Availability of Web-based Services

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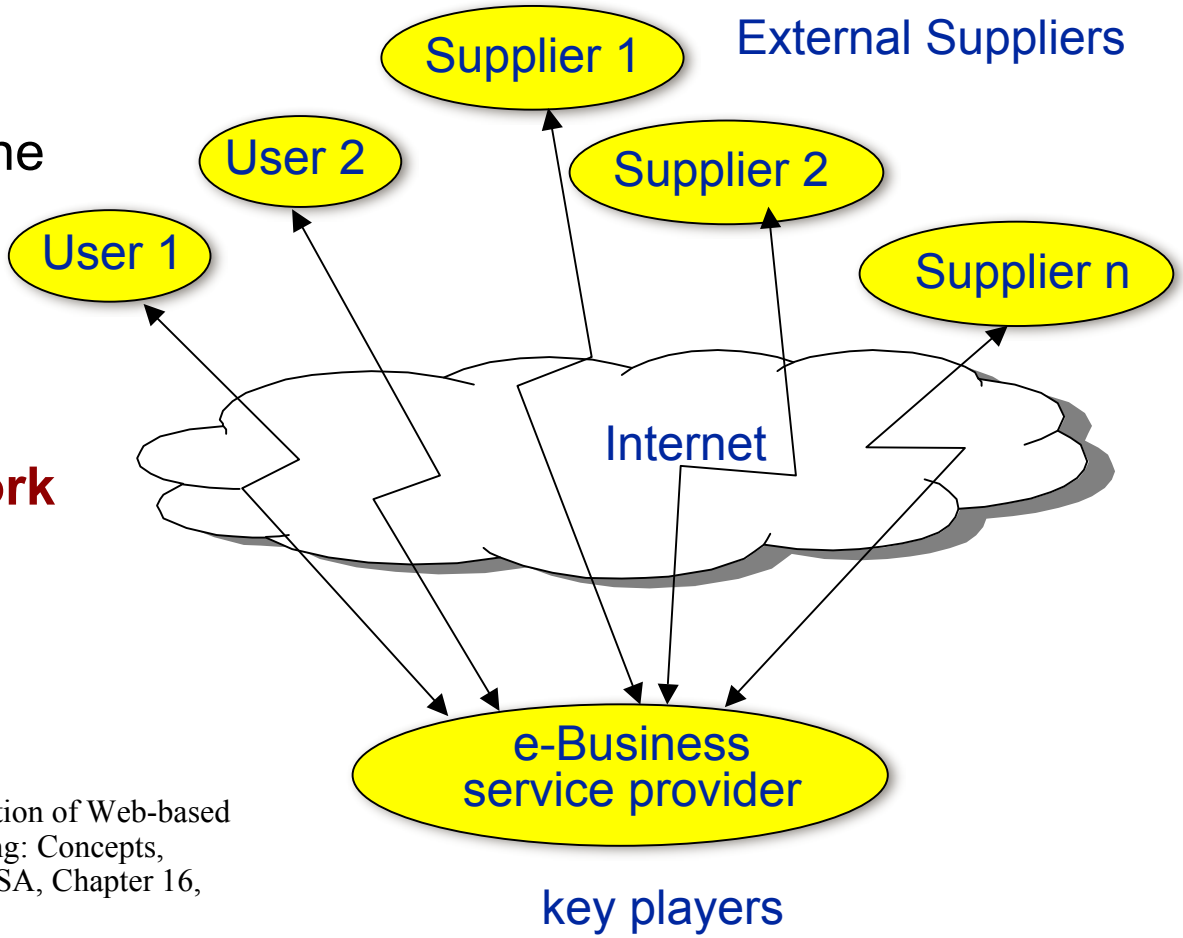
Context and motivations*

