Do we really understand the costs of failing to ensure transaction integrity?

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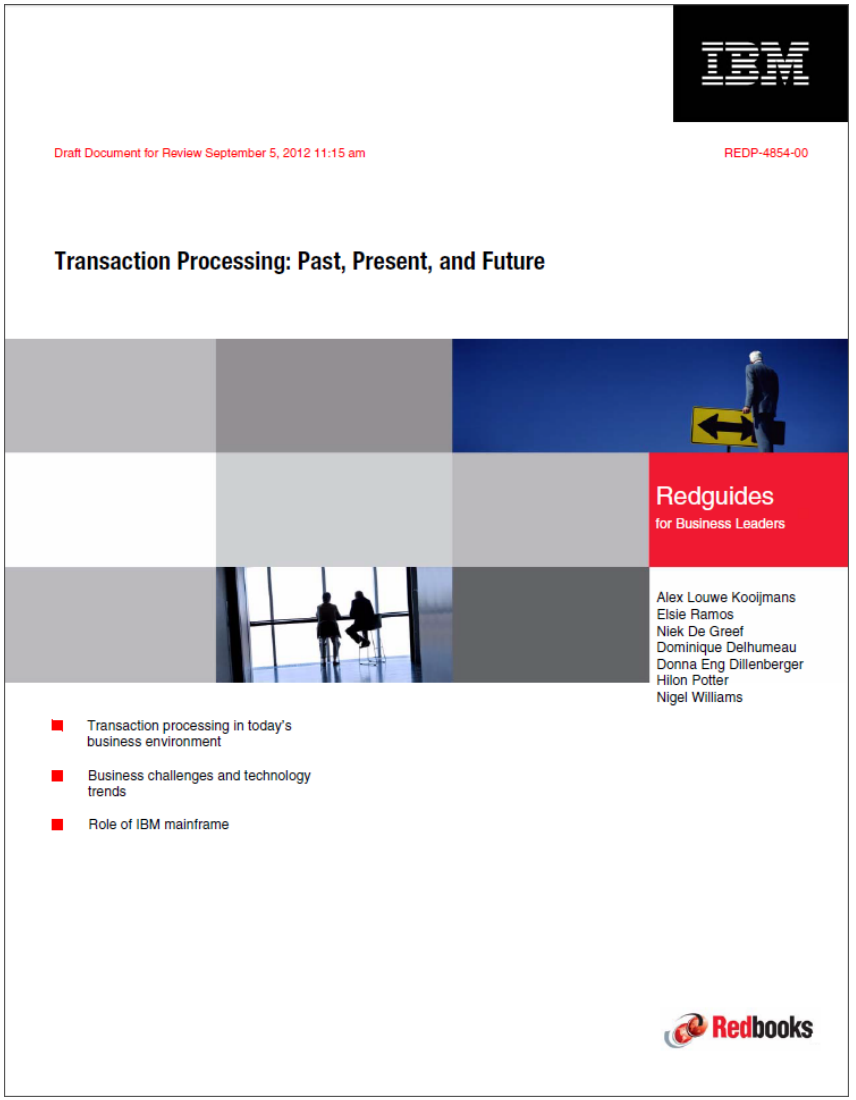
IBM Redbooks Project – The Role of System z in Transaction Processing and Integrity

- Develop an IBM Redguide on the topic of transaction processing with a focus on the role of System z in maintaining transactional integrity
- The Redguide will provide an insight into how this role is evolving, assess what organizations are doing to accommodate the explosive growth in transactions, and summarize the capabilities of the major IBM transaction processing products and solutions
- A key part of this project is to speak with leading organizations who want to share their transaction processing experience and successes



Some sample Survey Questions

- Are you witnessing a structural increase in transaction throughput?
- Service-orientation and business process management are now standard ways of developing new applications. Has the implementation of SOA and BPM solutions changed the way that you architect and manage your TP workloads?
- In recent years we have witnessed the emergence of new channels (the mobile channel for example). Are you implementing new channels, and are these new channels having an impact on how you architect and manage your TP workloads?
- In your opinion, which of the specific System z TP capabilities distinguish it most from other platforms (for example, security, scalability, workload management, systems monitoring, data integrity …)?
  - Do the aforementioned capabilities offer a competitive advantage?
  - What do you think the impact to the business would be if you could NOT use your current TP solution anymore (compliance issues, availability issues, etc.)?
- What is the scope of a typical business process in your environment and how does this relate to the transaction scope? How does the transaction scope relate to maintaining integrity?
- How do you see the role of middleware in supporting and guaranteeing transactional integrity? Would you see any role for the application itself in this space?
- Are there any other business or technical trends that you foresee will be impacting your TP workloads. In what way (volumes of transactions, complexity, performance, throughput, architecture, scope)?

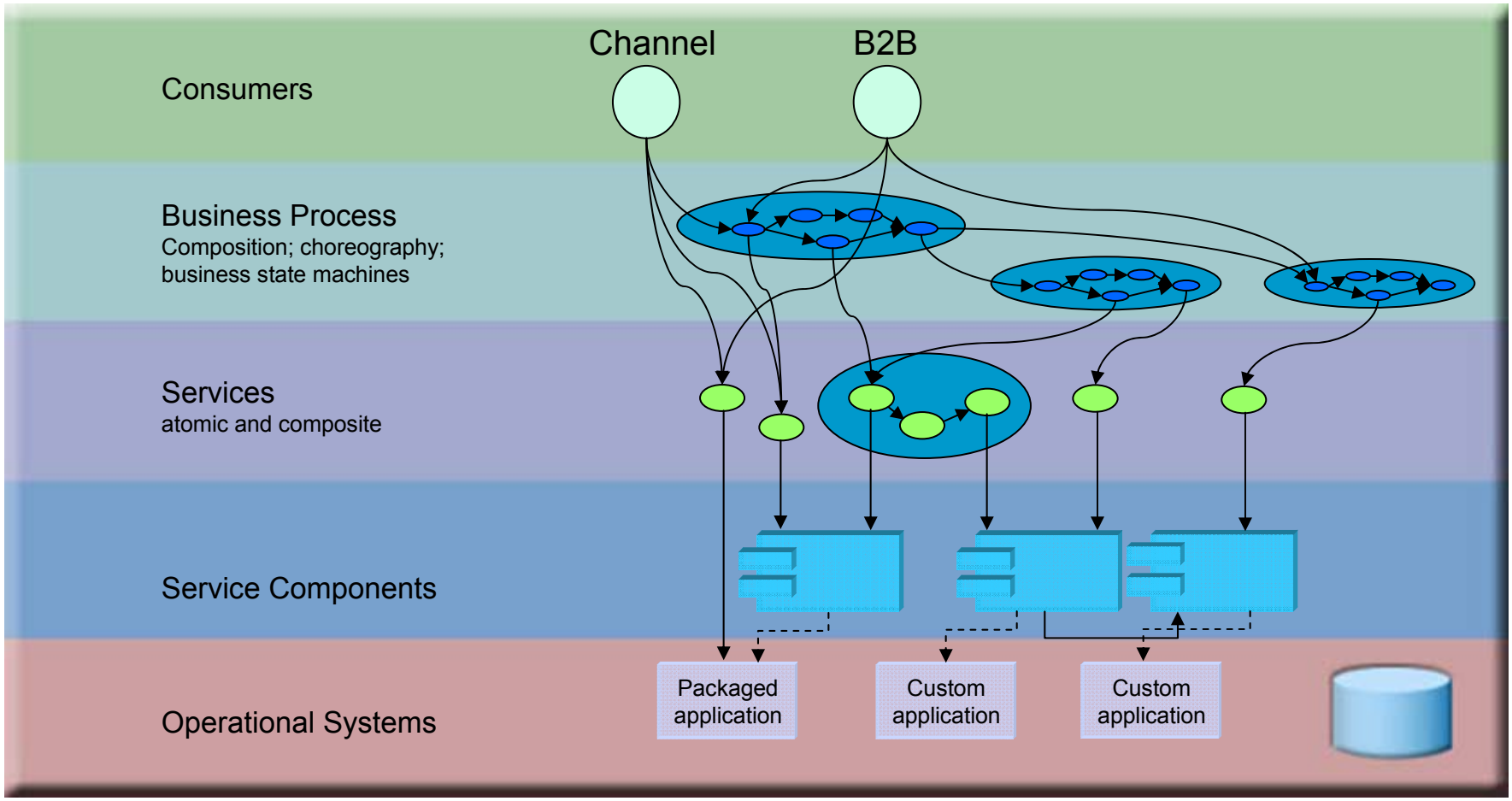
Transaction Processing – What do we mean?

