Introduction

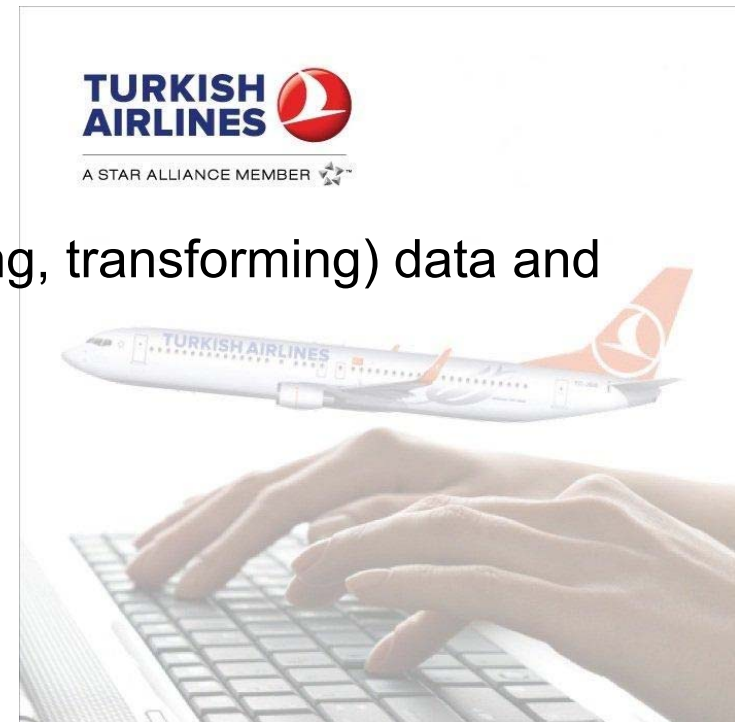## Advanced Information Systems and Business Analytics for Air Transportation

M.Sc. Air Transport Management
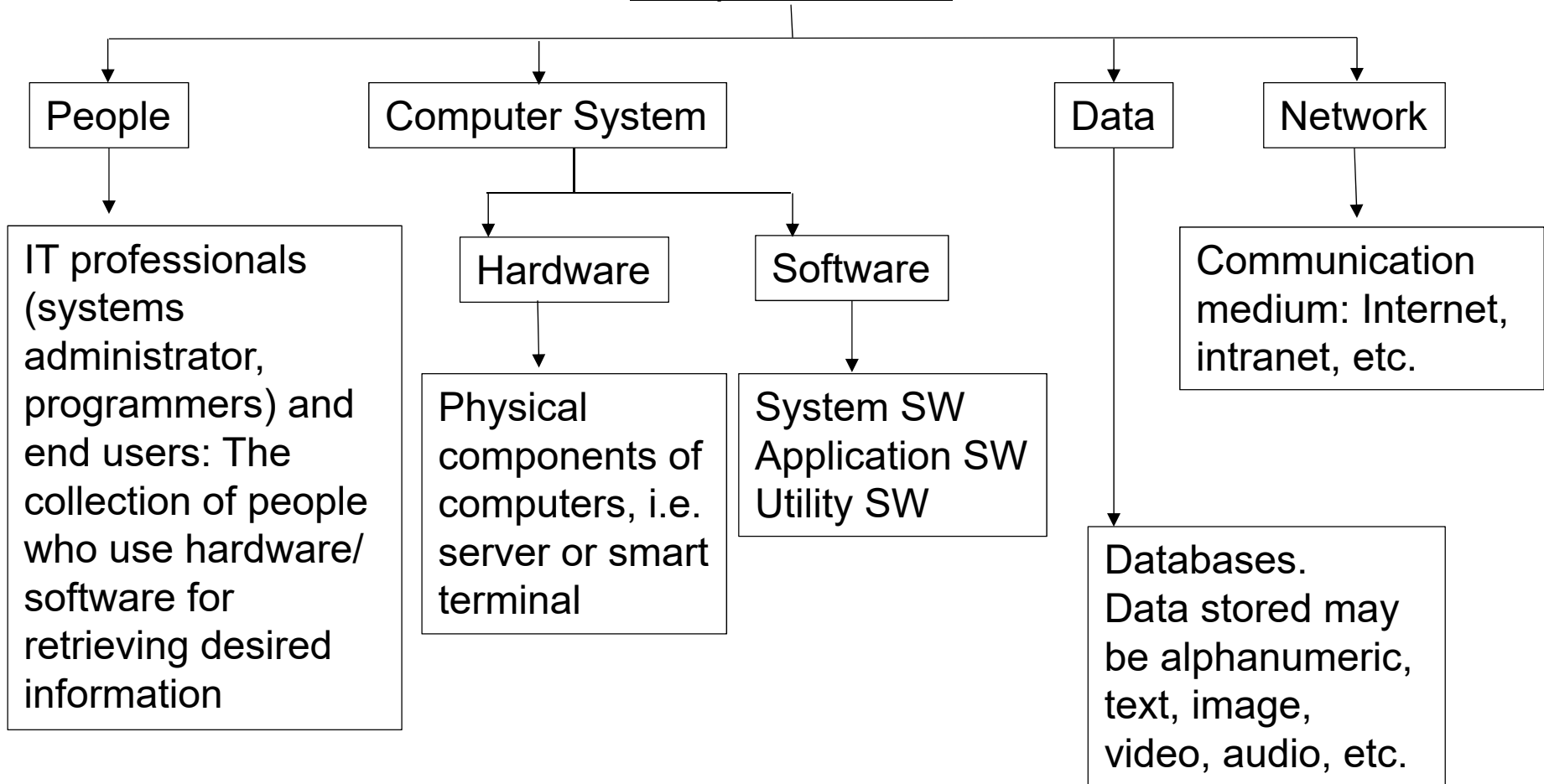
May 16-21, 2016

Slides prepared by Benny Mantin

Information Systems: Definition

- A combination of
  - people,
  - hardware,
  - software,
  - communication devices,
  - network,
  - data resources

  that processes (i.e. storing, retrieving, transforming) data and information.
- Information systems enable
  - collection,
  - storing,
  - processing,
  - analysis,
  - distribution of

  information.

