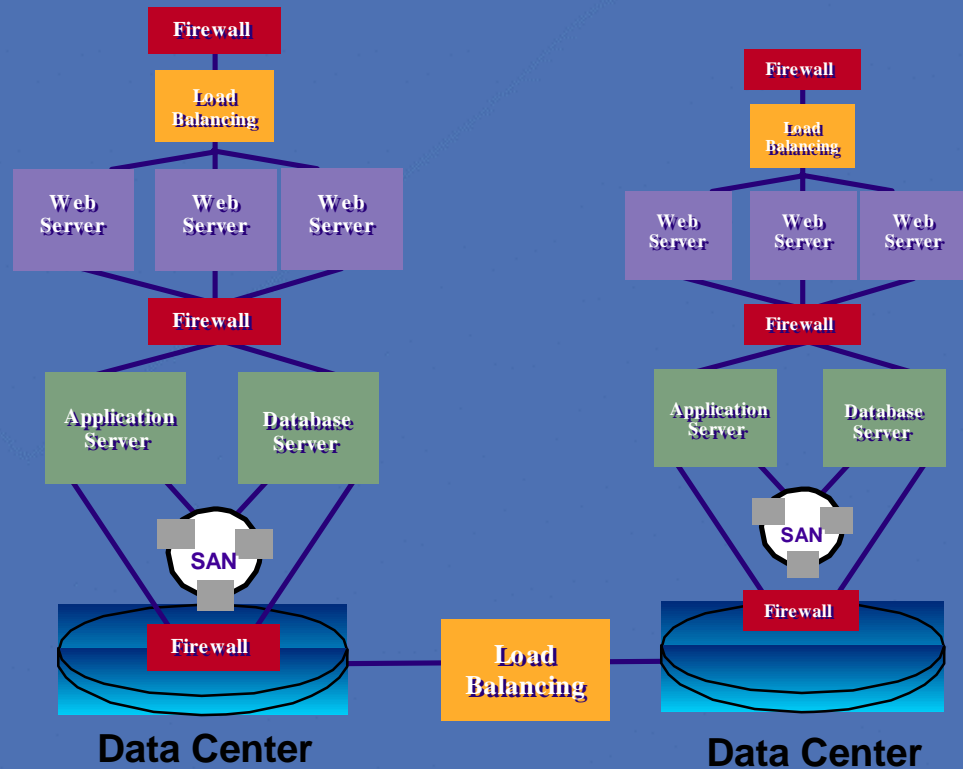
Source: Forrester Research, May 2000

# Sample e-business hosting implementations

## Single site

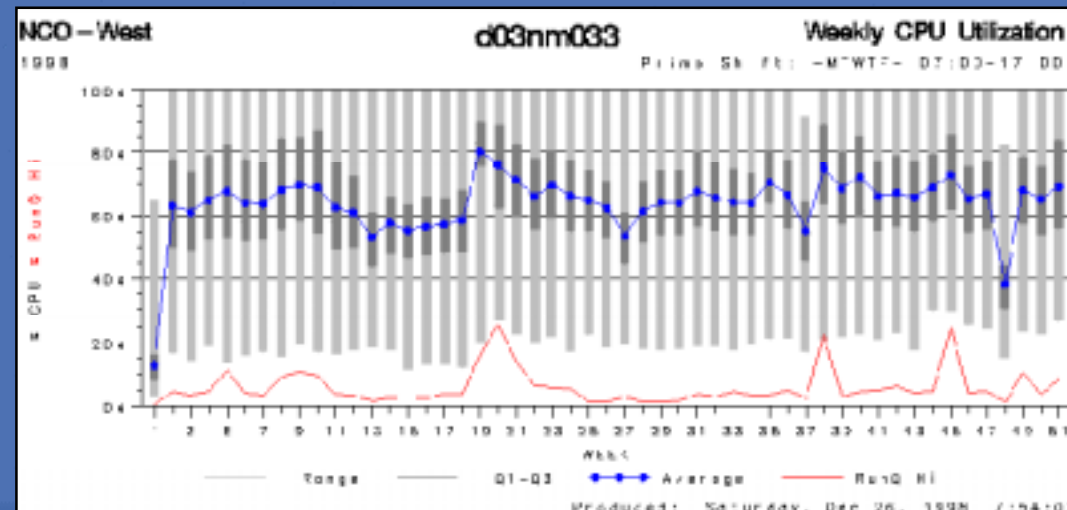


## Dual site



# Hosting server and network monitoring in near RT

- Key business drivers
  - 24x7 performance, capacity monitoring
  - Servers
  - CPU, memory, disk utilization
  - Load averages
  - Applications
  - End-to-end response time
  - Service levels
  - Outages, problems and changes
  - Network performance
  - Switch utilization, throughput, bandwidth capacity
  - 24x7 availability monitoring
  - Servers: IP ping, URLs
  - Applications: Web server, middleware, databases
  - Network: ports