Support e-business system designers in making objective architectural decisions

Assess the impact of failures on the quality of service provided to the users

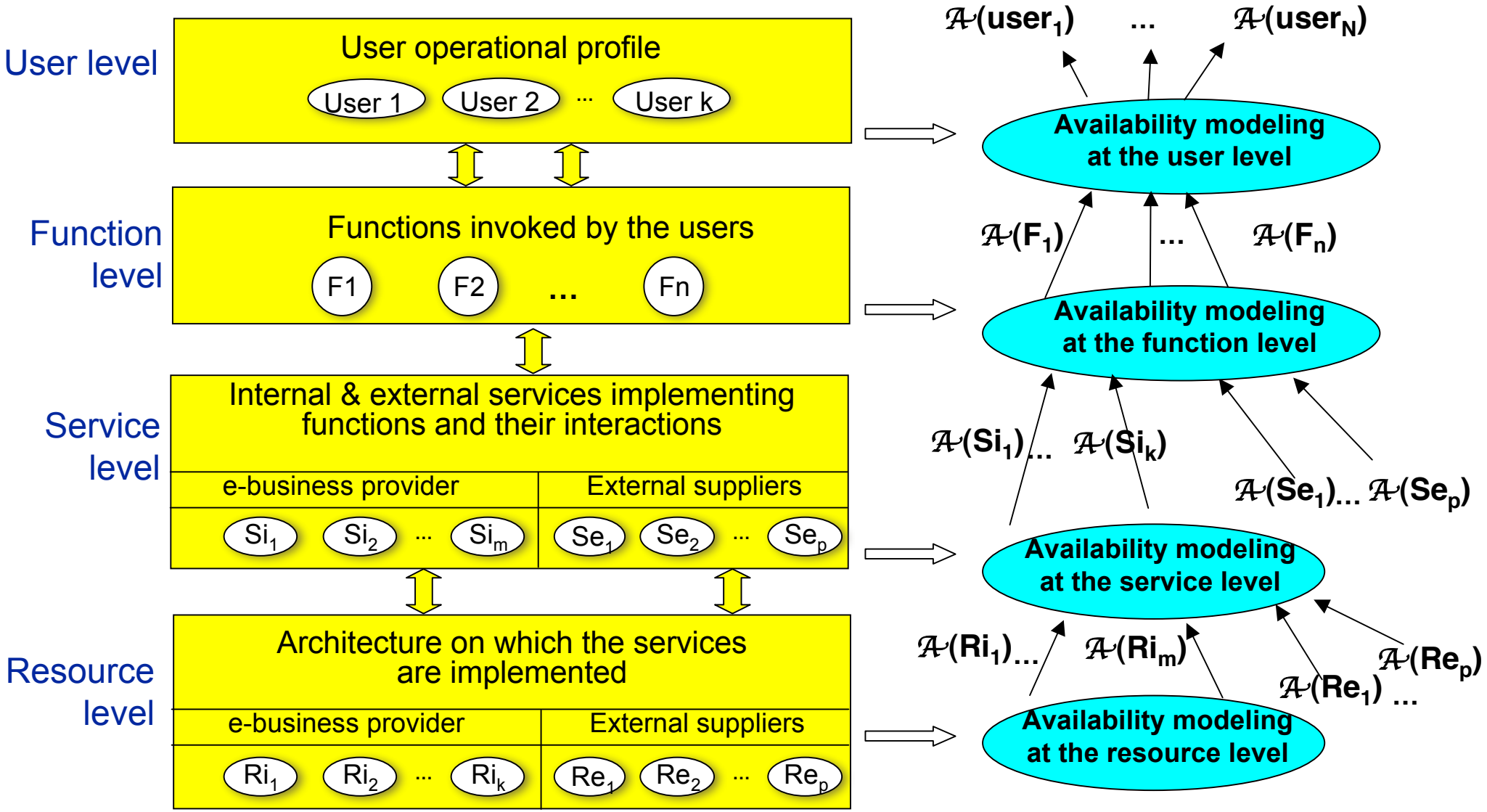
Hierarchical modeling framework

Web-based Business Applications



* M. Martinello, M. Kaaniche, K. Kanoun, "Performability Evaluation of Web-based Services", in "Performance and Dependability in Service Computing: Concepts, Techniques and Research Directions", IGI Global, Hershey, PA, USA, Chapter 16, N−ISBN 9781609607951, March 2011, 20p