- A transaction defined
  - A business transaction, for example buy a book.
  - An IT transaction – an individual indivisable activity that fails or succeeds.
- In short, a transaction provides the reliability that an exchange between two parties took place; either
  - At a high level – e.g. put the book on the counter, pay money, receive a book and receipt as a single transaction, or
  - At a low level – e.g. approval transfer of money through a credit card operation
- Where the emphasis lies, is defined by the value of the transaction, the required level of reliability, speed, etc.

Definitions and Terms

Transaction	A set of actions within an application that is seen as a unit of execution, for example, an order, trade, purchase, money transfer or reservation. Normally it is short-lived and, though not necessarily, a transaction corresponds to a unit of work.
Transaction processing	A type of workload that is characterized by high throughput and concurrent updates to shared data.
TP system	A computer system that hosts transactions.
Business transaction	A set of transactions representing a business function, for example, create account.
Business Process	A set of related business activities that lead to a particular business goal, for example, open account. It can be short or long lived, can involve human interaction and often consists of multiple business transactions.
Business Process Management	The activity of creating, managing, adapting, and monitoring business processes.
Transactional middleware	Products that provide features necessary for building TP applications, including TP systems, databases, application servers, connectors and BPM software.
Transactional Integrity	The assurance that the results of an operation are consistent with expectations. For a single transaction, integrity is assured by the ACID properties (see below). For a business process involving multiple business transactions, process integrity can be achieved using compensating transactions, but there may be a period of time during which consistency does not exist.
Atomicity	All changes to data are performed as if they are a single operation. That is, all the changes are performed, or none of them are.
Consistency	Data is in a consistent state when a transaction starts and when it ends.
Isolation	The intermediate state of a transaction is invisible to other transactions. As a result, transactions that run concurrently appear to be serialized.
Durability	After a transaction successfully completes, changes to data persist and are not undone, even in the event of a system failure.
Two-phase commit	An algorithm that coordinates all the processes that participate in a distributed atomic transaction on whether to commit or abort (rollback) the transaction.
Eventual consistency	A guarantee that a transaction will be correctly recorded and that the data will eventually be made consistent—even if there is a significant period of time during which the data is not consistent.

Architectural Context – Where is the Transaction?



What is so specific about a Transaction?

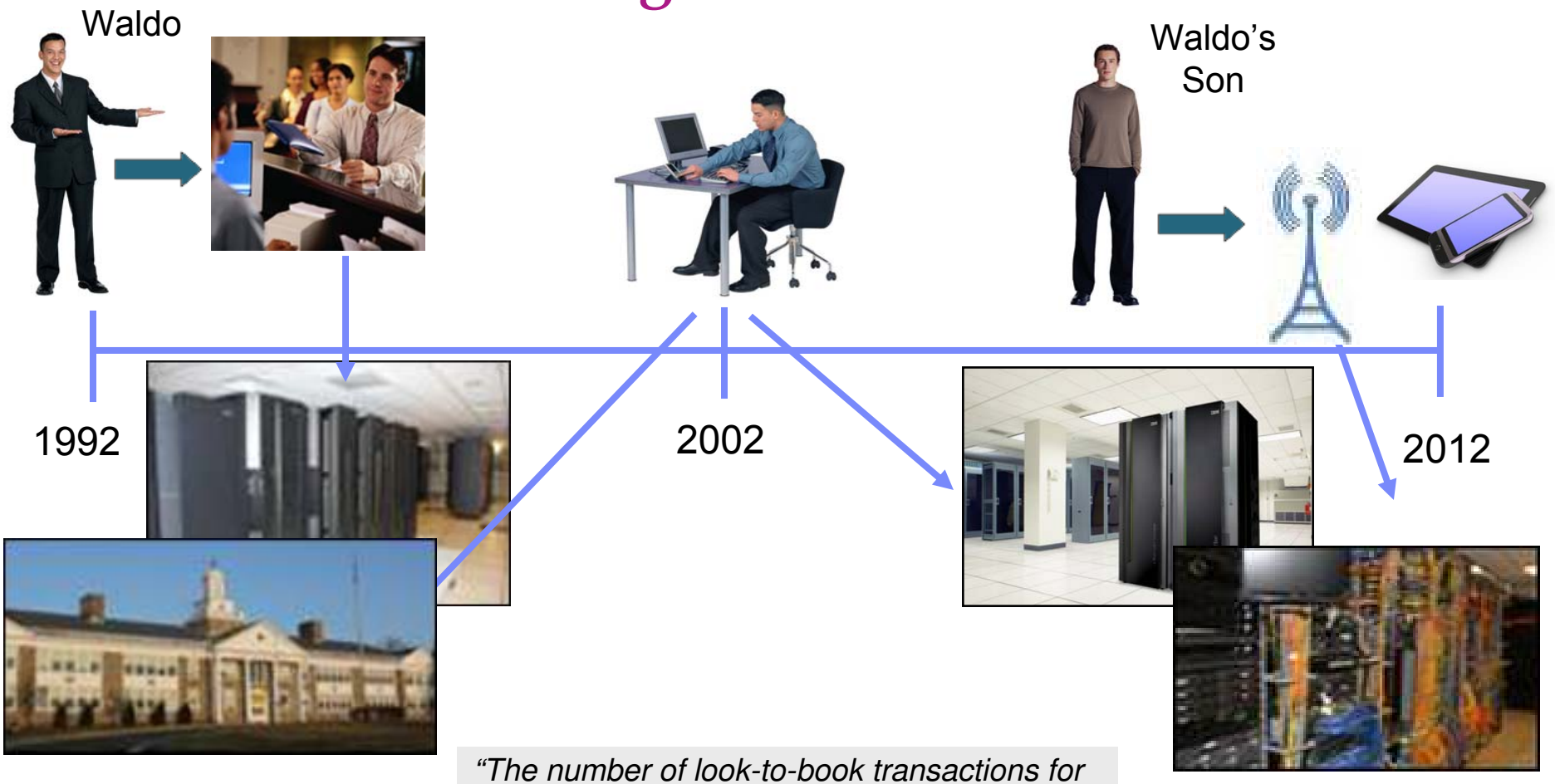
- A financial element exists
- A real-time element exists
- Transactions run in parallel and often need access to the same data
- When a transaction runs, it must run in its entirety and data must be consistent at all times
- Transactions must be secure

And how about Batch?