Components of IS

```
                          Components of IS
          ┌──────────────┬──────────────────────┬──────────┬──────────┐
          ▼              ▼                       ▼          ▼
      [People]    [Computer System]           [Data]   [Network]
          │          ┌──────┴──────┐
          │          ▼             ▼
          │      [Hardware]   [Software]
          ▼          ▼             ▼
```

People: IT professionals (systems administrator, programmers) and end users: The collection of people who use hardware/ software for retrieving desired information

Hardware: Physical components of computers, i.e. server or smart terminal

Software: System SW Application SW Utility SW

Network: Communication medium: Internet, intranet, etc.

Data: Databases. Data stored may be alphanumeric, text, image, video, audio, etc.

Bringing together people, IT, and processes to facilitate better and efficient decision making

IS in Business: Objectives

Support business processes and operations
- Transaction Processing Systems,
- Process Control Systems

Automate processes, paperless, etc.

Support business decision-making
- Management Information Systems,
- Decision Support Systems,
- Executive Information Systems

Aggregate data and make it useful to support decisions processes

Support strategic competitive advantage
- Expert Systems,
- Knowledge Management Systems,
- Strategic Information Systems,
- Functional Business Systems

Leverage systems to support firm's strategy

IS: Key Areas

Foundation concepts

Fundamental business and managerial concepts, such as system-components and their functions, competitive strategies

Information technologies

Operations, development, management of hardware, software, data, networks

Business applications

Major uses of IT, such as processes, operations, decision making, strategic/competitive advantage

Development processes

How end users and IS specialist develop and execute business/IT solutions

Management challenges

How IT resources are maintained, how to create business strategies and achieve high performance

IS: Framework

Management of IS resources and **strategies**

Development of IS solutions for business problems

Applications of IS operations, management, and strategic advantage

Technology of IS hardware, software, networks, and data management

Foundation Concepts of IS Fundamental behavioural and technical concepts

6
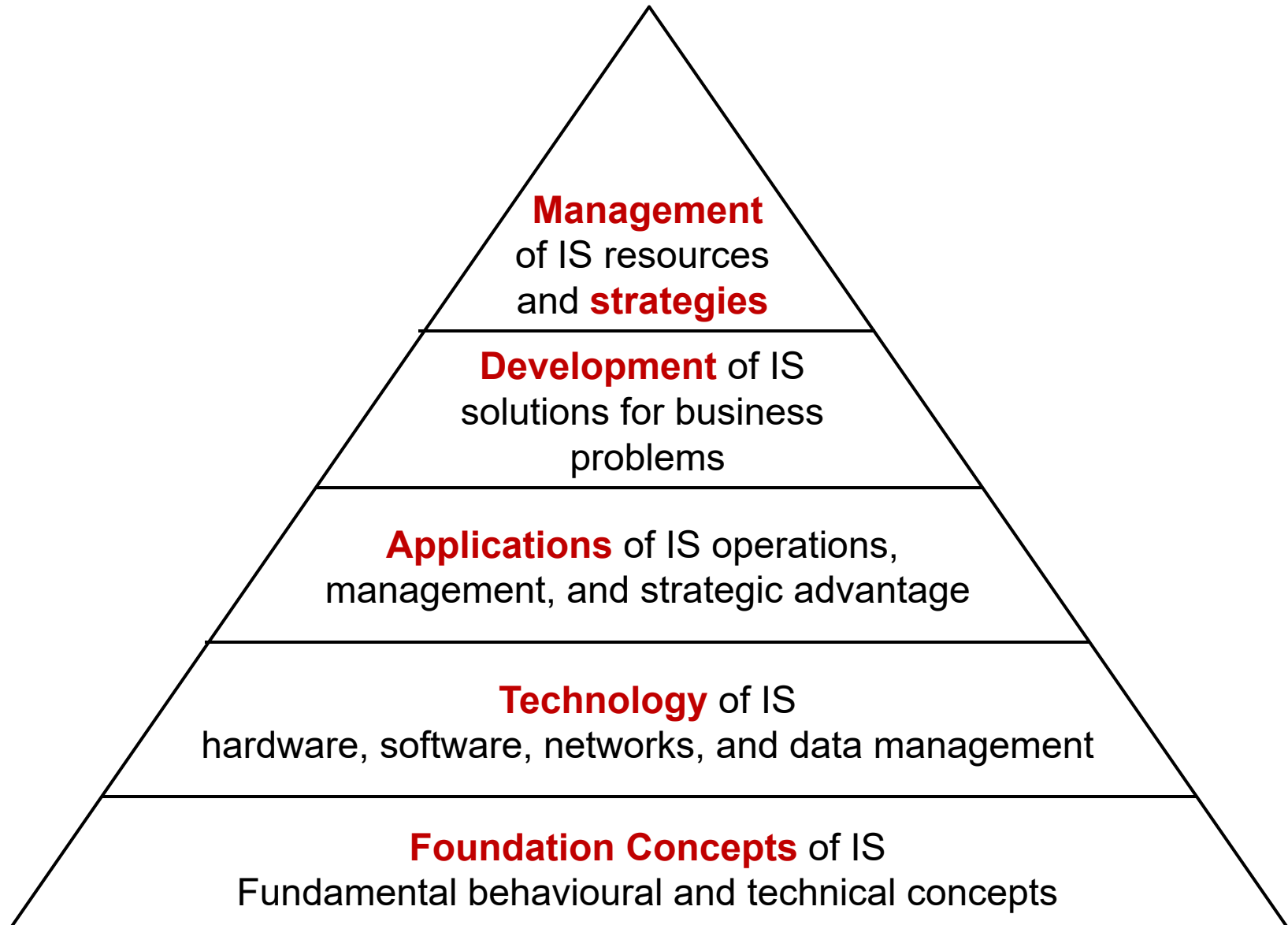
History of Information Systems

Name	Era	Scope	Perspective	Example	Technology
Calculation systems	1950-1980	Single purpose	Eliminate tedious human calculations	Payroll General ledger Inventory	Mainframe punch card
Functional systems	1975-2000	Business function	Use computer to improve operation and management of individual departments	Human resources Financial reporting Order entry Manufacturing (MRP and MRP II)	Stand-alone PCs Networks and LANs
Integrated systems (also cross-functional, process-based)	2000-….	Business process	Develop IS to integrate separate departments into organization-wide business processes	Customer relationship management (CRM) Enterprise resource planning (ERP)	Networks PCs Client-servers Internet Intranet
Connected world and Big Data	2005-….	Leveraging big data	Online decisions Better predictions => Better decisions Reduce variability	Customized service Precise operations	Mobile; tags, Other sources

Recall from operations!