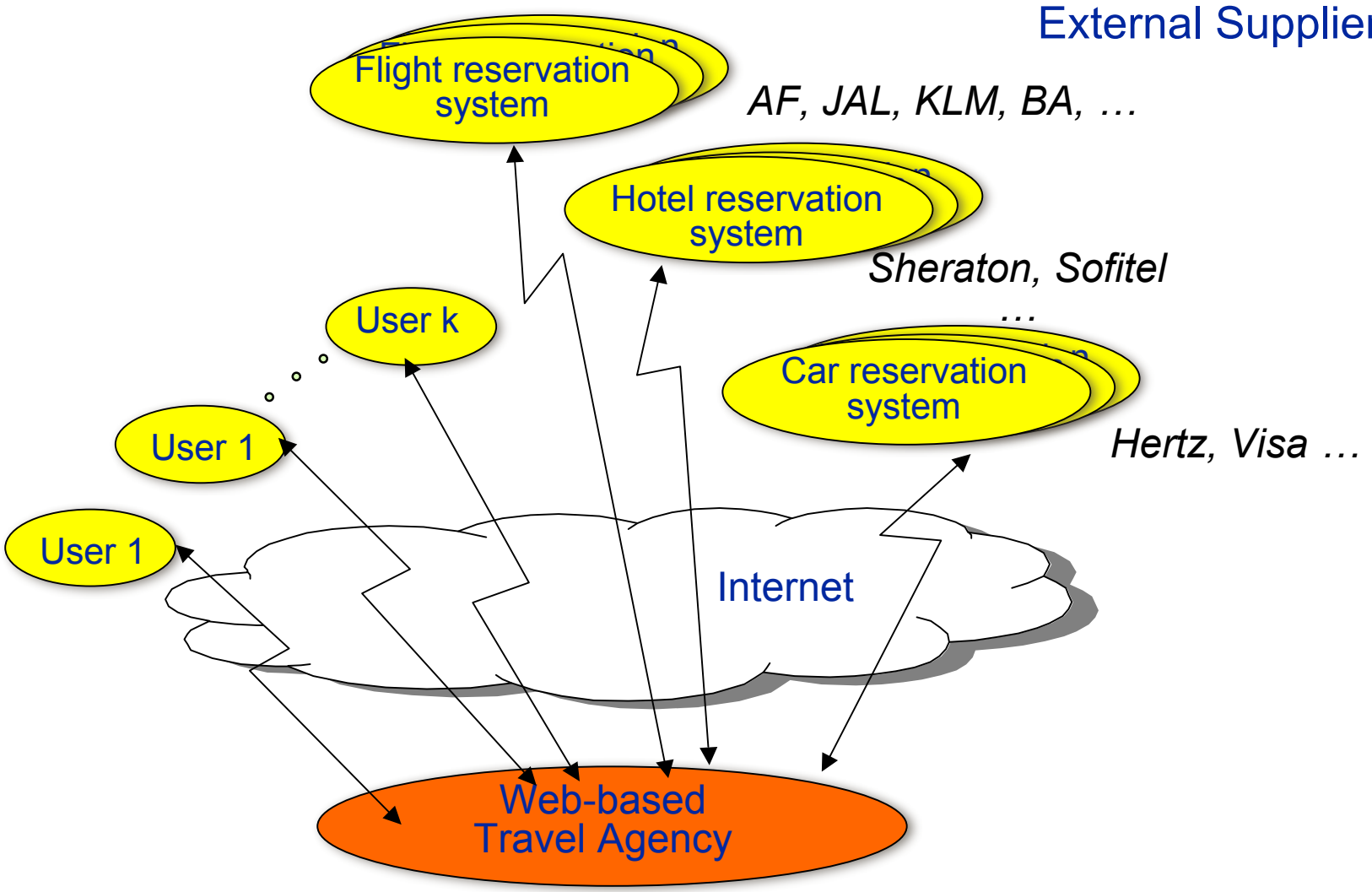
Hierarchical modeling framework



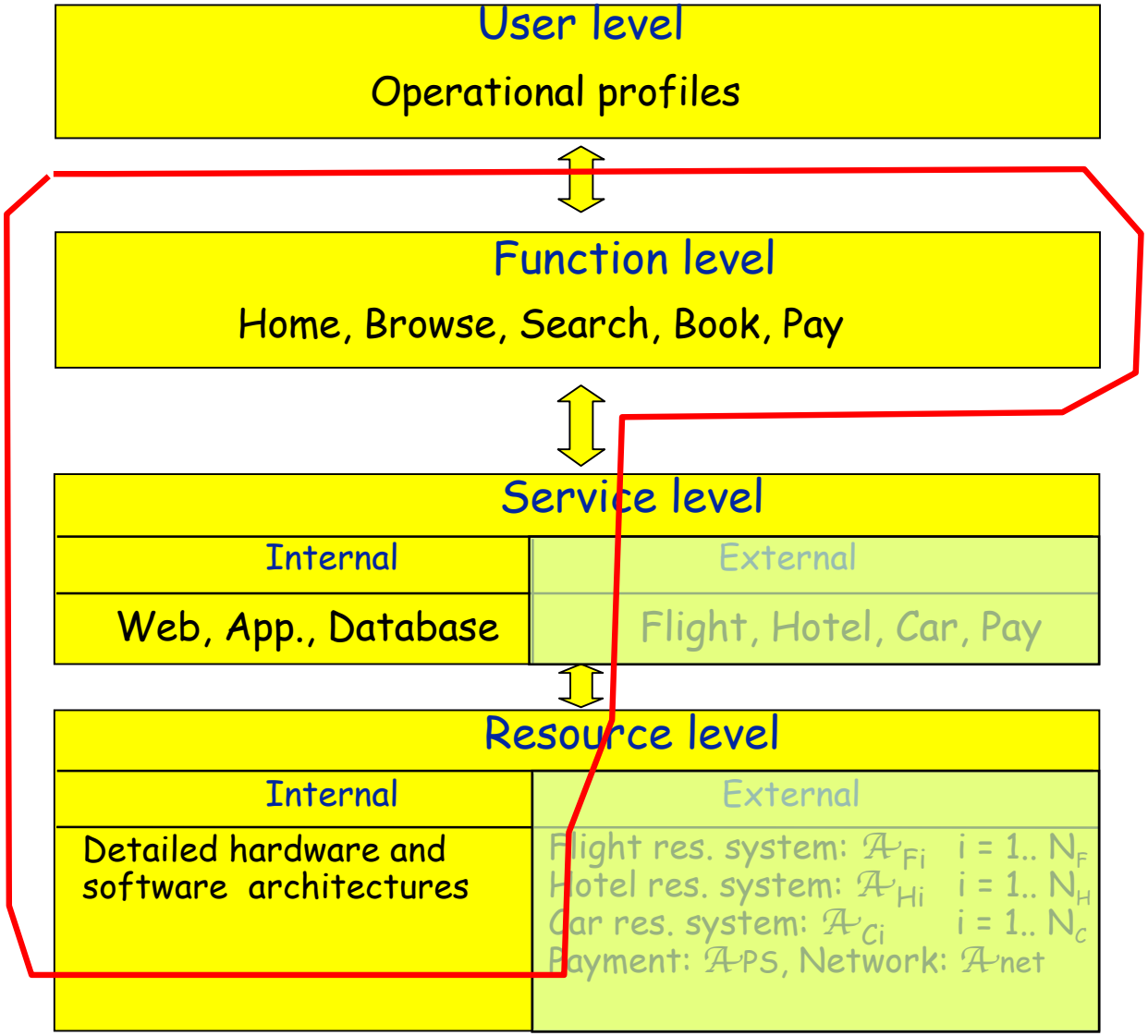
E-business system description

E-business availability modeling

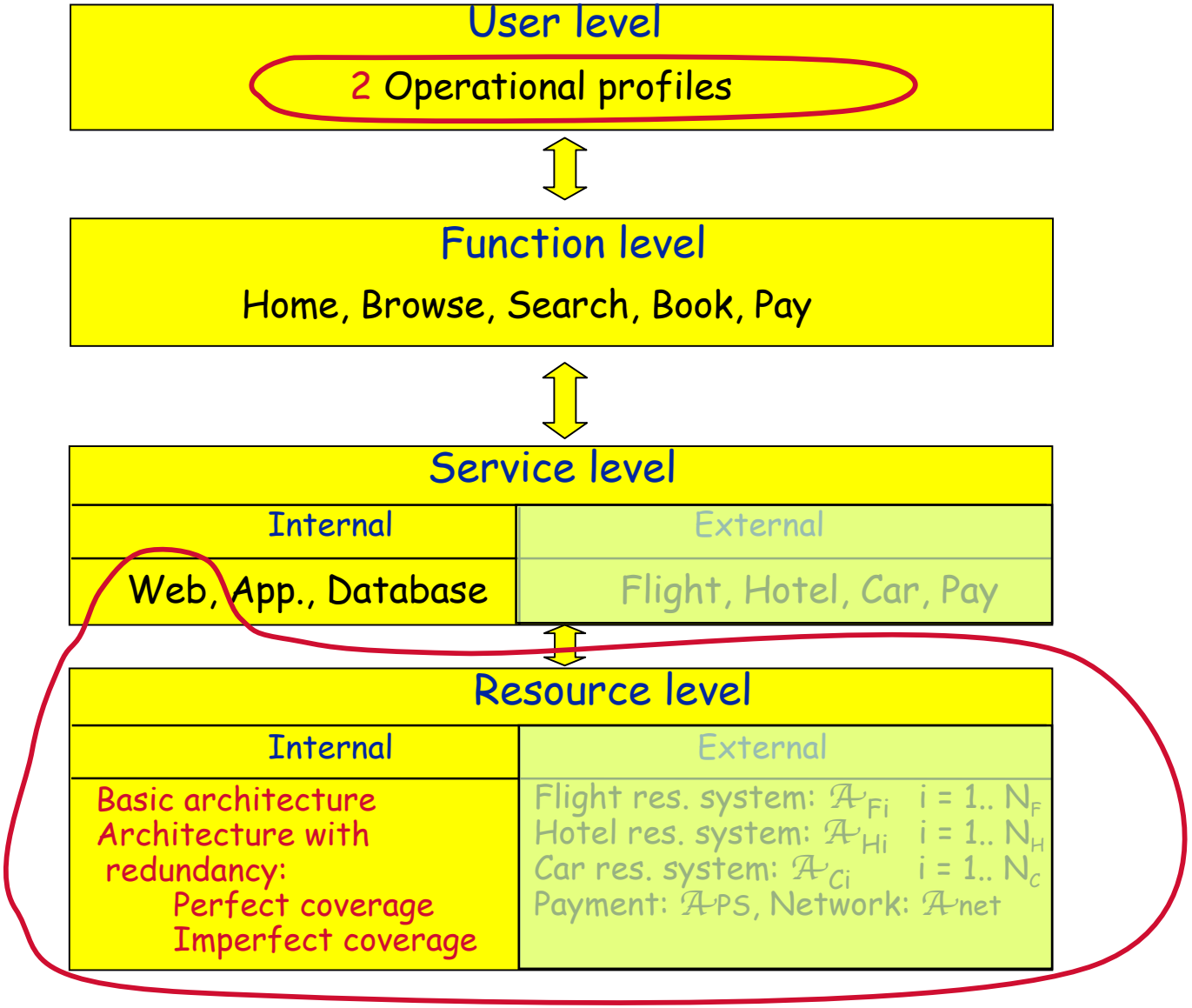
Case Study: Web-based Travel Agency



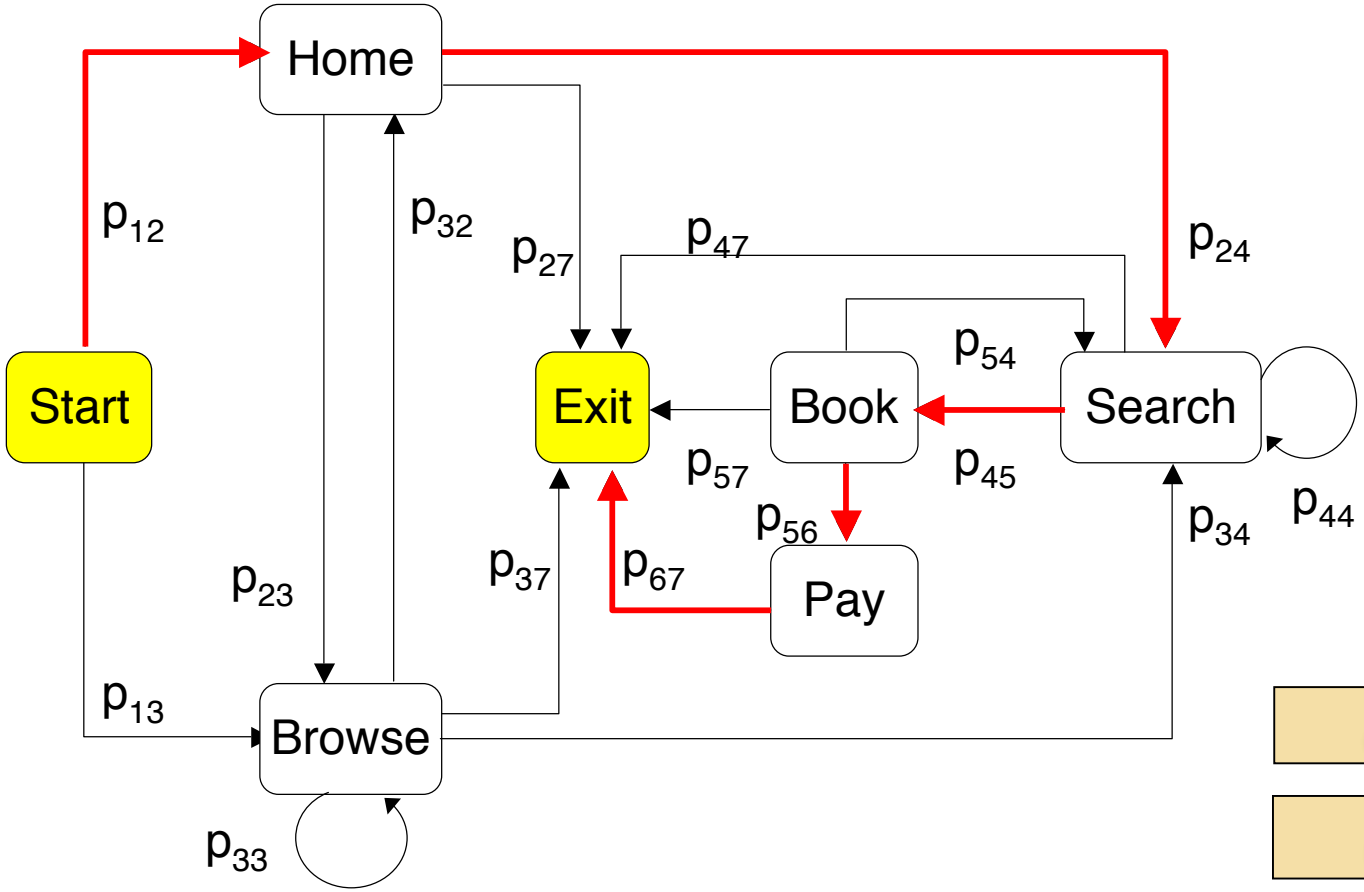
TA availability modeling



TA availability modeling

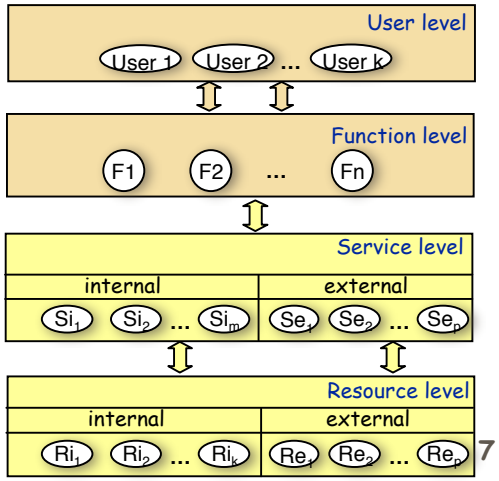


Function and User levels



p_{ij} Probability of invoking Fj after Fi

Functions invoked from "Start" to "Exit" ⇔ User scenario