# Problem management requirements for service provider

IBM responds to problems based on severity level...Modification needed for RTCA-DO-178B. We do comply with CFR 21 PART 11

- Severity 1 = a critical problem
  - Service, product, or network is unusable or unavailable
  - A user is unable to do any productive work
- Severity 2 = a major problem
  - Users can connect to the network and server(s)
  - Services or functions are interrupted or severely degraded
  - User cannot work at expected performance levels
- Severity 3 = a minor problem
- Severity 4 = a problem with no significant impact on the user

# Hosting security service requirements

- Key business drivers
  - Proven security capabilities
  - Security "health check" services
  - Ethical hacking (vulnerability assessments)
  - "Bulletproofing" services
  - Operating system hardening
  - Firewalls
  - Web security alarm services
  - Intrusion detection
  - Emergency Response Services

# Requirements for the RT Application Service Provider Enterprise

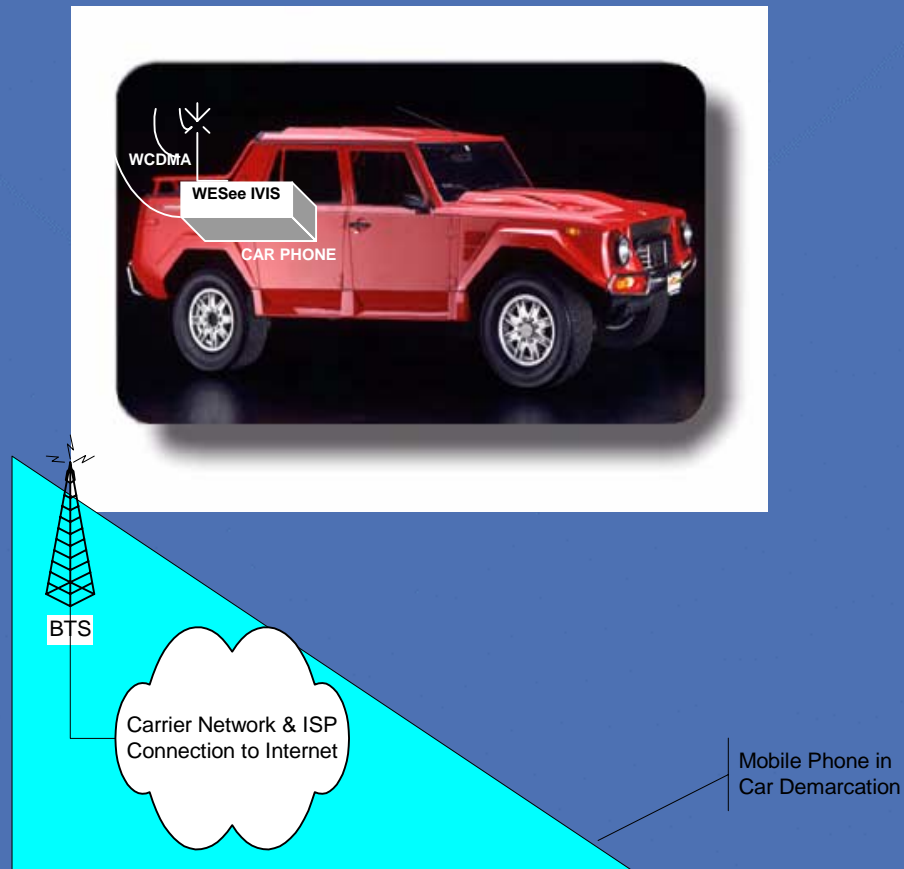
## ■ Key business drivers

- Consolidate delivery of services to the home or business including telephony, Internet access, and audio/video content
- Enable new services including remote monitoring and control for utilities and alarms (meter reading, power managing, security services)
- On-demand feature expansion (additional phone lines, faster data access, movie rental)
- Reduce on-site service (no truck rolls)