IS are great
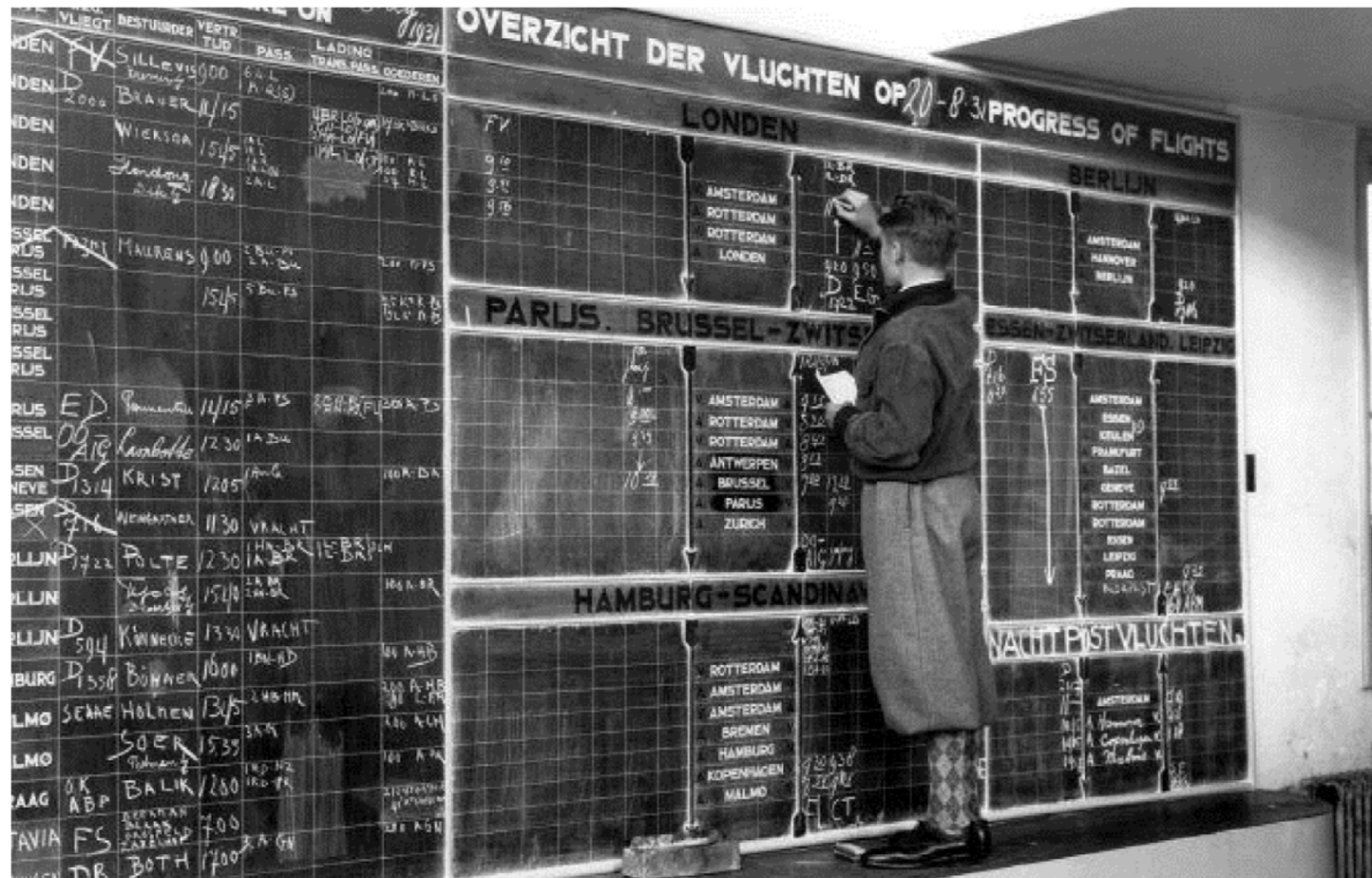
Cover 90% of requirements (wall to wall)
Remaining 10% causing 90% of problems…

Functional Systems

- Functional systems facilitated the work of a single department or function.
- These systems grew as a natural expansion of the capabilities of systems of the first era:
  - Payroll expanded to become human resources.
  - General ledger became financial reporting.
  - Inventory was merged into operations or manufacturing.
- These new functional areas added features and functions to encompass more activities and to provide more value and assistance.
- The problem with functional applications is their isolation.
- Functional applications are sometimes called islands of automation.

Integrated Systems

- **Enterprise Resource Planning (ERP) programs:** Core software used by companies to coordinate information in every area of business
  - Help manage companywide business processes
  - Use common database and shared management reporting tools
- **Business process:** Collection of activities that takes some input and creates an output that is of value to the customer

Big Data

- Volume
  - Large scale datasets
  - Internet increases in size
  - Example: in 2012 Walmart collected 2.5 petabytes of data (or 50 million filing cabinets…)
- Velocity
  - Speed is critical
  - (nearly) real-time
  - Rapid insights can provide a competitive advantage
- Variety
  - Messages, updates, images
  - Readings from sensors
  - GPS signals, and more
  - Facebook, twitter, smartphones, tablets, and more

Big Data

- According to 2012 data:

  - Companies in the top third of their industry in the use of data-driven decision making were, on average, **5% more productive** and **6% more profitable** than their competitors.

  - Was reflected in measurable increases in stock market valuations.

Big Data: ETAs

- Estimated Time of Arrival usually derived based on the speed of the distance travelled so far.
  - Landing too early: ground staff might not be ready
  - Landing too late: ground staff might sit idle
- In studying its hub, A major US airline found:
  - At least 10% had gap>10 minutes
  - At least 30% had gap>5 minutes
  - At the hub the problem amplifies:
    - Planes that should be held for connecting passengers are released too early because the airline thought the connecting plane would arrive later than the actual arrival time
    - Planes that shouldn't be held for connecting passengers are held too long because the airline thought the plane would arrive earlier than it actually did
  - These costs average more than $600,000 per hub per airline per year, according to one study

Operational trade-off!