User execution scenarios

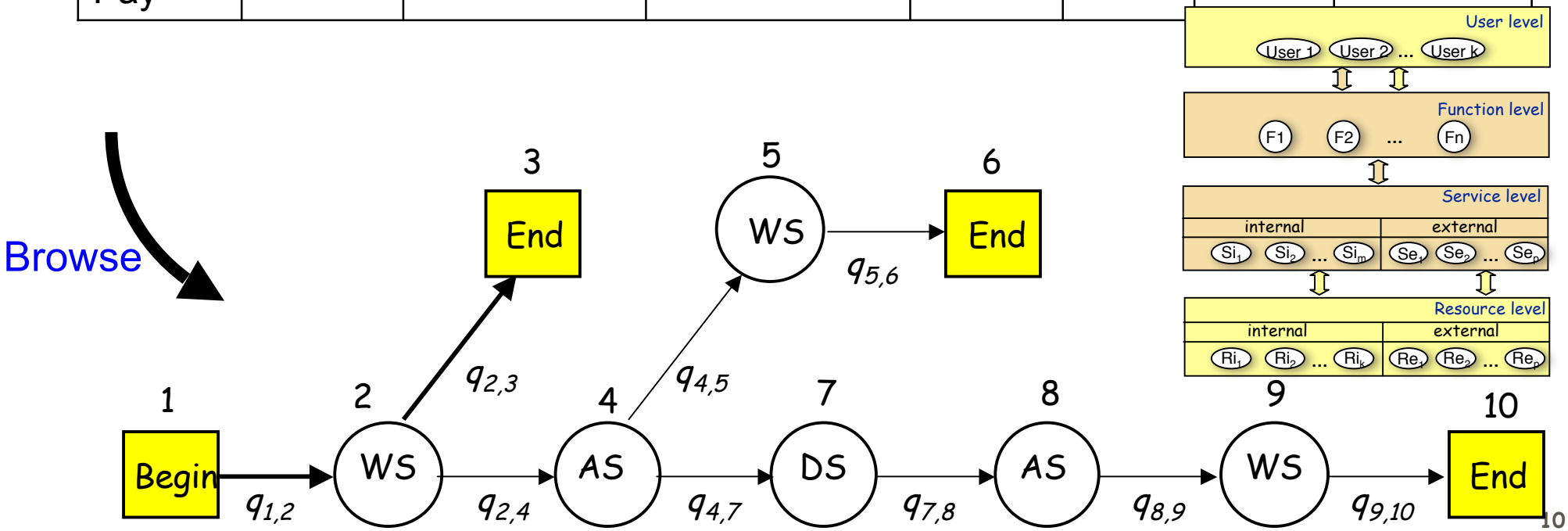
User scenario
1: Start-Home-Exit
2: Start-Browse-Exit
3: Start-{Home; Browse}*-Exit
4: Start-Home-Search-Exit
5: Start-Browse-Search-Exit
6: Start-{Home; Browse}*-Search-Exit
7: Start-Home- {Search-Book}*-Exit
8: Start-Browse- {Search-Book}*-Exit
9: Start-{Home; Browse}*- {Search-Book}*-Exit
10: Start-Home- {Search-Book}*-Pay-Exit
11: Start-Browse- {Search-Book}*- Pay-Exit
12: Start-{Home - Browse}*- {Search-Book}*- Pay-Exit