## ■ Key technology drivers

- Electro Optical Sensors
- Bar Code Reading
- RF TAGs
- Wireless CDMA/CDPD/GRPS
- Video Streaming
- VOIP - H323 & SIP
- RT Control Protocol
- RSVP

# Requirements for RT in Telematics / IVIS



# Requirements for RT in Telematics (Cont'd)

## ■ Key business drivers

- Driver monitoring
- Remote vehicle diagnostics
- Navigation systems
- Access to e-mail
- Access to the internet
- Concierge services
- Entertainment systems
- Navigation assistance
- Response to emergencies
- Driver assist...track stolen vehicles

## ■ Key technology drivers

- Location Based Services by way of GPS
- VLSI & Embedded systems
- Automotive Gateways
- Wireless GPRS/CDPD/3G/ WiFi
- Bluetooth
- Embedded Bridge-ware

# Requirements for RT in Telematics (Cont'd)

- Key business drivers
  - Operated by both Voice and Touch
  - Easy (EZ) Pass
  - Geographic Information Systems
  - Fleet management tools
  - Allow to continuously deploy new features and services.
  - Voice interface technology



# Requirements for RT in Telematics (Cont'd)

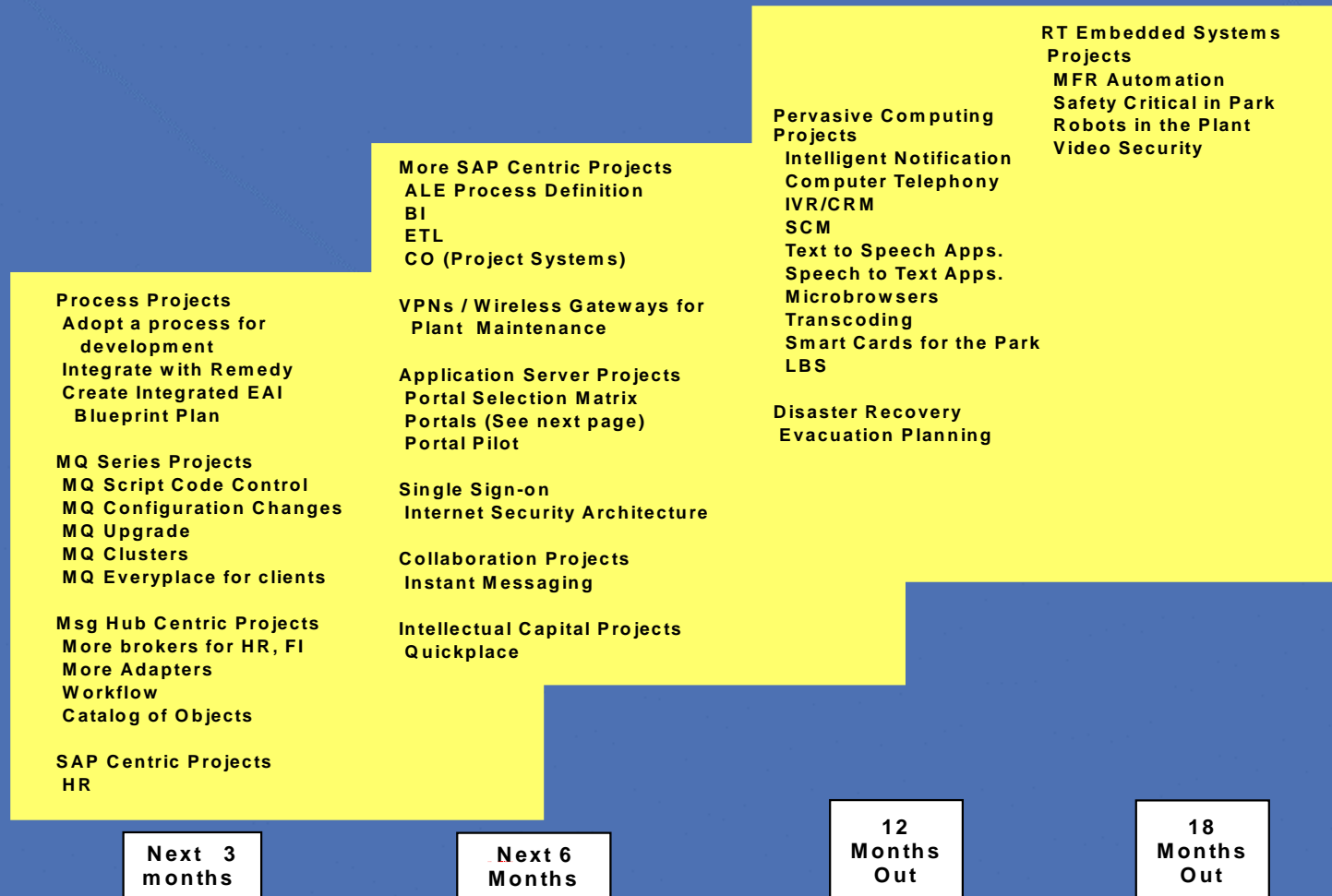
## ■ Key business drivers for MFR

- Power management
- Hardware-independent tools
- Faster boot time
- Compact solution for devices with limited storage capacity
- Hands-free and eyes-free communications
- Road rugged
- Robust graphics for map drawing
- Reliable Internet access/open architecture
- "skinnable" graphics enable designers to easily customise the appearance of their systems to different car lines