Big Data: ETAs

- PASSUR's RightETA:
  - Calculates these times by combining publicly available data about weather, flight schedules, and other factors with proprietary data the company itself collected, including feeds from a network of passive radar stations it had installed near airports to gather data about every plane in the local sky.
  - 2012: collected wide range of information on every plane it sees every 4.6 seconds
  - The result: An immense body of multidimensional information spanning more than a decade
  - Sophisticated analysis and pattern matching
  - What happened all the previous times a plane approached this airport under these conditions? When did it actually land?
- The airline virtually eliminated gaps between estimated and actual arrival times.

PASSUR ETA Study:
Reducing Variability in ETAs

Variance Between ETA & ATA ≥ 5 minutes
Variance Between ETA & ATA ≥ 10 minutes

After PASSUR Implementation

Before PASSUR

Passur data started 3/29
ETA = Estimated Time of Arrival
ATA = Actual Time of Arrival
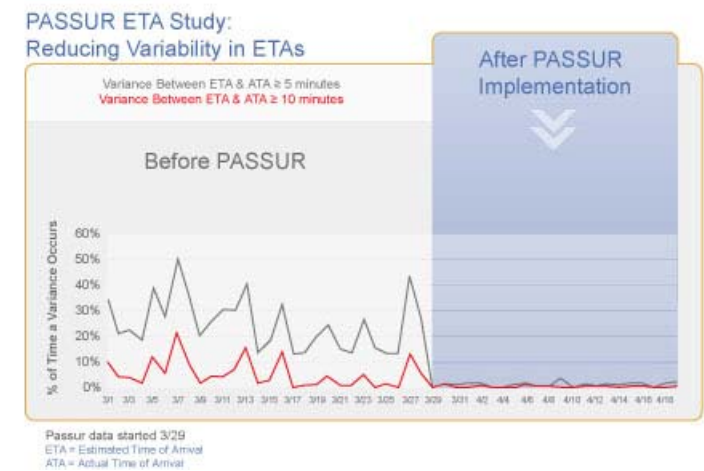
View the current runway configuration live, always updating

Select flights for future lookup in the archive; get an auto-alert when they return

User-defined color coding of flights for automated operational alerts

View live activity exactly as you want through pre-set or user defined filters

Current and forecasted weather

PortAlerts scrolls messages posted by airport ops, ramp tower ops, and other stakeholders

Unique PASSUR ETAs for precise ramp tower operations

PortalChat creates instant dialogue with all logged-on users, within or between organizations

Look ahead to arrival and departure volume, next 4 hours

Source: http://www.passur.com/Collateral/Images/English-US/portal.gif

Big Data: Getting Started

- Pick a business unit to be the testing ground. It should have a quant-friendly leader backed up by a team of data scientists.
- Challenge each key function to identify five business opportunities based on big data, each of which could be prototyped within five weeks by a team of no more than five people.
- Implement a process for innovation that includes four steps:
  - experimentation,
  - measurement,
  - sharing,
  - and replication.
- Keep in mind Joy's Law: "Most of the smartest people work for someone else." Open up some of your data sets and analytic challenges to interested parties across the internet and around the world.

Important: causality vs relationship
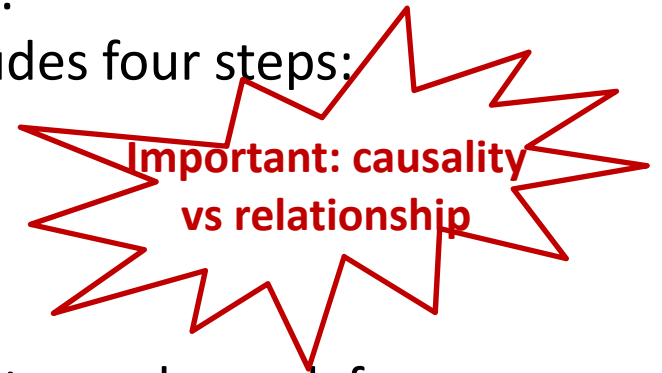
The Transformation Process

Inputs

data is collected (internal, external), converted into adequate format for processing

Transformation Process
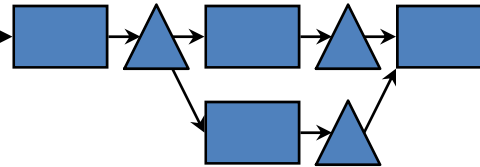
Outputs

information is stored for future use or communicated

raw data is converted to information
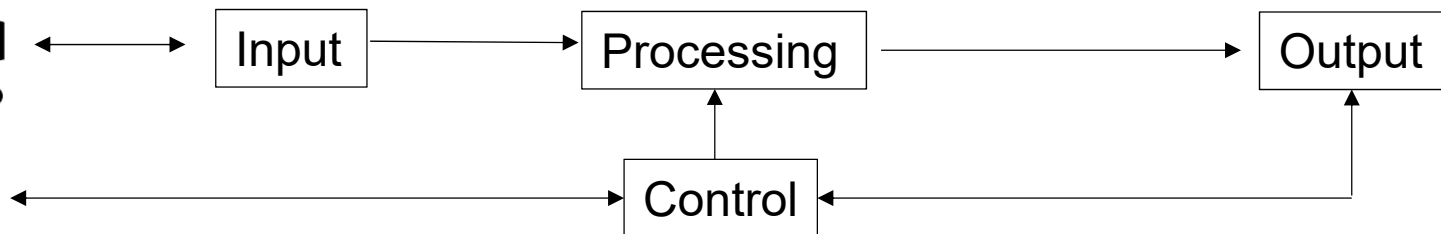
Importance of IS in business

IS help managers with efficient decision-making to achieve organizational goals and increase competitiveness

IS viewed as a process and can be integrated to formulate action- or operational strategies

Types of IS

Operation support systems	Management support systems	Office automation systems
Transaction Processing Systems (TPS)	Management Information Systems (MIS)	Text Processing Systems (TPS)
Process Control Systems (PCS)	Decision Support Systems (DSS)	Electronic Document Management Systems (EDMS)
		Electronic Message Communication Systems (EMCS)
Enterprise Collaboration Systems (ECS)	Executive Information Systems (EIS)	Teleconferencing & Videoconferencing systems (TVS)