User execution scenarios

User scenario		Class A (%)	Class B (%)
1: Start-Home-Exit	SC1	10.0	10.0
2: Start-Browse-Exit	SC1	26.7	6.6
3: Start-{Home; Browse}*-Exit	SC1	11.3	4.2
4: Start-Home-Search-Exit	SC2	18.4	13.9
5: Start-Browse-Search-Exit	SC2	12.2	20.4
6: Start-{Home; Browse}*-Search-Exit	SC2	7.6	9.7
7: Start-Home- {Search-Book}*-Exit	SC3	3.0	4.7
8: Start-Browse- {Search-Book}*-Exit	SC3	2.0	6.9
9: Start-{Home; Browse}*- {Search-Book}*-Exit	SC3	1.3	3.3
10: Start-Home- {Search-Book}*-Pay-Exit	SC4	3.6	6.4
11: Start-Browse- {Search-Book}*- Pay-Exit	SC4	2.4	9.4
12: Start-{Home - Browse}*- {Search-Book}*- Pay-Exit	SC4	1.5	4.5
		7.5%	**20.3%**

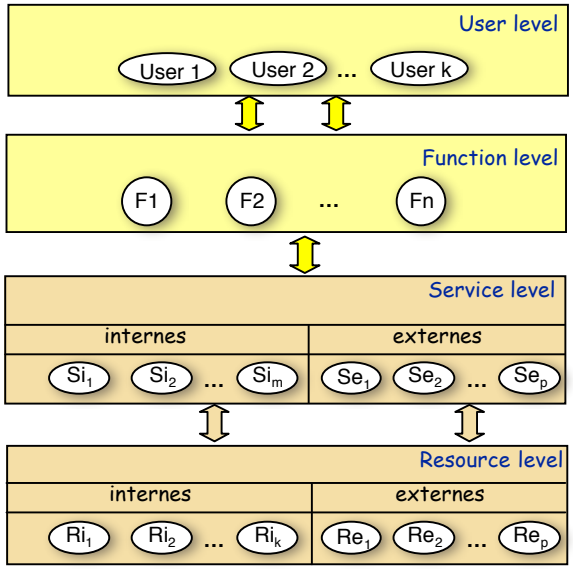
Service and function levels

	Internal services			External services			
	Web	Application	Database	Flight	Hotel	Car	Payment
Home	✓		✓				
Browse	✓	✓	✓				
Search	✓	✓	✓	✓	✓	✓	
Book	✓	✓	✓	✓	✓	✓	
Pay	✓	✓	✓				✓

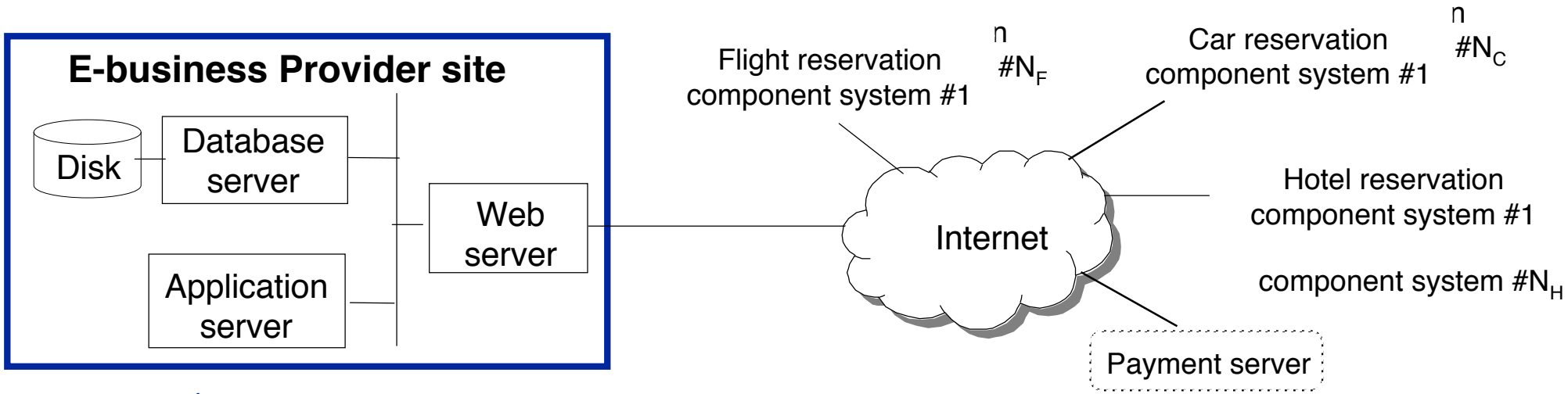


Service and Resource levels

- External service:
  modeled as a black box
- Internal services:
  detailed analysis of e-business provider architecture solutions
  - Organization of services on the hardware support
    - Dedicated hosts for each server / Multiple servers on the same host
  - Fault tolerance strategies
    - Non-redundant servers / Replicated servers
    - Recovery: client-transparent or not
  - Maintenance policies
    - Dedicated / Shared repair resources
    - Immediate / Delayed maintenance
  - Fault assumptions
    - permanent, transient