## ■ Key technology drivers

- Java - J2ME applications
- Visual Basic and ActiveX support
- OSGi support
- Microbrowsers
- GDI-Sub
- Server-side technology and in-vehicle infrastructure
- Voice recognition technology
- ARM9-based mobile multimedia processors
- Text-To-Speech technology

# DAY 1 Conclusion



# Welcome Distinguished Members of the Open Group

- Day 2 Agenda

- Theory for Building Infrastructure and Applications
- Building RT Requirements using Simulators

# Building RT Requirements using Simulators

The screenshot shows the IBM Message Queue Simulator window. The input parameters are:

- System arrival rate (LAMBDA): 3
- System service rate (MU): 4
- Number of servers in system (C): 1
- The maximum number allowed in the system (N): 99999
- The maximum limit on the source (K): 99999

The simulation results are displayed in a text area:

```
(M/M/1) - (GD/9999/9999)

LAMBDA=3.000000 LAMBDA EFF=3.000000
MU=4.000000 RHO=0.750000
WS=1.000000 WQ=0.750000
LS=3.000000 LQ=2.250000
VALUES OF P(N) FOR N=0 TO 35, OTHERWISE P(N) <0.00001
P(0)=0.250000
0.187500 0.140625 0.105469 0.079102 0.059326
0.044495 0.033371 0.025028 0.018771 0.014078
0.010559 0.007919 0.005939 0.004454 0.003341
0.002506 0.001879 0.001409 0.001057 0.000793
0.000595 0.000446 0.000334 0.000251 0.000188
0.000141 0.000106 0.000079 0.000060 0.000045
0.000033 0.000025 0.000019 0.000014 0.000011

CUMULATIVE VALUES OF P(N)
```

The status bar at the bottom left shows "Ready".