Classification Levels

Top-level management

Strategic level

Decisions are made based on information from mid-level management

Mid-level management

Tactical level

Internal & external information sources collected to process strategic decisions

Low-level management

Operational level

Collecting all inputs available
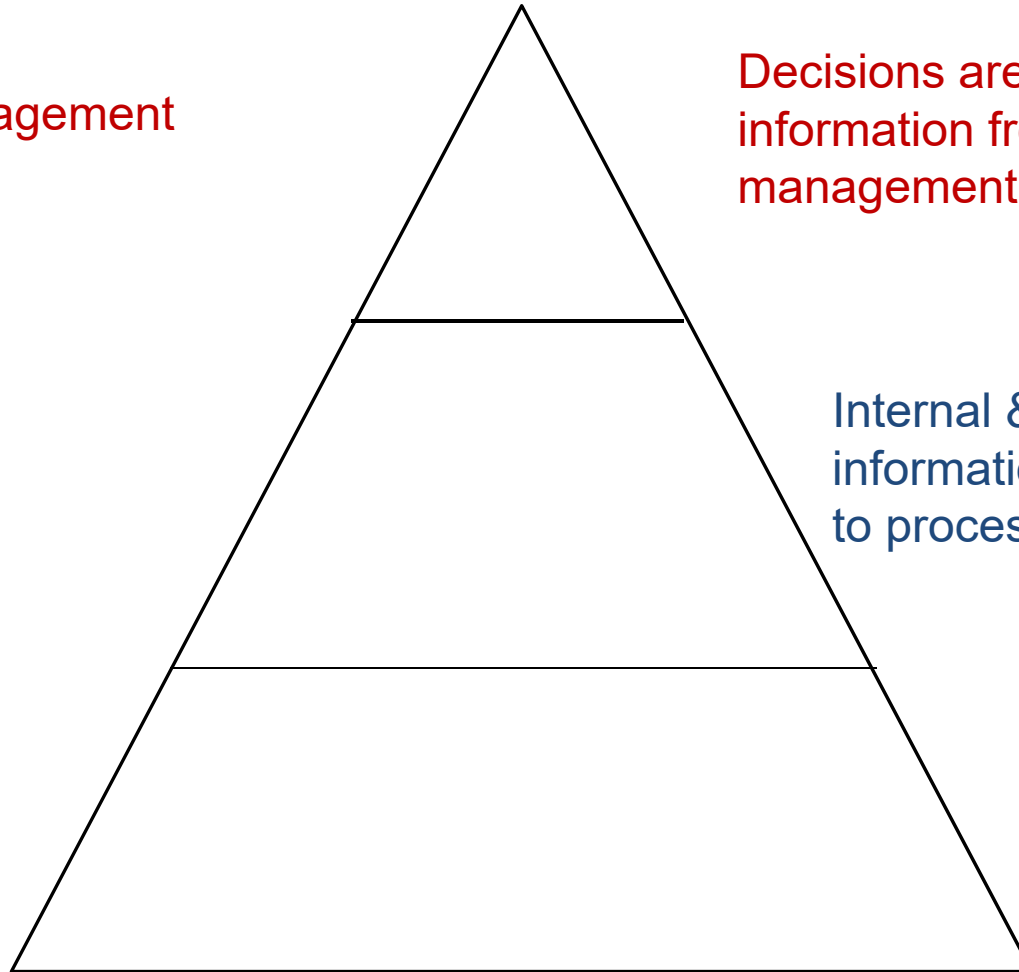
Functional Areas of Operations

- Functional areas are interdependent
  - ⇒Each requires data from the others
- Better integration of functional areas leads to improvements in communication, workflow, and success of company

Functional areas of operation	Marketing & sales	Supply chain management	Accounting and finance	Human resources
Business functions	Marketing of a product	Purchasing goods and raw materials	Financial accounting of payments from customers and to suppliers	Recruiting and hiring
	Taking sales orders	Receiving goods and raw materials	Cost allocation and control	Training
	Customer support	Transportation and logistics	Planning an budgeting	Payroll
	Customer relationship management	Scheduling production runs	Cash-flow management	Benefits
	Sales forecasting	Manufacturing goods		Government compliance
	Advertising	Plant maintenance		

Business Processes

- Taking one or more inputs to create an output that is of value to customer
    - Customer can be traditional external customer or internal customer
- Managers can look at their organization from the customer's perspective

Business Processes

Input	Functional area responsible for input	process	Output
Request to purchase computer	Marketing and sales	Sales order	Order is generated
Financial support to purchase	Accounting and finance	Arranging financing in-house	Customer finances through the computer company
Technical support	Marketing and sales	24-hour help line available	Customers' technical query is resolved
Fulfillment of order	Supply chain management	Shipping and delivery	Customer receives computer

Example of business processes related to the sale of a PC

Recall

Inputs

Raw material, people, information, capital etc.

Transformation Process

Outputs

Goods
Services

Uninformed customers → Online agency (Opodo) → Informed customers → Buy? → No → Leave