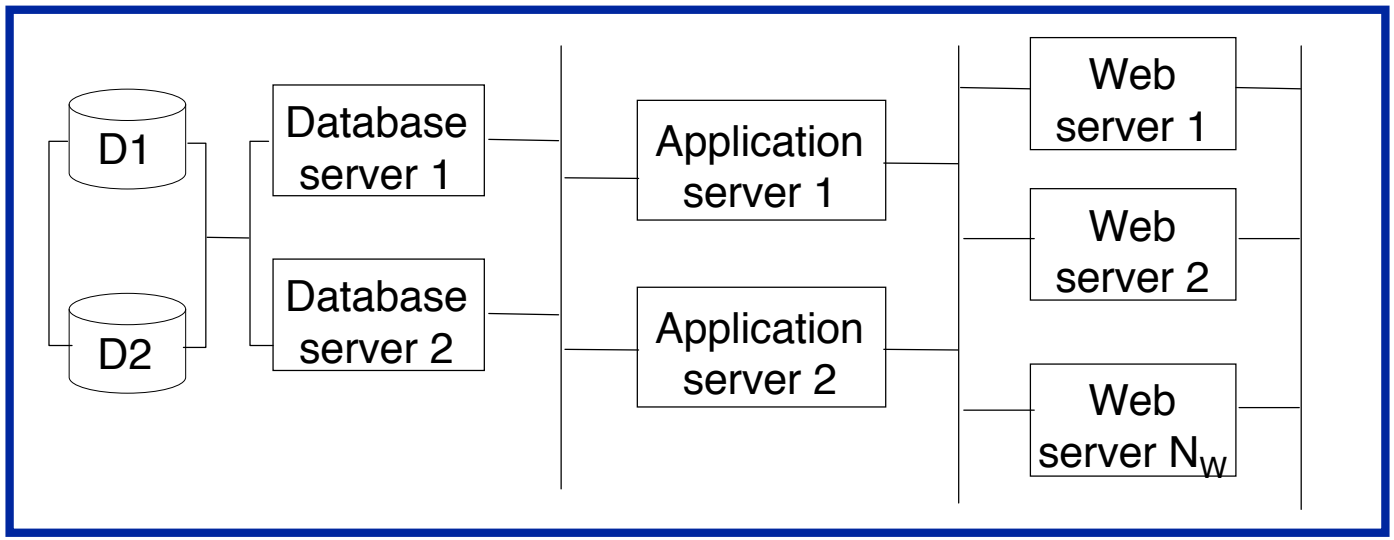


Resource level: TA example

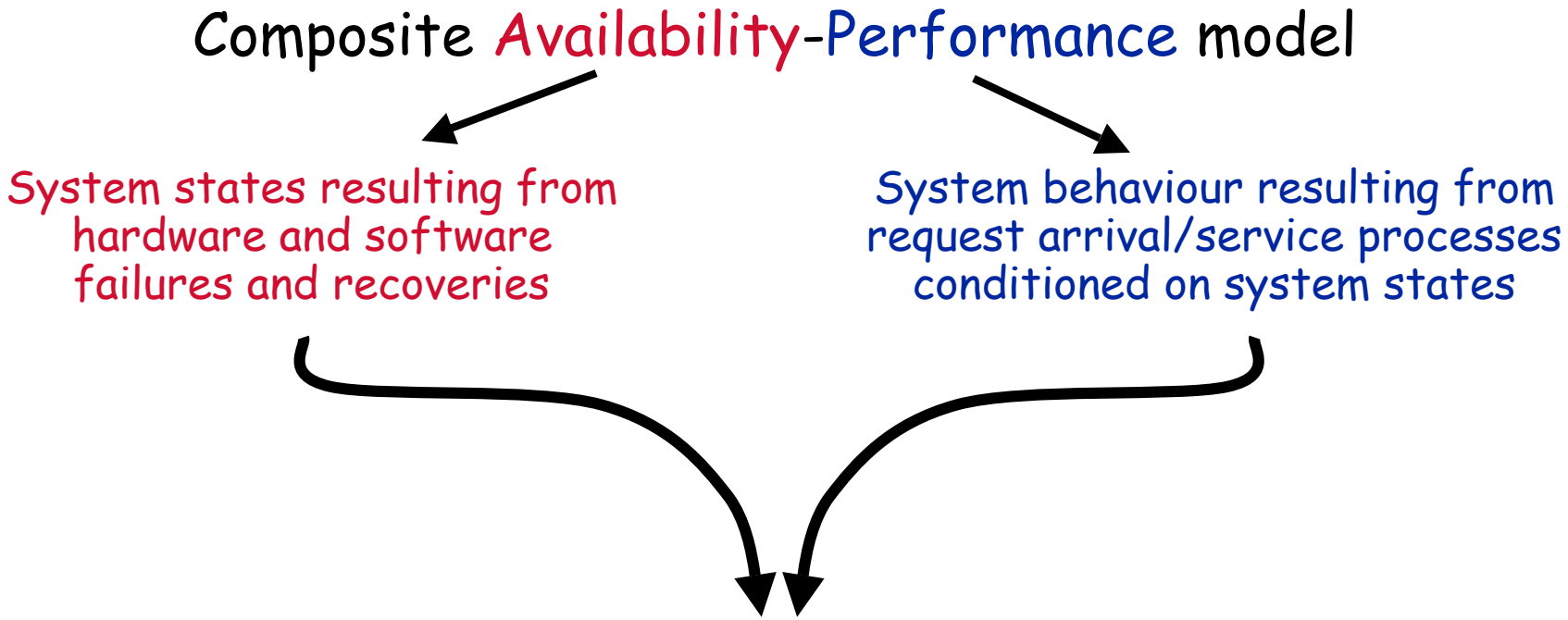


Basic architecture

Architecture with redundancy



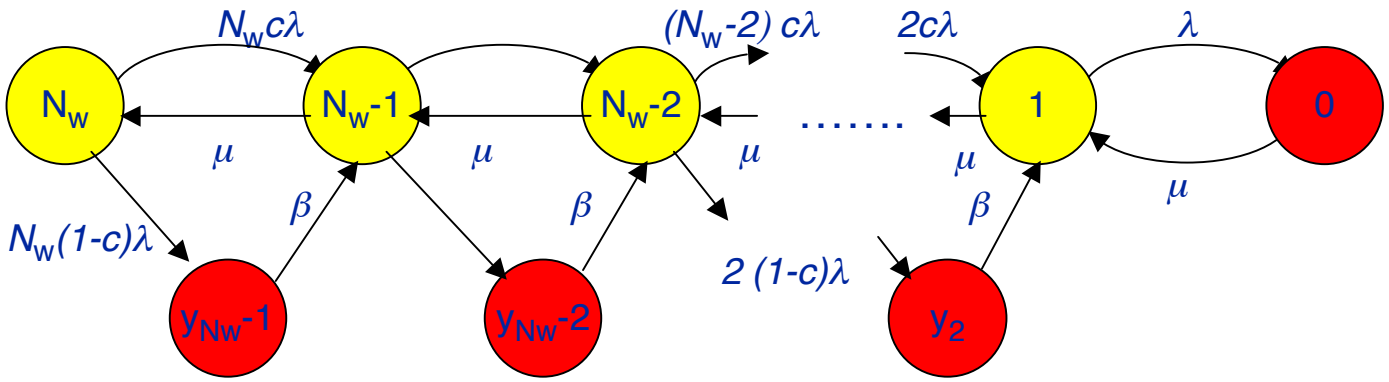
Web service: Modeling approach



A(WS) = A(Web service) = 1 - Prob. {WS in a down state or overloaded}

Web service: Modeling example

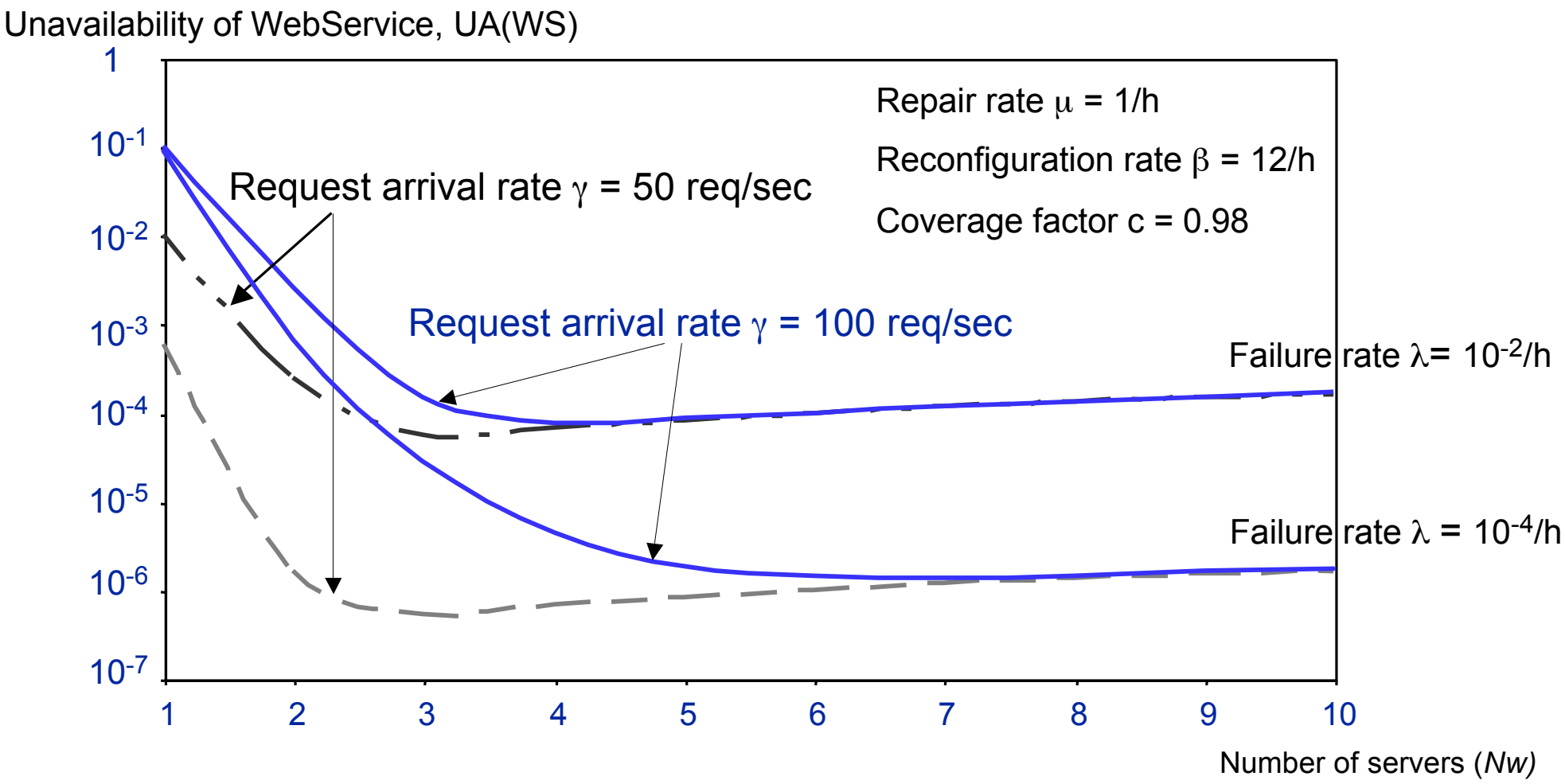
- Redundant architecture: imperfect coverage