- *OLTP* supports interactive applications where work is divided into individual operations
- In *Batch processing* one or more programs process a series of records (a batch) with little or no action from the user or operator
- In the past, OLTP had clear "open“ and “closed” times.
- The expectation for anytime-access to business functions implies fewer and shorter windows for maintenance, TP middleware must provide for continuous runtime environment
- Furthermore 24 hour access to online transactions also implies batch processes must run in parallel with online transactions
- Near real time batch processing is therefore more and more undistinguishable from OLTP

“The currently defined maintenance window is actually not acceptable anymore. We have projects in place to reduce and eventually eliminate planned outages.” (ABN AMRO Bank)

Transaction Processing Evolution



Brick & Mortar Based

"The number of look-to-book transactions for our hotel chain has changed from 8 – 10 searches for one booking, to potentially thousands of searches for one booking."
(Misha Kravchenko, Marriott International)

Multi-channel consumer driven

Transaction Volumes are increasing

- Without exception, our customers are experiencing a rapid increase in the rate of transactions, caused primarily by web and mobile device initiated activities.
- For example, reservation systems that previously supported only travel professionals are now directly accessible by anyone on the Internet. As a result, the number of users has increased from tens of thousands to hundreds of millions.

> *"We run several thousand transactions per second now that our systems are opened up to the Internet and mobile devices." (**Misha Kravchenko, Vice President Information Resources, Marriott International**)*

- In the finance sector, where credit card companies now need to instantly authorize billions in purchases from merchants around the world, and banks must provide their customers access to banking and investment accounts from anywhere at any time of the day, in real time.

> *"We now have a peak workload of 20 thousand transactions per second." **(Marcel Däppen, CTO for zEnterpise Systems, UBS WM&SB)***

The Value of a Transaction

- Different questions to be asked?
  - What is the impact if a transaction does not happen at all?
  - What is the impact if a transaction completes in error?
  - What is the impact if a transaction completes with incorrect data?
- Can the impact be easily corrected, for example:
  - Sending a voucher if the wrong book got sent
  - Giving the client a free upgrade if the preferred seat did not get booked
  - Re-deposit the check that did not get deposited
  - Re-wire the $100 Billion deposit from the central bank..?
  - Undo the drop in stock price because of an error in a health check of a major bank?

The value of a transaction in this context is not the value of the money paid in the transaction, but the losses that occur if the transaction is not completed or completes with the wrong results.

Transactional Integrity – Recovery Options

- Manual business user action to roll back updates
  - Business process not automated
  - Still most used at business transaction level, due to complexity of automation
- Compensational transaction automates roll back of updates
  - Used in automated processes that span multiple business activities
  - Can become very, very complicated
  - Some actions for the compensating transaction can be generated, but contextual limitations
- Full automated recovery of an LUW
  - Traditionally used in transaction processing systems
  - Proven technology for decades

The Importance of getting it right

"We estimate the cost of our reservation system being unavailable at three thousand dollars per second." ***(Misha Kravchenko, Marriott International)***

"To provide unique value to the business UBS processes SWIFT messages within strict time limits." ***(Marcel Däppen, UBS WM&SB)***

A large financial organisation indicates outages to payment systems at critical times of the day (for example, the CHAPS1 cut-off time) could cause direct financial loss because of fines and compensation claims, but equally important are the intangibles in the loss of reputation and affected customers taking their business elsewhere.

The Importance of getting it right

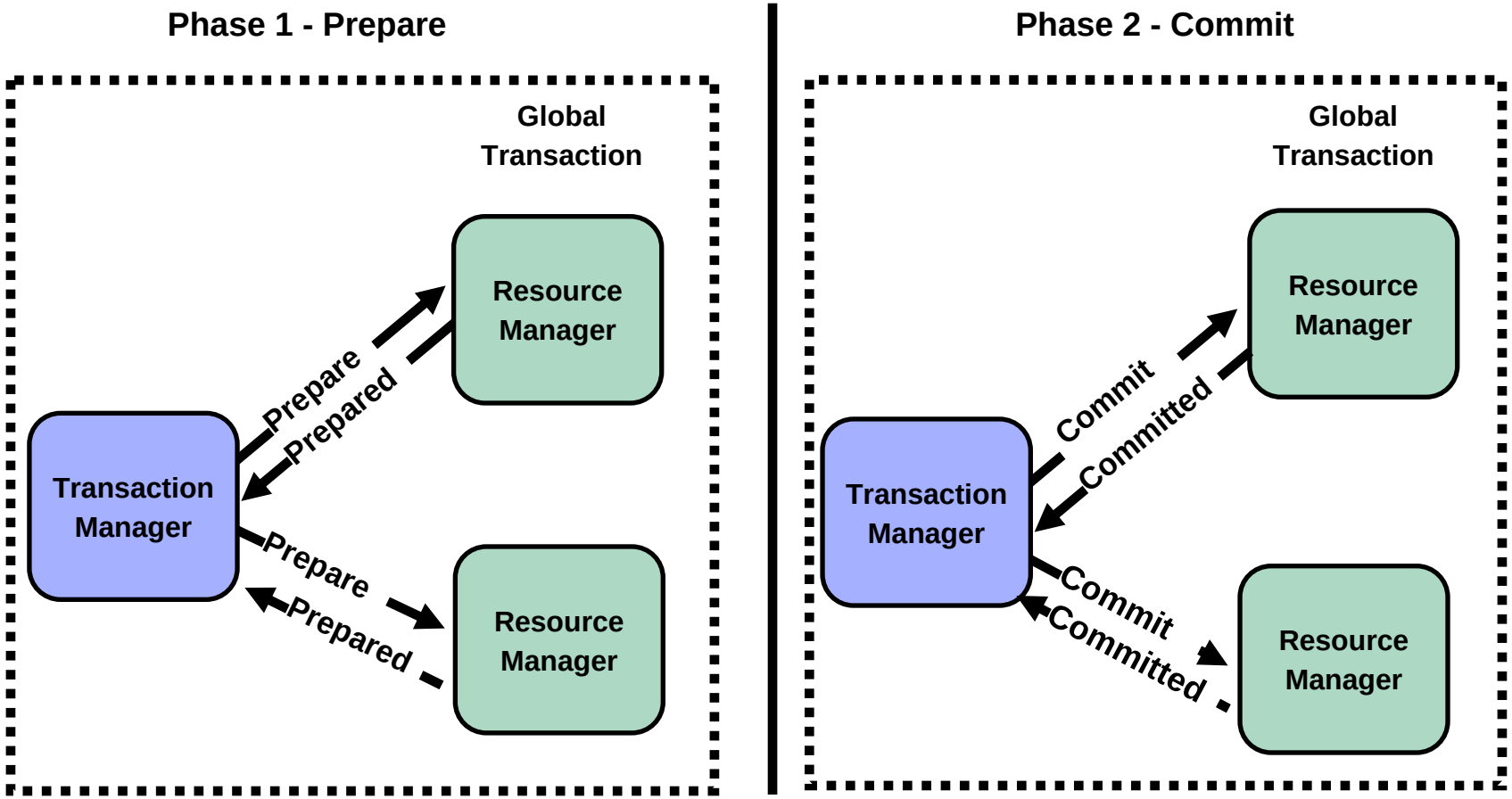
- Transaction integrity
  - The assurance that the results you expect are being achieved
  - If for some reason a transaction does not complete successfully, the end user should be informed and the databases should be left in a consistent state
- Integrity today is provided by the services in the middleware and other IT infrastructure
  - Local / global transactions need local / distributed commit coordination
- ACID (atomicity, consistency, isolation, durability) properties

Many of our interviewed clients told us that they rely on middleware to such an extent that they have effectively abdicted responsibility for transaction integrity. The developer can now choose the transaction pattern that he wants to implement based on the transaction integrity requirements.