Yes

Order information

Uninformed Airline → Opodo's Information system → Informed Airline
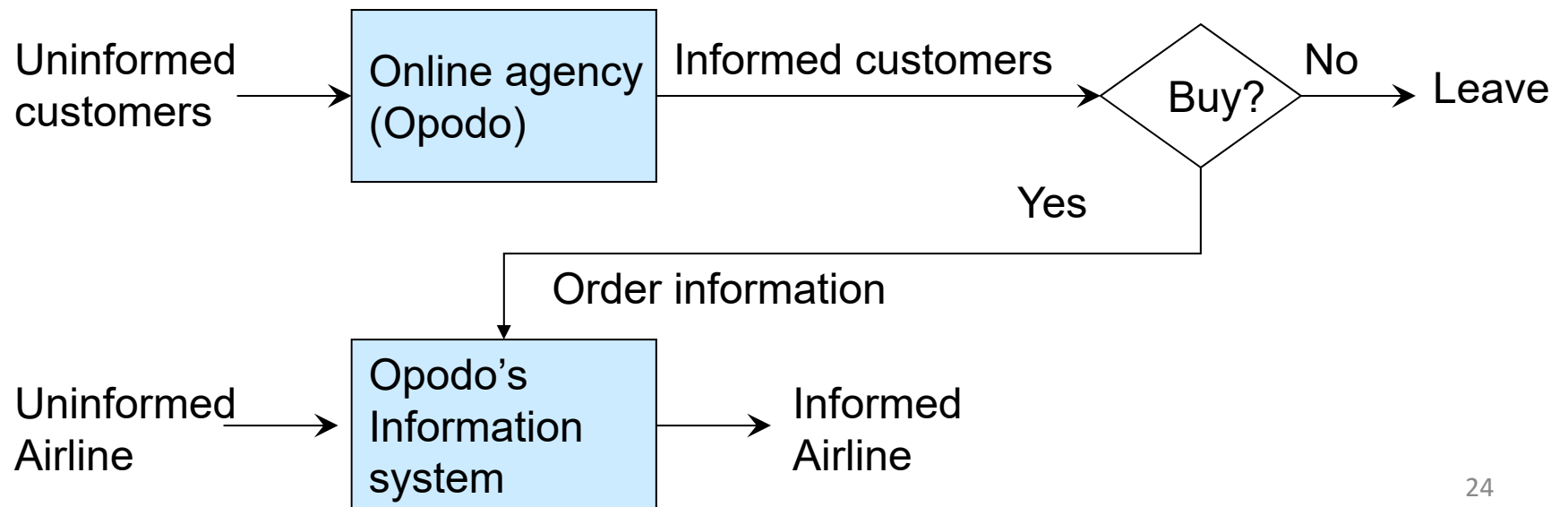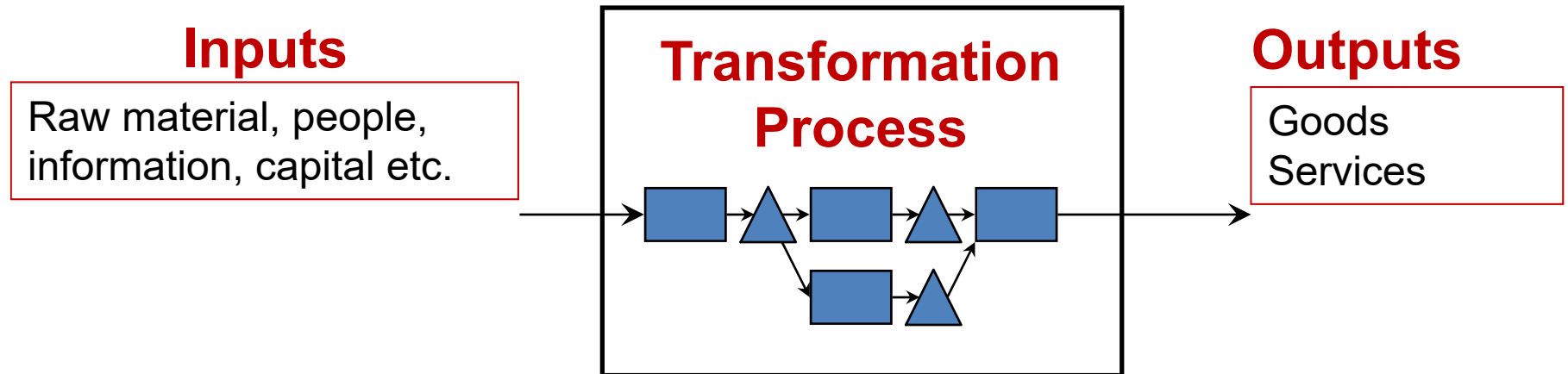
Marketing and Sales, M/S

Functions:

- Developing products
- Pricing
  - (but generally not dynamic pricing)
- Promoting products to customers
- Receiving customers' orders
- Forecasting sales

Supply Chain Management, SCM

- Functions:
  - Purchasing
  - Manufacturing/production
- Inputs:
  - Sales forecasts from M/S functional area
  - Necessary for production planning, purchasing
    - Recall: A/F ratio method to generate a distribution based on forecast (newsvendor setting).
  - Collaborate with M/S to decide
    - Raw materials
    - packaging

Accounting and Finance, A/F

- Functions:
  - Recording raw data about:
    - Transactions (including sales),
    - Raw material purchases,
    - Payroll,
    - Receipt of cash from customers
- Outputs:
  - Sales records: an input for M/S in setting sales forecast
  - Sales forecast is an input for SCM: staffing and production planning decisions
  - Records from accounts receivable: an input for M/S in monitoring customers' credit-granting

> Raw data: Numbers collected from those operations, without any manipulation, calculation, or arrangement for presentation

Human Resources, HR

- Functions:
  - Recruit,
  - Train,
  - Evaluate,
  - Compensate employees
- Inputs:
  - Sales forecasts to plan personnel needs

Information Systems

- Identify potential inputs/outputs for each functional area
- Need to understand the types and form of data; how data is used
- ERP software generally facilitates data sharing between functional areas

The firm

SUPPLIER
S

SCM

Sales forecast, sales order

Product availability, order status

HR

Legal requirements, job info.

Hiring needs, personnel info.

M/S

Sales order data

Cost/profit analysis

A/F

Order status

Orders

Customer

M/S Outputs:
- Sales strategies
- Product pricing
- Employment needs

Customers communicate orders to M/S in person or by telephone, e-mail, fax, the Web, etc.

The firm

SCM Outputs:
- Raw material orders
- Packaging orders
- Resource expenditure data
- Production and inventory reports
- Hiring information

Orders for raw material & packaging

Raw material info.; delivery

Legal requirements, job info.

Hiring needs, personnel info.

Production, plans, material & inventory

Sales data and manufacturing cost analysis

Product availability data & order status

Sales forecast

S

SCM

HR

M/S

A/F

Customer

The firm

SUPPLIER
S

A/F Outputs:
- Payments to suppliers
- Financial reports
- Customer credit data

SCM

Production plans, materials, inventory data

Sales data, manufacturing cost analysis

Legal requirements & job info, payroll & benefit expense data

Hiring needs & personnel info

HR

Sales order data

Cost/profit analysis

M/S

A/F

Invoices and credit memos

payments

Customer

The firm

SUPPLIER
S

Hiring needs, personnel info

Legal requirements, job info

SCM

Payroll, benefit/expense data, legal requirements, job info

Legal requirements, job info.

Hiring needs, personnel info

Hiring needs, personnel info.