  - Availability model



  - Performance model: M/M/i/K
    - p_K(i): probability a request rejected in state i due to WS buffer full

$$A(Web\ service) = 1 - \left[\sum_{i=1}^{N_w} \Pi_i\, p_K(i) + \sum_{i=1}^{N_w-2} \Pi_{y_i} + \Pi_o\right]$$

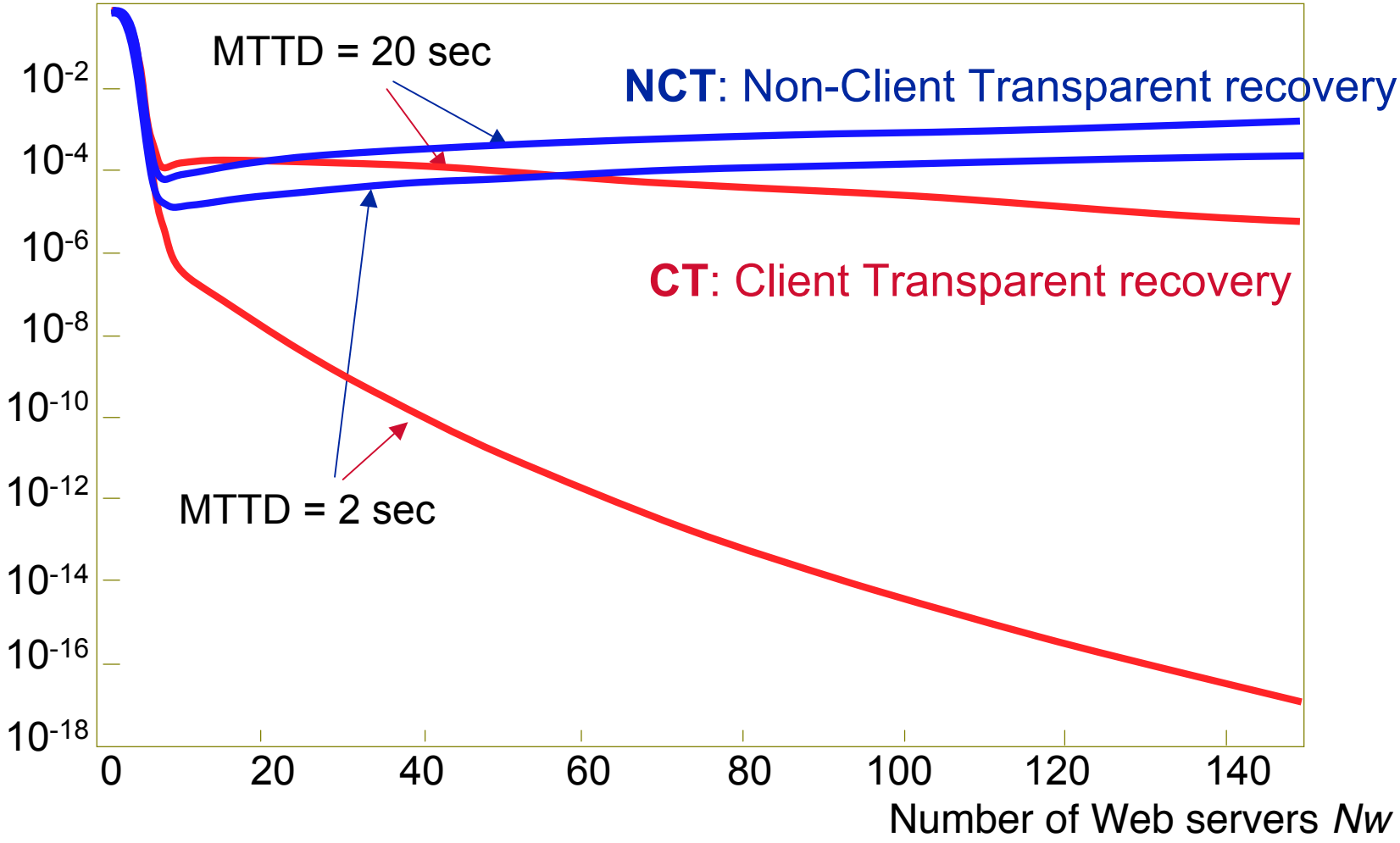
Evaluation results — Service level



Architecture with redundancy

Impact of Mean Time To Detection (MTTD)