"If you're updating an account in a database, it doesn't matter whether you're in IT and responsible for the applications being run or if you're in a line of business and are responsible for those business transactions. What you want to know is that the update did in fact occur, and that it has been recorded correctly." ***(Rob High, IBM Fellow, Vice President and CTO for Watson, IBM Software Group)***

Transaction Integrity (1)

- Distributed commit processing – two phase commit



Transaction Integrity (2)

- Asynchronous transactions
  - In a *synchronous* model, the expectation is that the service requester and the service provider are both available at the same time.
  - An *asynchronous* model removes this requirement by adding an intermediary queue of work.

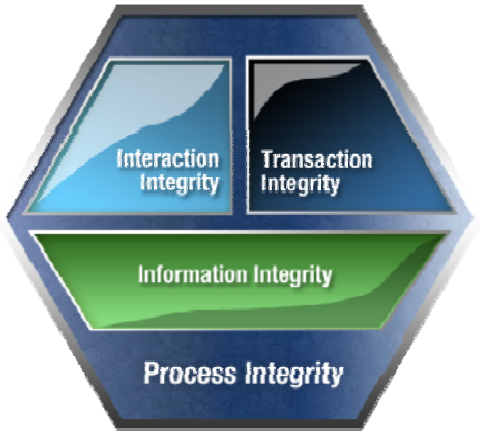
> *"We try to keep the unit of work always as short as possible and we trigger non-critical business tasks in an asynchronous way."* ***(Marcel Däppen, UBS WM&SB)***

- Compensating transactions
  - Business processes now span an increasing number of systems, and maintaining robust integration and consistency becomes ever more challenging.
  - As a result, the concept of *eventual consistency,* based on *compensating transactions*, is emerging
  - A *compensating transaction* is a group of operations that undoes the effects of a previously committed transaction.

IBM Redbooks

But integrity covers more than the transaction itself...

- *Process integrity* depends on transaction integrity but it is also dependent on interaction and information integrity.
- *Interaction integrity* is the ability to ensure that elements of people's interactions with information systems are intact
  - This is somewhat similar to the notion of transaction integrity, but focused on the user interactions within an activity
- *Information integrity* provides consistency of information consumed or produced by business processes.



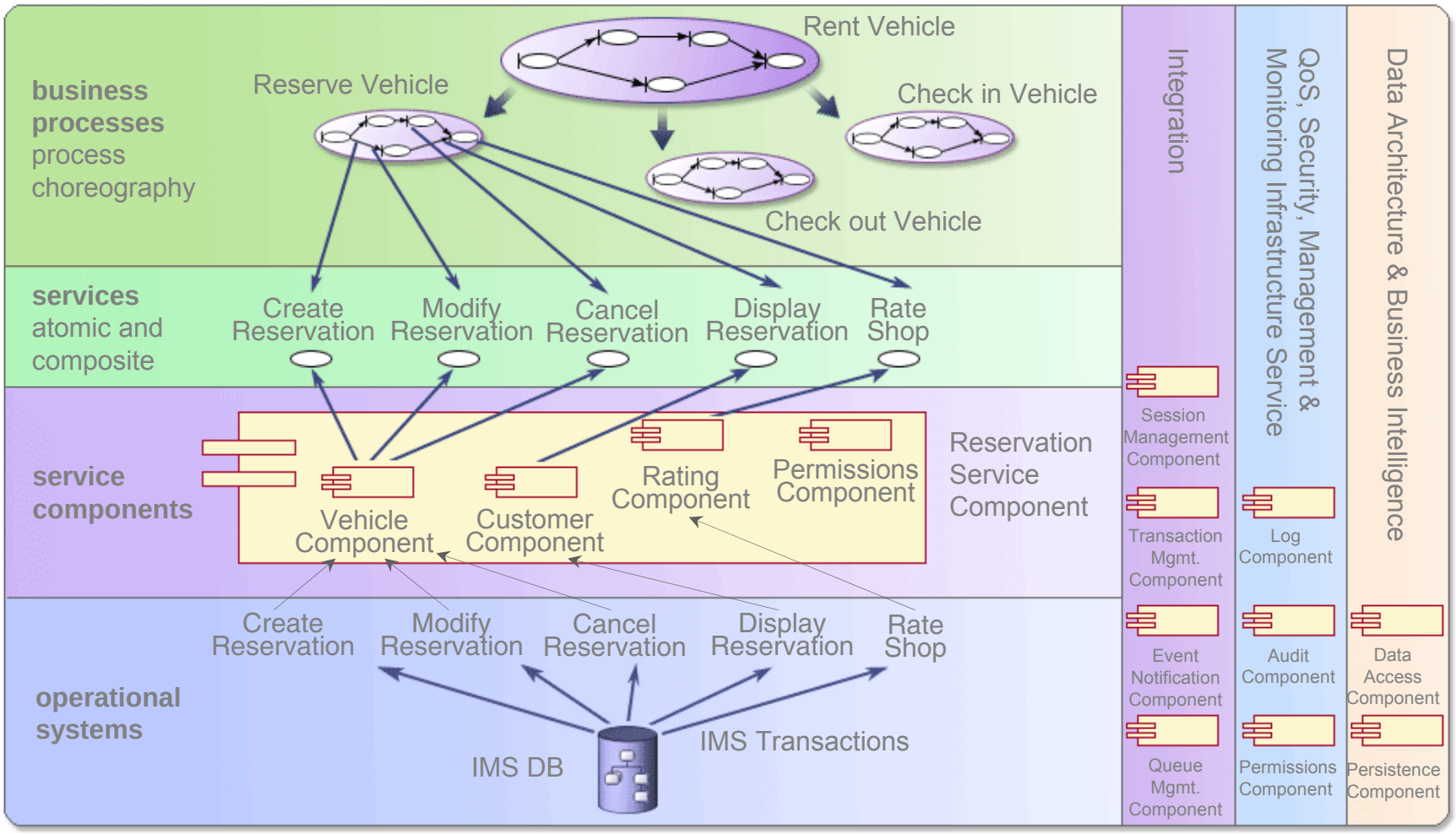
Process integrity takes SOA to the next level

Supporting integrity of transactions, interactions and information

Process Integrity is the ability to conduct reliable business activity in a secure, scalable SOA environment with seamless synchronization between:

Services ■ Human Tasks ■ Information ■ Domains ■ Users

Transactions in an SOA Landscape - Example

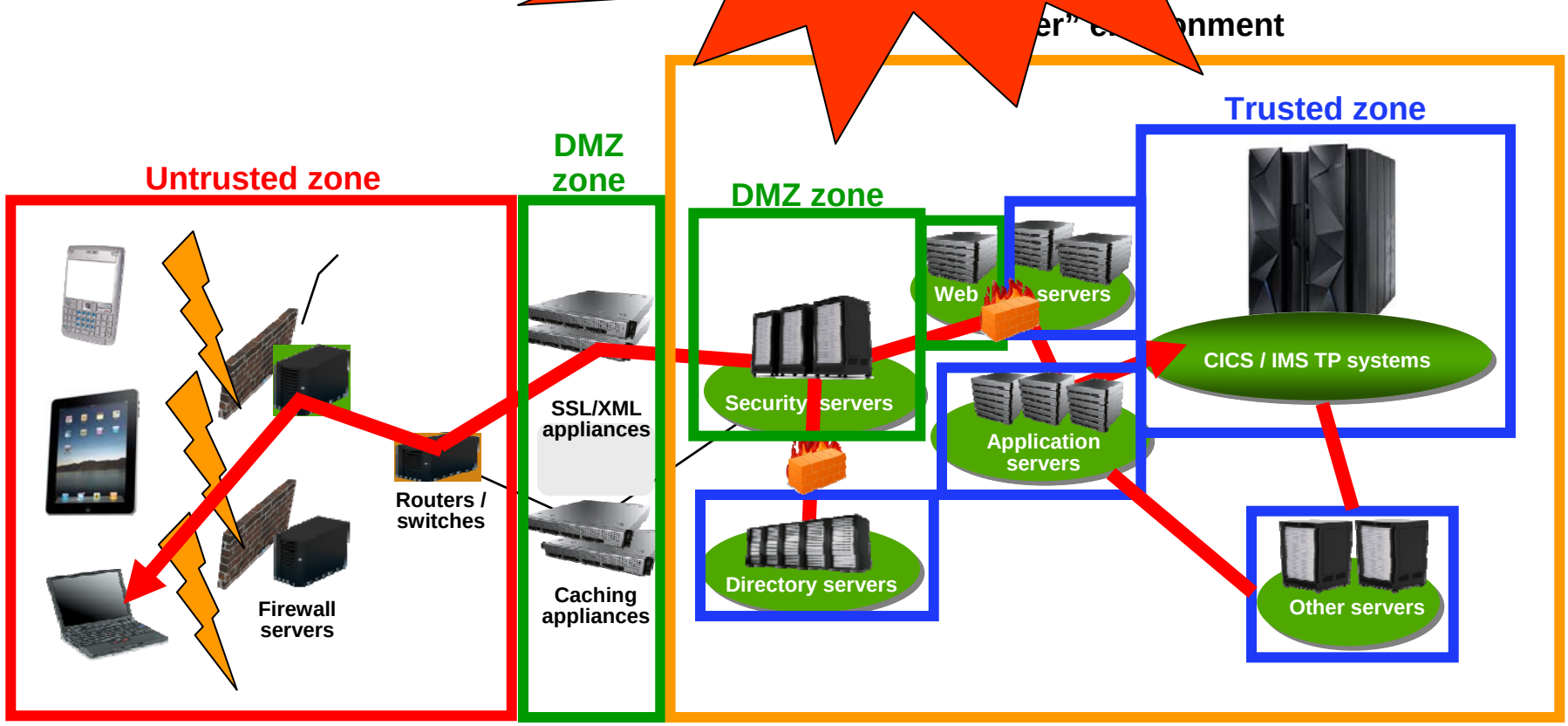


EXAMPLE

For illustration only

Transaction Integrity

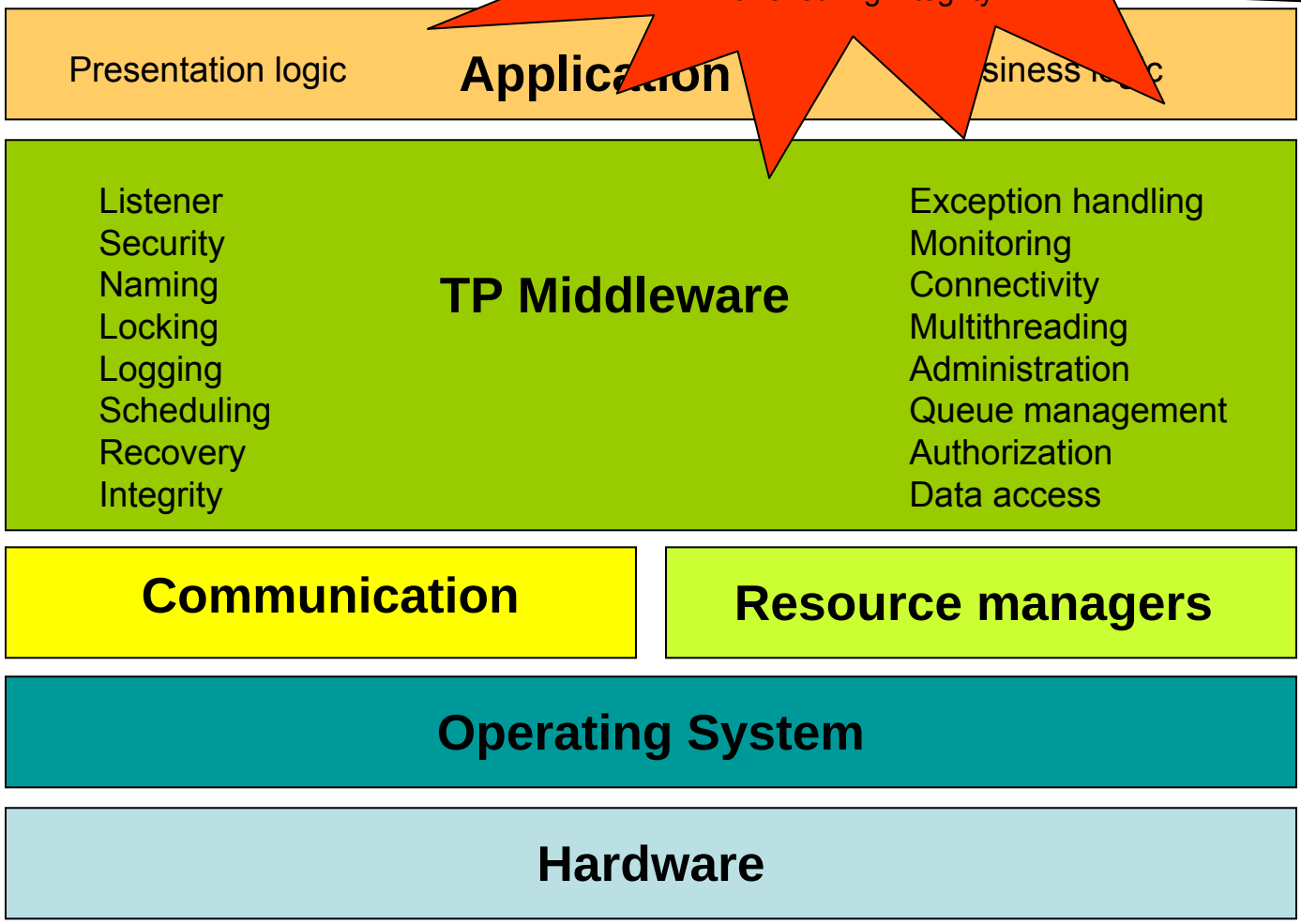
Where does my transaction context start?



Our clients we talked to generally see significant complexity and risk in using "distributed transactions" and tend to avoid them, even though technologies exist to support them, such as the XA protocol.

Transaction Processi

IBM's point of view is that the middleware and underlying O/S and HW are ultimately responsible for ensuring integrity



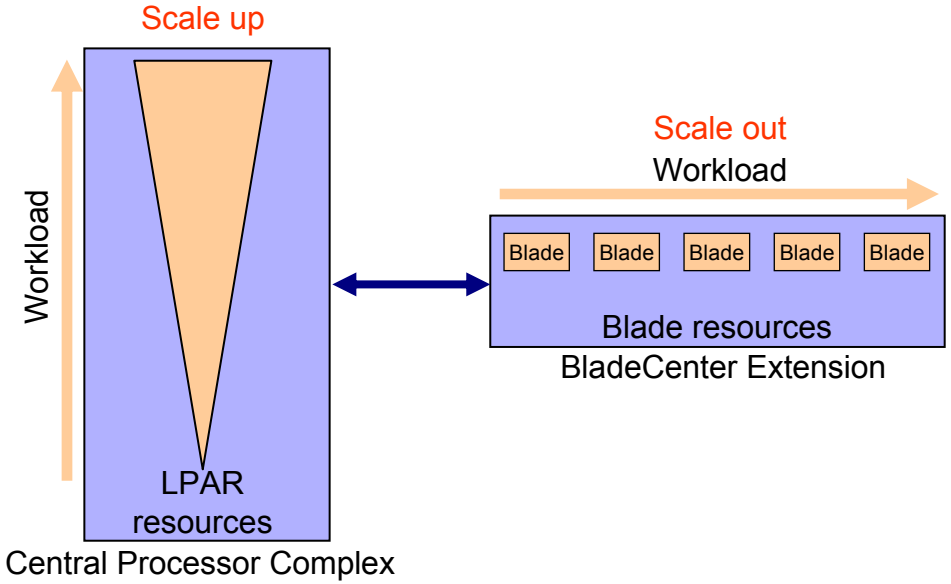
IBM Redbooks

Scale up / scale out Models for Transaction Processing

- Traditionally TP systems are *scaled-up* by adding resources to a single node in the system
  - Advantage: resources (CPUs, memory, storage, and so on) can be shared by the operating systems, TP middleware, and applications
  - Simplifies assuring transaction integrity
  - Most efficient for high volume workloads, with strongest read and update integrity needs
- The *scale-out* model, means adding more nodes to a system
  - A share-nothing approach, which raises a need for data partitioning or data replication
  - Efficiently for high volume read-only workloads, and workloads that do not need absolute time-critical data consistency