M/S

A/F

HR

HR Outputs:
- Regulation compliance
- Employee training and certification
- Skills database
- Employee evaluation and compensation

Customer

Summary of Functional Areas

- Marketing and Sales:
  - Sets product prices, promotes products through advertising and marketing, takes customer orders, supports customers, and creates sales forecasts
- Supply Chain Management:
  - Develops production plans, orders raw materials from suppliers, receives raw material, manufactures products, maintains facilities, and ships products to customers
- Accounting and Finance:
  - Financial accounting to provide summaries of operational data in managerial reports, controlling accounts, planning and budgeting, and cash-flow management
- Human Resources:
  - Recruits, hires, trains, and compensates employees, ensures compliance with government regulations, and oversees the evaluation of employees
- Information systems:
  - capture, process, and store data to provide information needed for decision making

- Employees from one functional area need data from other functional areas
  - Functional area information systems should be integrated, so shared data are accurate and timely (for example, via ERP)

AIRLINE SYSTEM COMPONENTS

Some of the systems unique to airline industry

- Several elements:
  - Demand management
  - Inventory distribution
  - Compliance
  - Emergency

Overview of Aviation IS

Pricing And Revenue Management System

HR Management System

Air Cargo System

CRM System

Maintenance And Engineering System

Business Processing System

Sales and Marketing System

Airport Management System

Flight Operations System

Finance System

Crew Management System
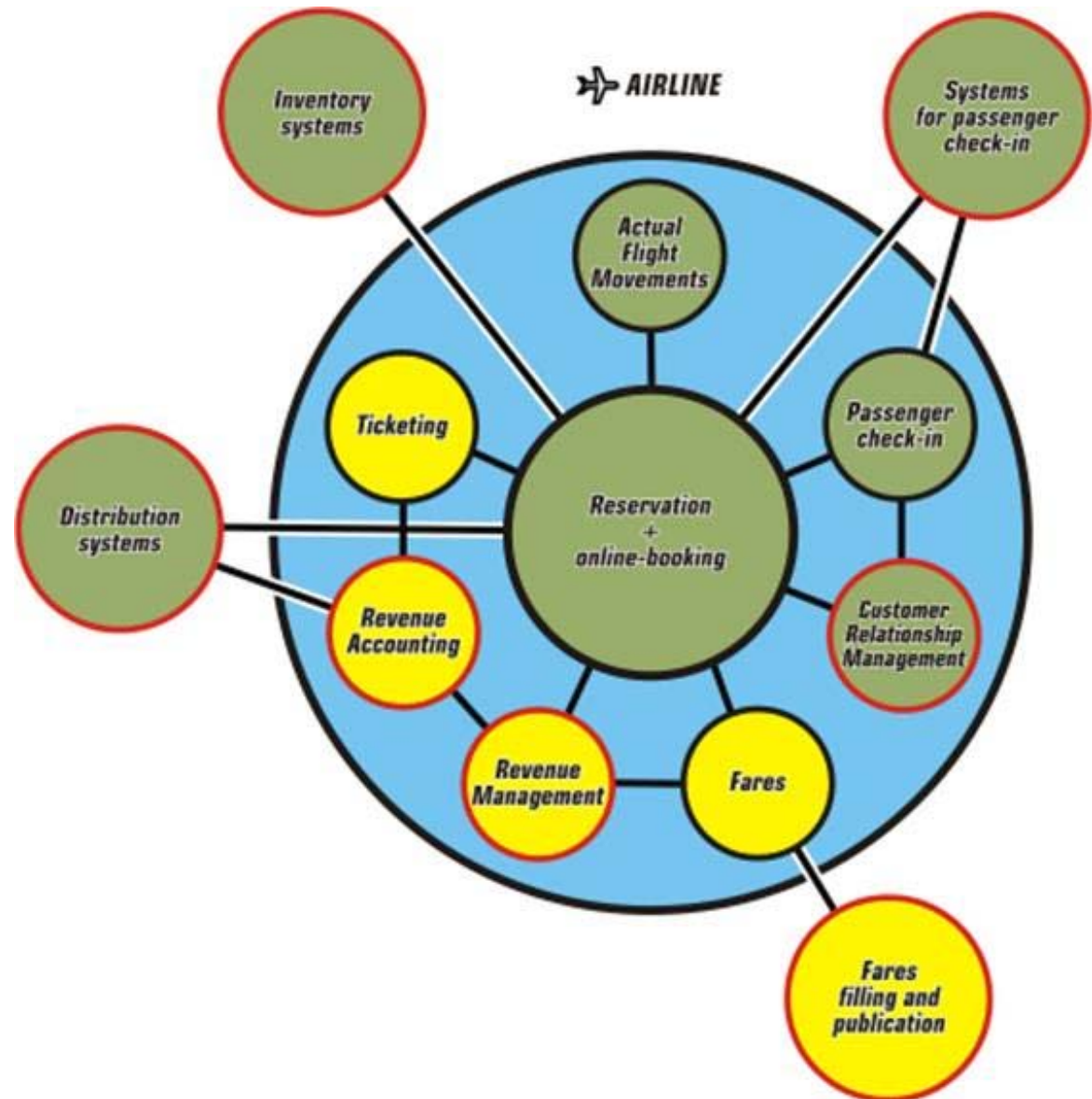
Central Reservation System
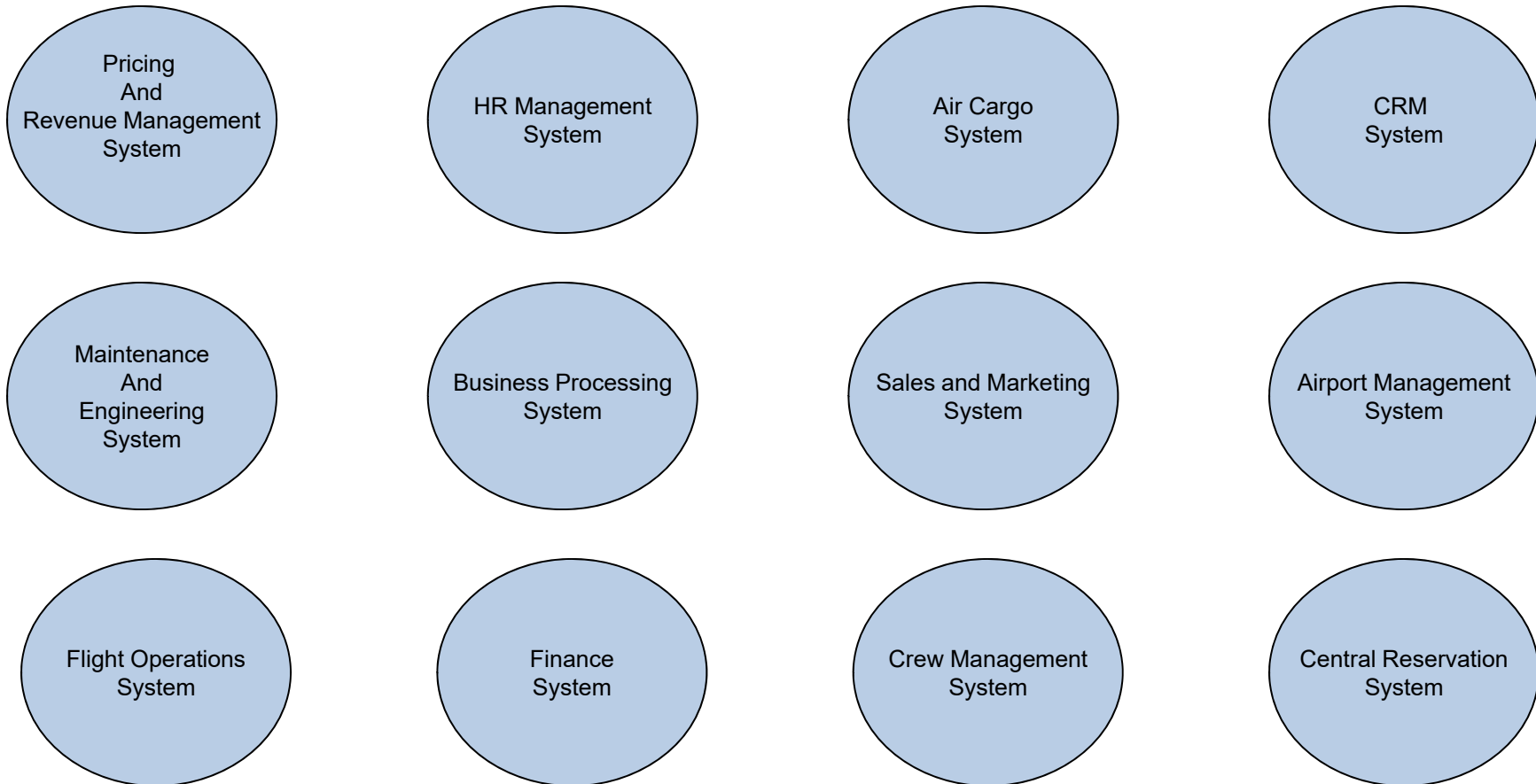
Some overlap between systems above, may be combined