Unavailability of WebService, UA(WS)



Impact of User Profile

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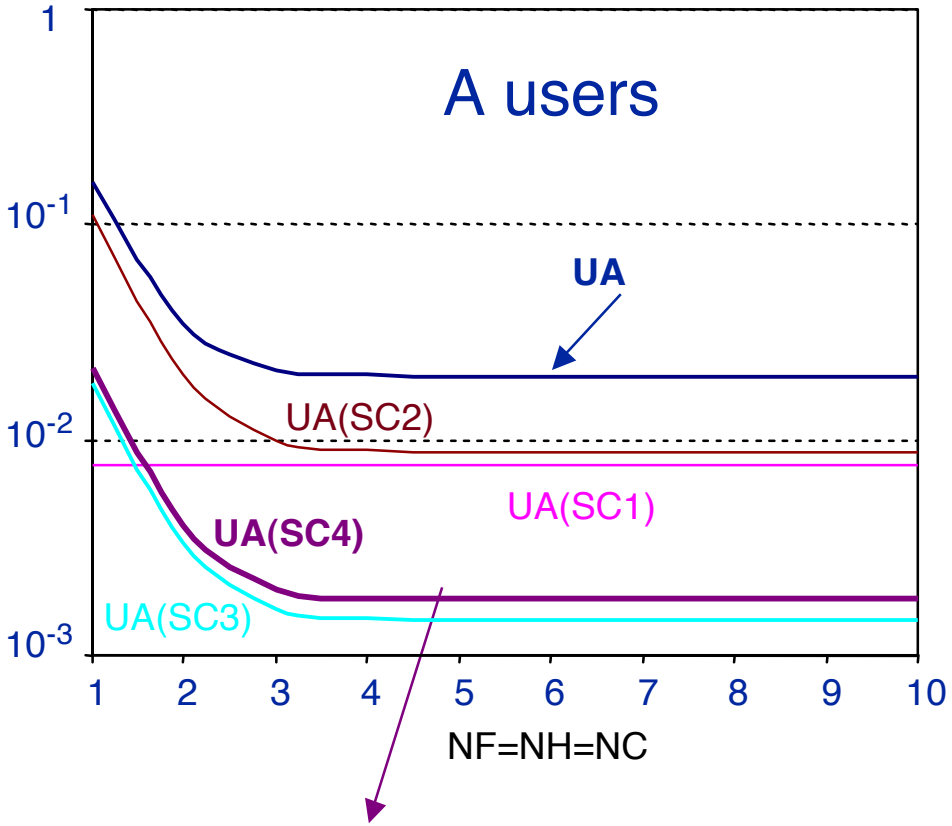
		7.5%	**20.3%**

Impact of User Profile

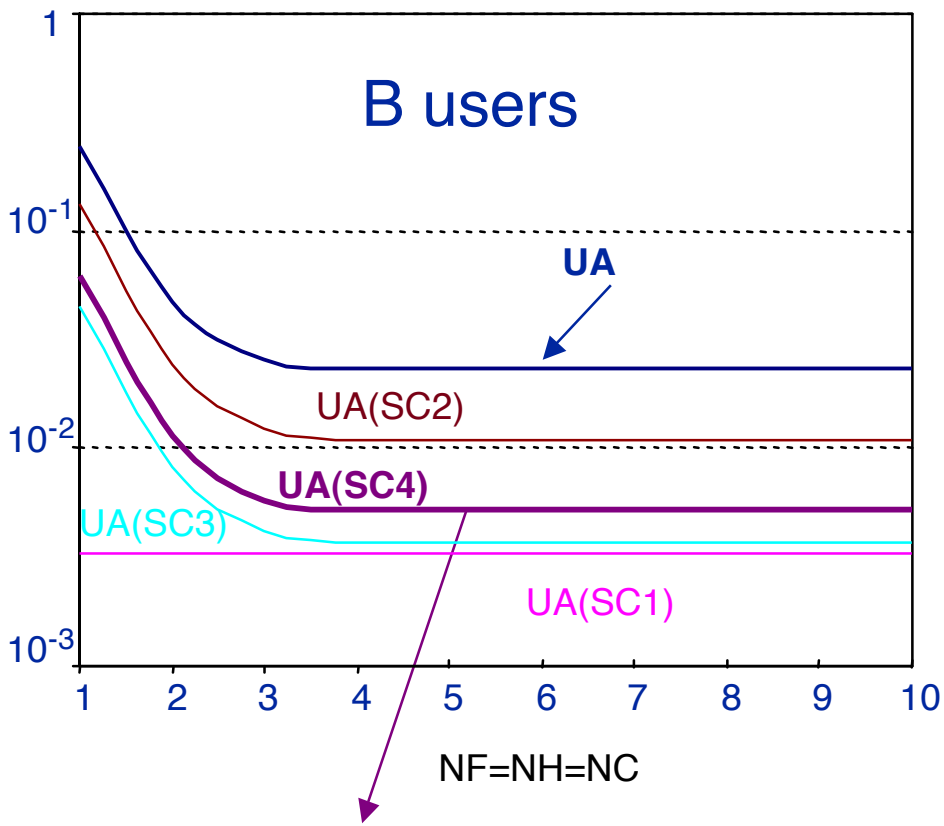
$N_F = N_H = N_C$	$\mathcal{A}$ (A users)	$\mathcal{A}$ (B users)
1	0.842355482	0.768755879
2	0.965090024	0.955291581
3	0.978672771	0.975935054
4	0.980044591	0.978019988
5	0.980181909	0.978228688
10	0.980197168	0.978251879

☞ User perceived unavailability 173 hours/year 190 hours/year

Impact of User Profile



16 hours downtime per year



43 hours downtime per year

570 Million€ Loss of revenue 1.55 Billion€

Transaction rate: 100 Trans./ sec
Revenue per transaction: 100€

Conclusion

- Contribution
  - Hierarchical modeling framework
    - Failures
    - Performance degradation
  - User perceived availability
    - Operational profile
  - Example: travel agency
    - Illustration of the main concepts of the proposed framework
    - Examples of dependability analysis results to support design solutions
  - Other example
    - Cloud computing?