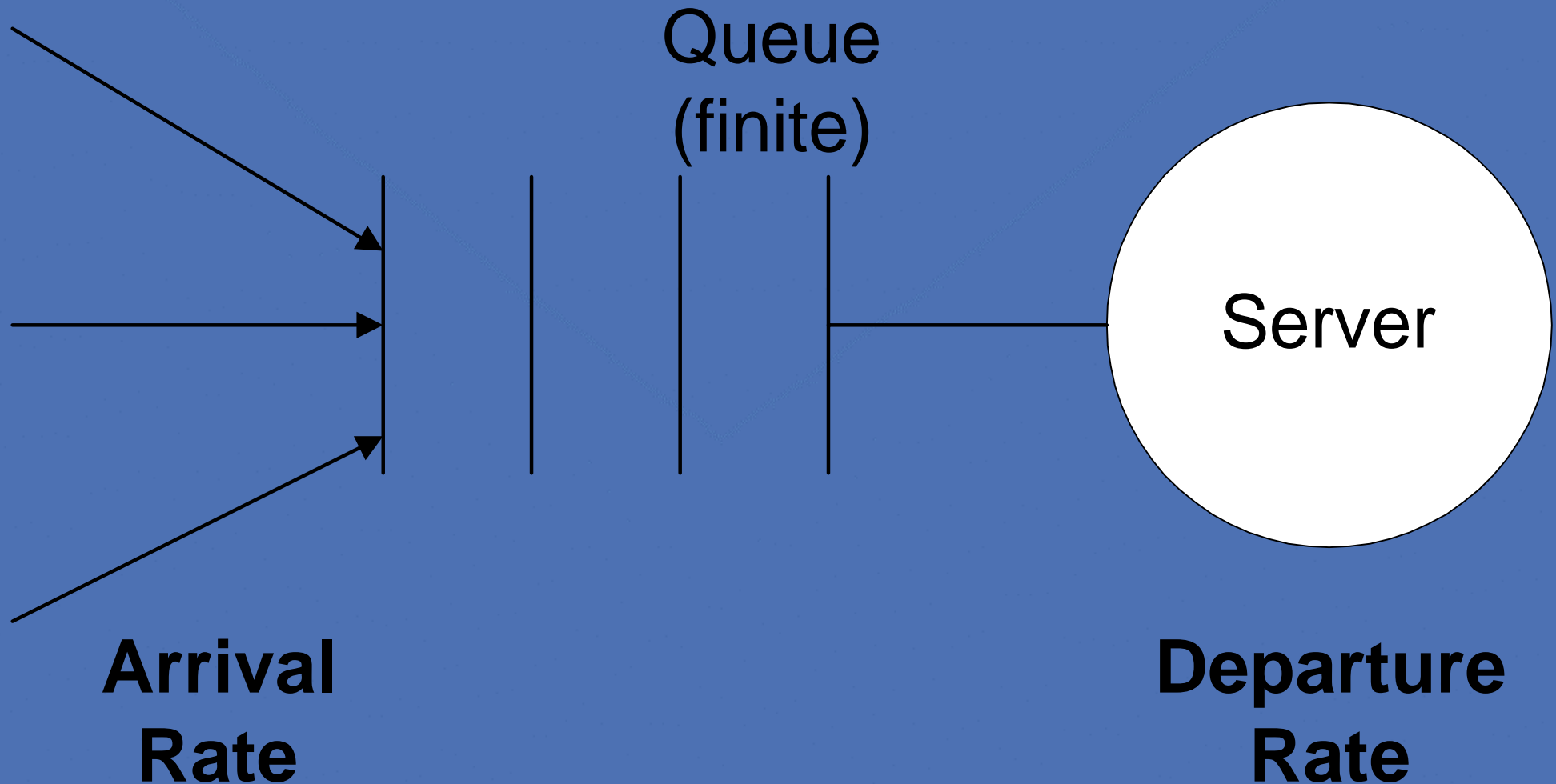
# How and why queuing simulators are used for RT:

- Goal is to answer the following questions as they relate to a system:
  - How long does a message wait to get serviced (delay)?
  - If the queue fills, what happens?
  - What size should the queue be?
  - What is the average packet length?
- Performance is then based on the following:
  - Delay...jitter
  - Loss probability
  - Units of throughput = packets (or message's)/unit time