zEnterprise: Both scale-up and scale-out

- The "shared everything" architecture enables applications to dynamically scale up almost unlimited within a sysplex, with no manual intervention to add resources
- Applications with an architecture that permits running many occurrences on physically separate servers can benefit from the "scale out" behavior of the zBX.
- Often applications comprise components that require scale-out and components that require scale-up server architectures. For example database-update transactions, can typically be implemented on the System z hardware and HTTP Server that serve many clients serving web pages can be implemented on the zBX.
- zEnterprise is design to host these heterogeneous workloads while managing the platforms in a single management scope and on one logical server platform.



Business Challenges, as seen by our Clients

- New business services to attract customers and maintain their loyalty

"We try to provide a friendly and pleasant online experience to our customers and that also rewards them for their loyalty." ***(Misha Kravchenko, Marriott International)***

- Business agility and optimization

"Right-fit pricing is integral to achieving and maintaining competitive advantage. The goal is to book inventory down to the last room available to maximize yield." ***(Misha Kravchenko, Marriott International)***

- Control of risks and ability to respond to regulatory scrutiny

Our interviewed clients stated that they implement an audit trail of who does what, and stresed the need to externalize user privelege rights in a rules engine that has similar SLA requirements as the TP systems.

- Requirement to build partner relationships, and manage acquisitions and mergers

"The major business trends impacting our TP systems are increasing customer expectation, the need for quicker delivery of applications and more partner integration" ***(China Merchants Bank)***

- Pressure to reduce costs

One of our interviewed clients indicates, the overall cost of the service layer is greater than the process layer, which in turn is greater than the media access layer. This means that the best ROI is achieved through service reuse.

Technology Trends (1)

- SOA and web services

"We have moved most of our services to stateless web services, which expose core transactions directly." ***(Misha Kravchenko, Marriott International)***

- The mobile channel

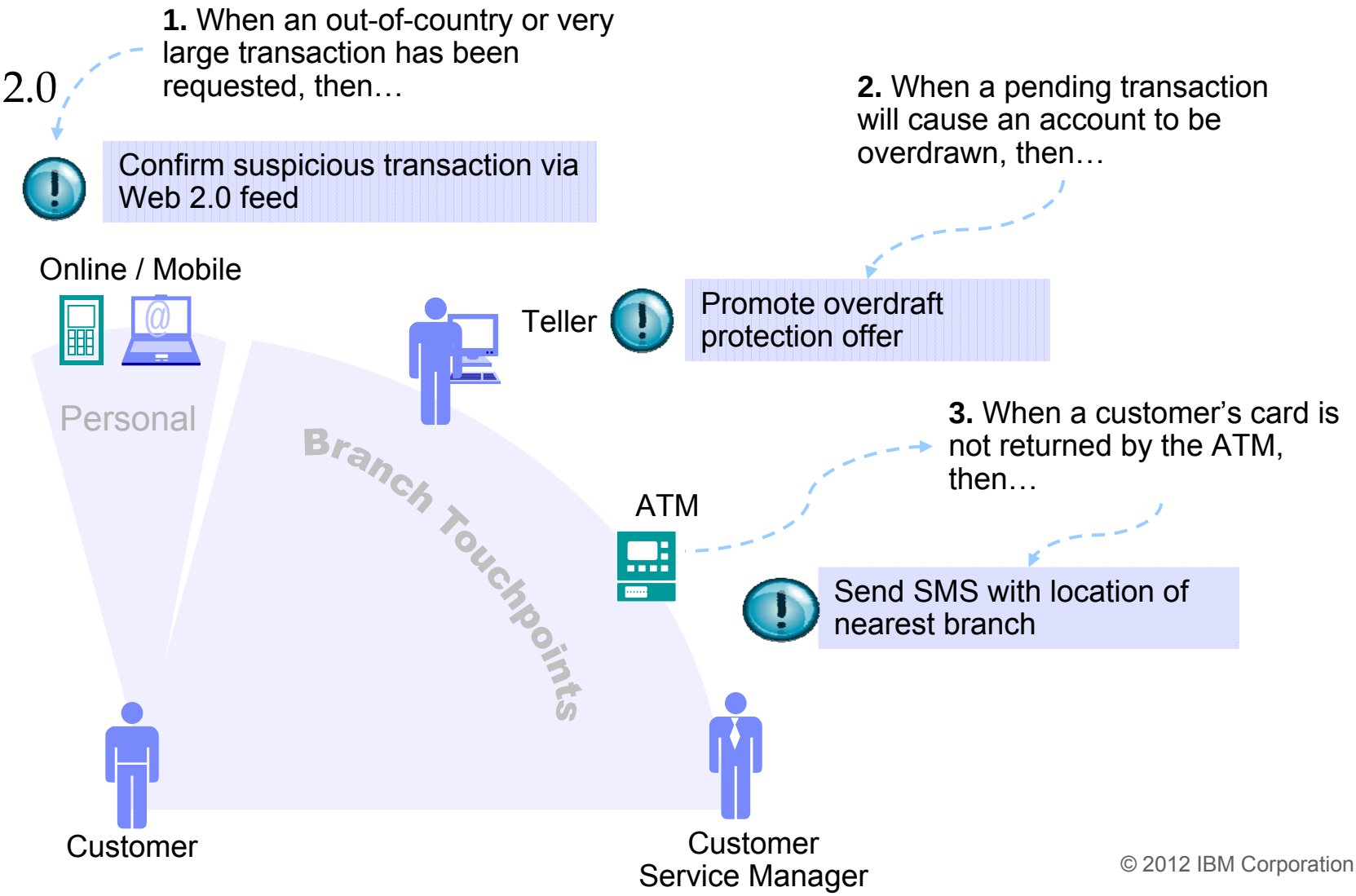
"The use of web services is strategic for the bank." ***(Marcel Däppen, UBS WM&SB)***

- Situational applications - a new paradigm for application delivery
  - Typically difficult to predict the additional demand resulting from the launch of the new offering

"We expect more growth coming from the mobile channel and we also foresee a workload increase from new self-service applications." ***(ABN AMRO Bank)***

Technology Trends (2)

- Web 2.0



Technology Trends (3)

- Business events and business rules

> *"Customers now demand a more real-time dynamic view of their portfolio gains and losses. In some scenarios, event-based solutions will help us to provide this in a more efficient and decoupled way."* ***(Marcel Däppen, UBS WM&SB)***

- Business process management imperative realizes competitive advantage, while saving costs
- Demands for real-time analytics raises need for specialized analytics engines
- Hybrid systems
  - Applications today are heterogeneous, including TP components
  - Workload-optimized systems with tuned-to-the-task components for tasks such as complex database queries or XML processing
  - Efficient management and monitoring of hybrid systems is becoming a strong requirement for IT service providers
- Cloud
  - Challenges in security, monitoring, and reliability are being addressed by standardization and middleware solutions
  - Practical implementations of cloud-based TP systems are emerging

The Future of Transaction Processing

New computing paradigms

- Increase in computing "things," appliances, sensors, and devices
- The produce volumes of data organizations are seeking and finding new value in
- Mobile devices will become the standard for everyday computing
- Social networks and mobile technologies will change the way businesses create value
- At the same time, new economies and massive new consumer markets are emerging

A future infrastructure is required that is

- Designed for data
  - Able to process large volumes of information
  - Process structured, well-governed information
  - But also informal unstructured data, such as tweets, video, speech, images
- Tuned to the task
  - Matching workloads to systems that are optimized for the specific task
- Managed elastically and reliably
  - The new computing model has to dependably cater for significant variances in data and transaction volumes
  - The infrastructure is managed with cloud technologies to improve service delivery and efficiency.