# Queuing terminology reviewed for RT:

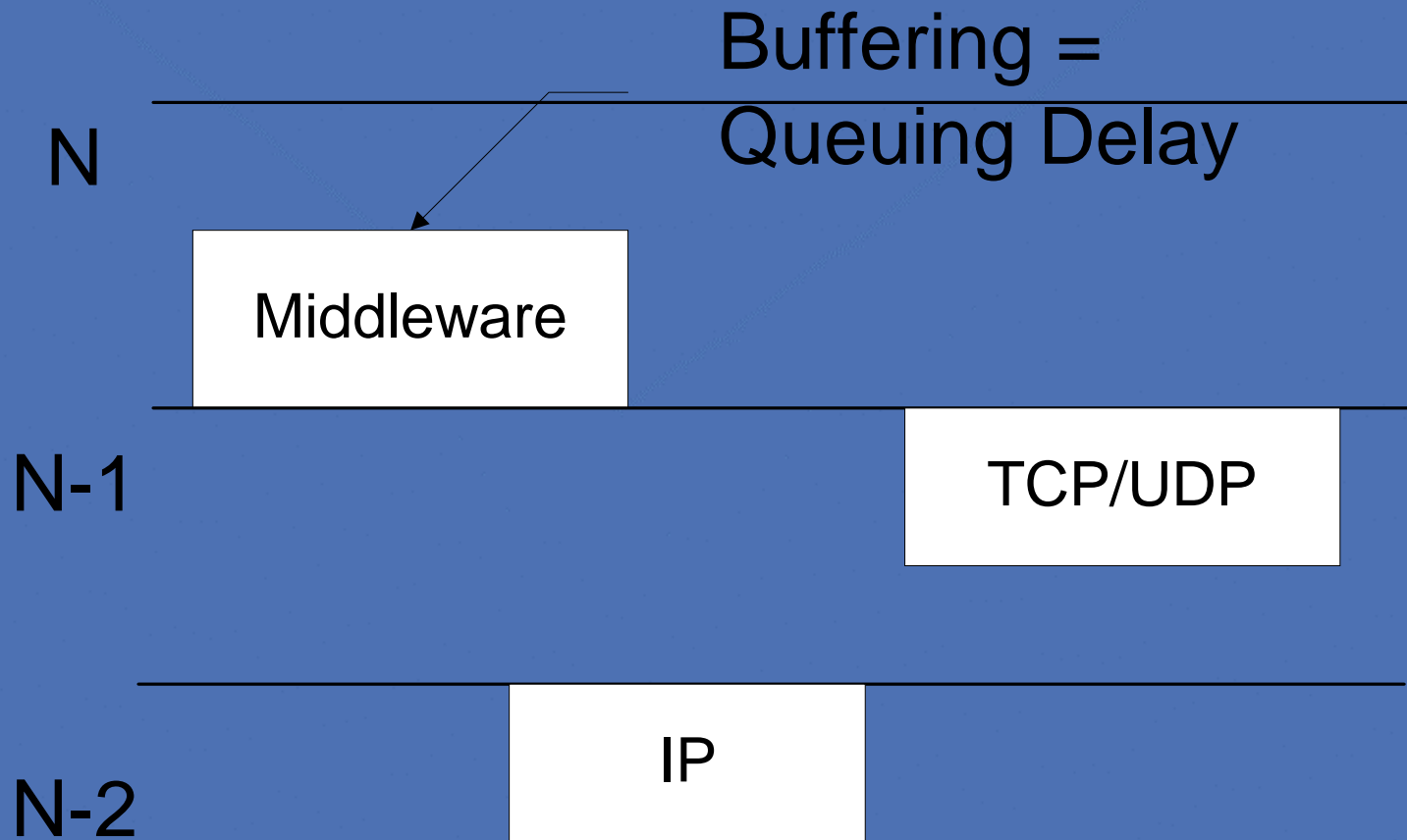
- Blocking probability
- Throughput
- Finite size
- Filled
- Queue states (pure death, steady, transient, pure birth)
- Server states (busy, idle)
- Service time
- Arrivals (random or stochastic)
- Poisson (equally spaced in time)
- Erlang (Models B & C)
- Engset ( $M > N$ )
- Little's Formula
- Statistic Dependencies
  - Message arrival process (Poisson)
  - Packet-length distribution (fixed, random)
  - Number of servers
  - Service discipline (LIFO, FIFO, SIRO)
- Link utilization (load vs. capacity)
- Simulation
- Kendal notation (a/b/c):(d/e/f)
- Human behavior

## Queuing terminology for RT (Cont'd)



NOTE: Interchangeable terms (arrivals = inserts and departures = deletes)

# Queuing terminology for RT (Cont'd)



# Building RT Requirements with SimCity

NOTE:Program ran separately.