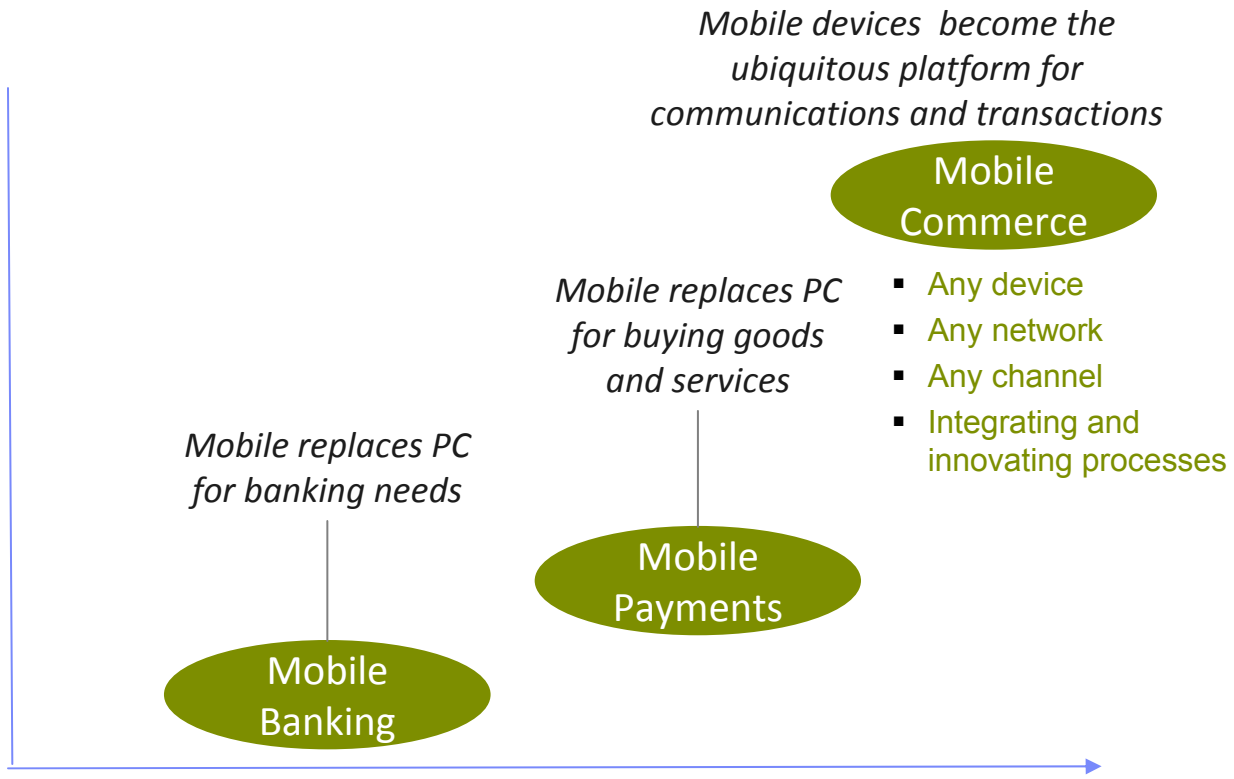
Continued Growth of the mobile Platform

- The mobile platform is leading to a re-establishment of the industry ecosystem and the emergence of new business models
  - *Branchless* financial services companies are emerging, providing a new set of services, sometimes combined with other commercial propositions, purely based on the mobile platform
  - Mobile devices facilitate new and enhanced products and services, extending the "electronic wallet," integrating diverse services, serving as a distribution channel and many other functions
  - Mobile network operators will diversify into financial services, media services, and citizen services, and will integrate with brick and mortar businesses
- The impact of the mobile channel will be most dominant in developing markets
  - No legacy of technology allow new mobile capabilities to be embraced quicker
  - Accelerated by the increasing spending power of the large population
- Our clients expect globalization and the emerging markets to have a significant impact on their TP systems in the future

Example: Opportunities for mobile Commerce

The opportunity for a financial institution is to extend his services to mobile users and evolve to broader mobile commerce portfolio integrating services from merchants, MNOs and for citizens

The evolution of the mobile economy is now at an inflection "hype" point



- Innovative new players are aggressively entering the consumer payments market
  - mPesa (Safaricom, Kenya)
  - G-Cash (GlobeTel, Philippines)
  - PayPal (Ebay, USA)
  - RevolutionMoney (Amex, USA)
  - Mobile Suica (DoCoMo / Japan Rail)
- Consumer transaction volume (P2P, P2B) is expected to almost double by 2016 (from 197 billion to 387 billion transactions)
- Total value of consumer payments is projected to increase from $340 trillion in 2008 to $650 trillion in 2016

Source: IBM Market Intelligence

Mobile is now the primary way to engage clients

New Business Integration Models

- Tighter cooperation and integration of organizations through the use of technology
  - Standards-based business APIs are emerging
  - Enable integration of commercial services from network operators, social networking, others
  - New capabilities will be developed, combining products from various industries into new offerings
- Cloud computing models continue to evolve and provide businesses with easy access to information processing facilities to realize the emerging business integrations
- *Hybrid* transactions emerge, from businesses as well as information processing perspective
  - Elasticity and reliability of the internal information processing needs to be assured
  - Disruptions in external, dependent services from IT facilities must be catered for
- This increasingly complex environment needs new "multi-party transaction integrity"
  - Provide global consistency capabilities for these hybrid types of transactions
  - Transactions across multiple systems, geographically dispersed, hosted in the cloud, and managed outside the realm of the IT department

Our customers indicate they see significant challenges with the current capabilities for managing distributed transactions across multiple systems, even if these transactions are all managed internally

The Big Data Challenge

- The amount of data is growing ten-fold every five years; both structured and unstructured data, from many sources
- New opportunities to accomplish tasks with a better understanding of clients, partners, competitors, current state of the business, and the impact of past actions.
- To extract business value from this volume of data, businesses need high capacity and new systems that integrate traditional transaction processing capabilities with deep analytics
- These will allow businesses to take actions from real-time transactions, becoming more responsive to trends anywhere in the world
- By incorporating transactions into deep analytics, completely new services to the long tail of customer segments can be provided