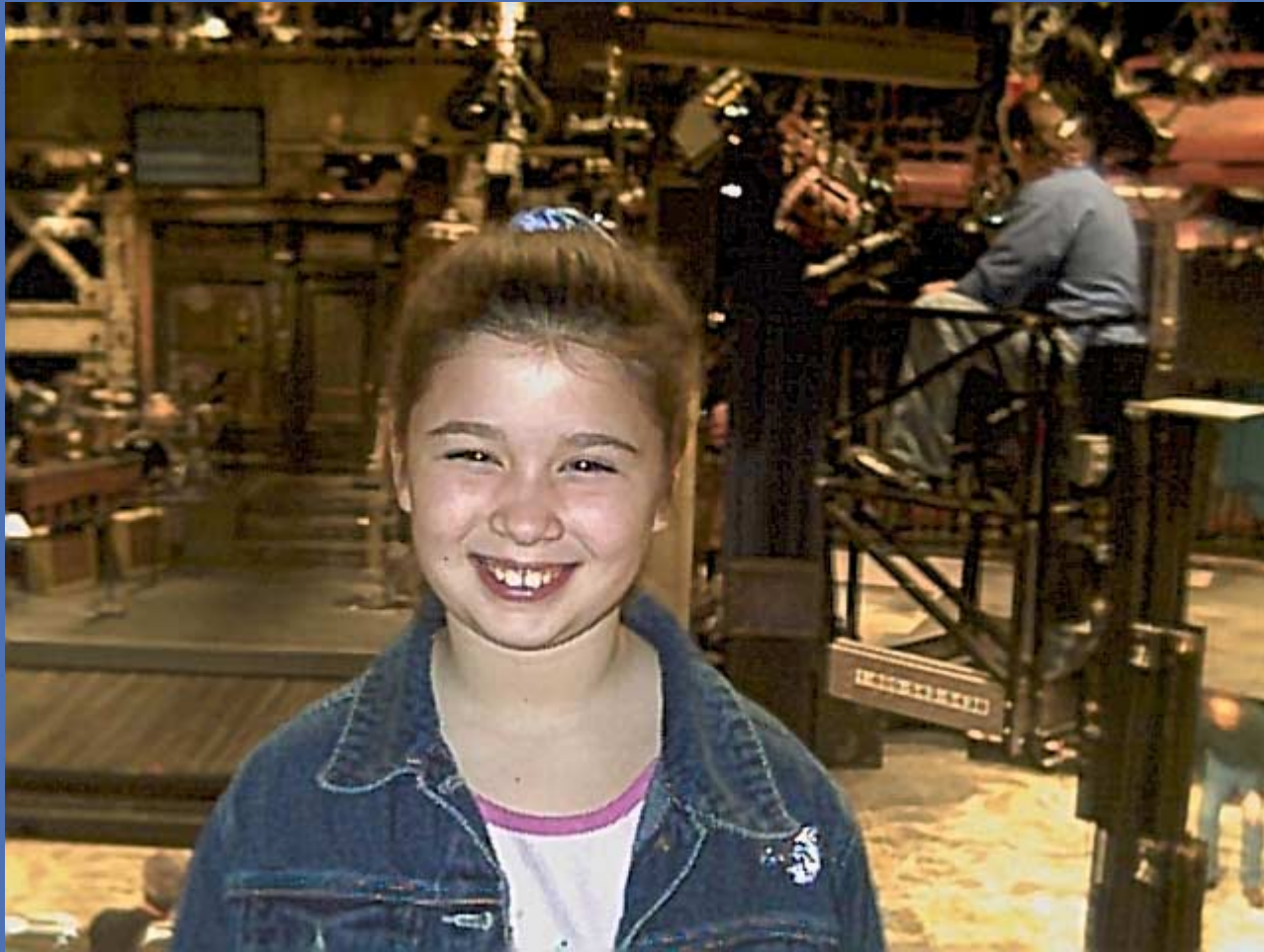
# How to model an RT System:

- Data collection
  - Gather queuing data by benchmarking, among other things
- Data reduction
- Model building
  - Use the data gathered from the benchmarks as input
  - Excel spreadsheets for extrapolation
  - Tweak spreadsheets and programs to match reality
- Model extrapolation
  - Awk script with Java front end for simulation of server and queue
  - Awk script or website ([www.erlang.com](http://www.erlang.com)) for simulation

# RT requirements conclusion

- Pervasive Computing
- Enterprise Computing in RT
- RT Telematics
- Add your own requirements by way of Simulation
- This RT system shall....support questions.

**CREDITS: SimCity by**



**SAMANTHA NOELLE LEWIS**

## Book referenced, available, and on the horizon:

- LEWIS, R. SCOTT, WIRELESS PC-BASED SERVICES [2001] COPYRIGHT PRENTICE HALL
- DOUGLASS, BRUCE [1999] REALTIME UML
- Please contact me with questions at:

[scottlew@us.ibm.com](mailto:scottlew@us.ibm.com)