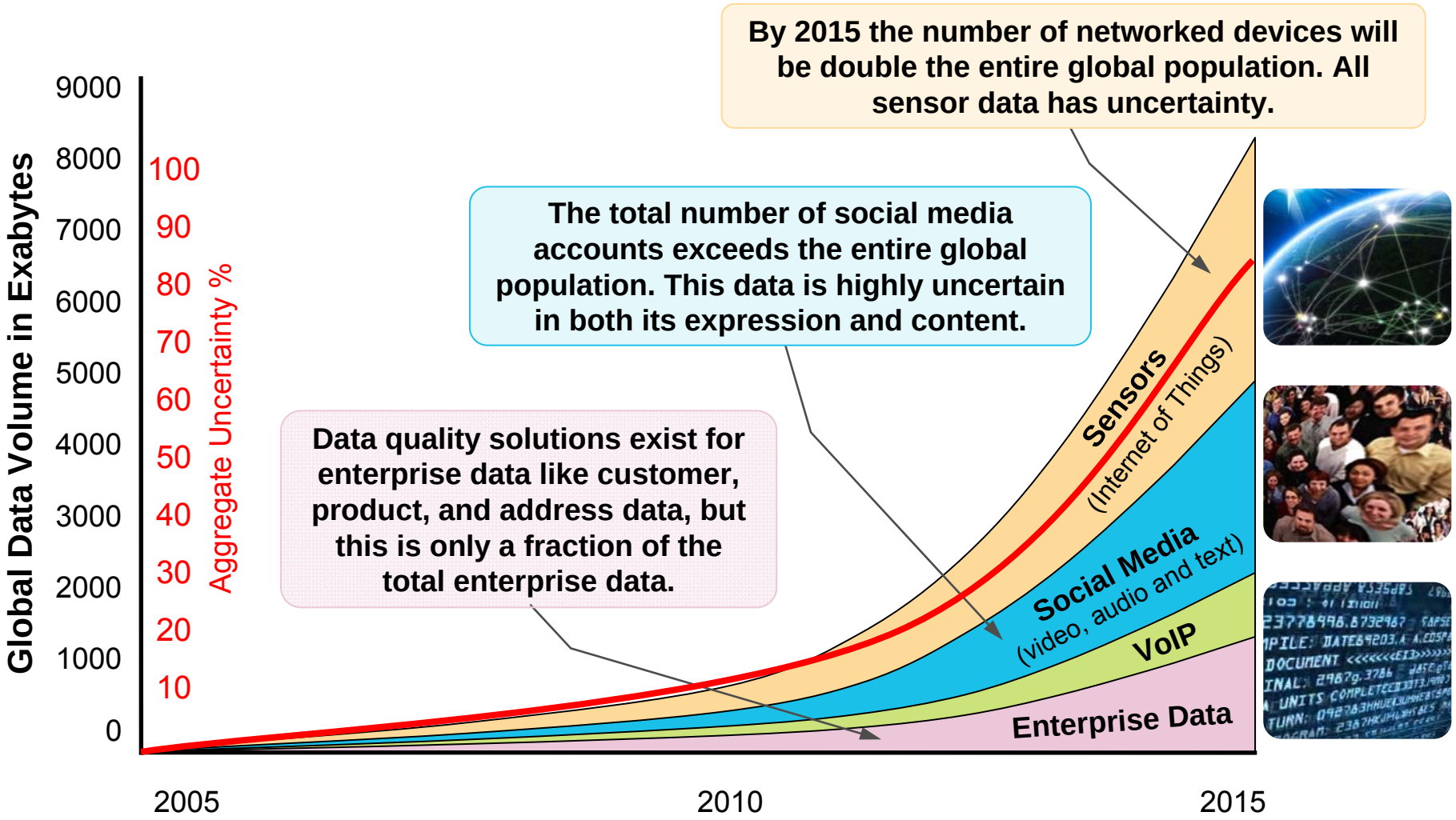
Real time scoring with DB2 for z/OS and SPSS Modeler 15

- Delivers better, more profitable decisions, using the latest data, at the point of customer impact
  - Enables more informed customer interaction
  - Improves fraud identification and prevention
- With improved accuracy, speed and performance while reducing cost and complexity
  - Improves accuracy by scoring new and relevant data directly within the OLTP application
  - Scales to large data volumes to improve accuracy of data models
  - Delivers the performance needed to meet and exceed SLAs of OLTP applications
  - Minimizes demand on network, HW, SW and resources

New!

All within the transaction!

By 2015, 80% of all available Data will be uncertain



What does all of this mean to future IT Architectures

- More transactions, more complex transactions
- Realtime data access becomes imperative, caching more selectively applied
- Trust importance implies renewed emphasis on integrity, reliability, availability
- User interaction on mobile decreases importance of Web app / portal front ends
- Stateless interaction pattern becomes more dominant
- Middle tier will be bypassed to achieve high throughput and/or fast response times
- Distributed transactions not a solution for high volume, low latency services
- Severe scaling limitation of certain solutions will surface and reorient clients towards workload-optimized systems
- Requirement to provide elasticity and high volume transaction processing capability at the same time
- Facilitate more complex transactions (in flight analytics)

Summary

- In this paper we reviewed the past, present and future of transaction processing
- We described how we arrived at where we are and where the future of transaction processing might lead us
- The impact of innovations and trends in various areas were evaluated in this paper.
- Some of the most thought-provoking are mobile platforms, new business integration models and big data. The next generation of transaction processing systems will address new challenges and needs as these trends emerge.
- The world's most important solutions for transaction processing run on IBM systems and the distinguishing capabilities and the leadership position of System z were also highlighted in this paper.
- System z has been the flagship platform for transaction processing
- The traditional strengths of System z for transaction processing systems is its scale-up architecture that facilitates a mix of high-volume and time-critical workloads with high integrity requirements on the accessed shared data
- The business and technology trends highlighted in this paper indicate that this type of transaction processing capability continues to be key in many organizations.
- Moreover, new capabilities that address the magnitude and the functional needs of tomorrow's transaction processing requirements will extend the current strengths of the System z platform.
- System z environment also addresses the capability for a scale-out processing model of transaction processing. With this capability, transaction processing workloads can be combined on systems that are geared towards the scale-out application model.
- This combination of capabilities assures that System z is the unique platform that enables organizations to run transaction processing workloads on technology that is tuned to the task, and is perfectly positioned to address today and future transaction processing needs.

Thanks to:

- With special thanks to these clients for providing information to us and giving permission to use their quotes:
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  - Dominique Delhumeau - Distinguished Engineer working for IBM in France
  - Donna Eng Dillenberger - Distinguished Engineer at IBM Research
  - Hilon Potter - Chief IT Architect working at the IBM Design Center in Poughkeepsie
  - Nigel Williams - Certified IT Specialist working in the IBM Design Centre, Montpellier, France

- Marcia Harelik, WebSphere on z Market Management
- Ella Buslovich, International Technical Support Organization, Poughkeepsie Center
- Rob High, IBM Fellow, Vice President and CTO for Watson
- Alan Little, Distinguished Engineer; Architect for WebSphere Foundation
- Ian J Mitchell, Distinguished Engineer; CICS Transaction Server
- Claus Jensen, STSM and Chief Architect SOA-BPM-EA Technical Strategy
- Jonathan Collins, TPF, z/TPF Software Product Manager
- Colette Manoni, STSM, TPF Design and Development
- Shyh-Mei Ho, Distinguished Engineer; IMS On Demand SOA Chief Architect
- Helene Lyon, Distinguished Engineer and European IMS Architecture Team Technical Executive
- Sandy Sherrill, IMS Worldwide Market Manager
- David Rhoderick, System z Competitive Project Office
- Matthew Sykes, WebSphere Application Server Development
- Anna Wang, Solution Architecture - Banking and Financial Services Center of Excellence
- Martin Braun, Senior IT Architect; Industry Architect for GAD, IBM Germany
- Mark Cocker, CICS Technical Strategy and Planning
- Yannick Le Floch, Architect European Design Center

Questions?

Valuable reading

- Customer Briefings
  - "Achieve Greater Agility with Optimized Solutions from IBM"
- Case studies
  - Marriott International case study
- Articles
  - Interview with IBM Fellow Rob High. "Business benefits of extreme transaction processing technology"