Central Reservation

Central Reservation System
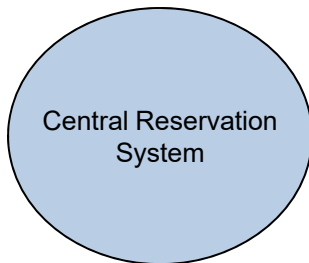
System to book ticket on airline. Generally, facilitates:

- Internet booking: passengers, travel agents and corporate customers can search for flights and fares, and book airline seats on the internet

- E-Ticketing: replaces a conventional paper ticket with an electronic ticket. All booking and ticket details are stored in the airline's computer system. Passenger is issued an e-ticket receipt for security and immigration purposes.

- Booking through ATM and Kiosk

- Integration with major Global Distribution Systems

- Integration with call center for booking over the phone

Customer Relationship Management, CRM
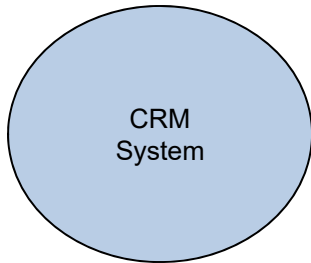
CRM System

The 80/20 rule: 20% of customers generate 80% of revenue.

The CRM system should provide

- Prediction into customer buying behavior
- Identify frequently flying and high profile flyers
- Integrate to DW/BI system
- Forecast demand
- Identify customers for marketing campaign based on customer profile and past data
- Provide for customer feedback through various touch points (SMS, PDA, Survey): Involve Customer

The crux is to identify behavior of customer/ prospect for better retention and service

Recall Call Center case (Operations)

Sales and Marketing
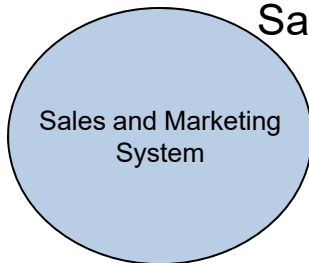
Sales and marketing systems provide

- Management of sales record and integration with Financial and revenue system
- Alerts based on defined competitors events
- Daily KPI monitoring
- Campaign management
- Target and actual achieved reporting by
    - Reason
    - Route, flight, slot and carrier type
    - Configurable parameter
- Alerts integrated with CRM system

Sales and Marketing System

Pricing and Revenue Management
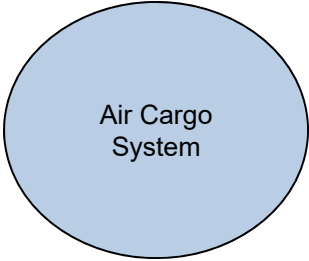
Pricing
And
Revenue Management
System
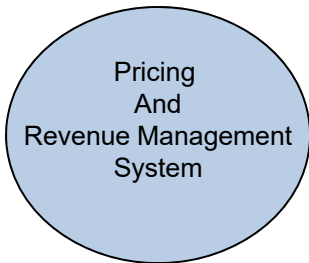
The use of real-time dynamic pricing allow airlines to

- Adapt inventory controls to the very dynamic market conditions including competition stemming from low-fares, alternate pricing models, and distribution channel differences.

- Use integrated controls for selling over e-commerce channels along with traditional distribution channels and provides the infrastructure for customer-centric revenue optimization

- Revenue Management systems enhance airline revenues by optimizing traffic and yield mix with the help of past data, current trends, and demand forecast for different flights, segments and fares.

Air Cargo

Air Cargo
System

Tracking and Managing Cargo:

- Use of RFID tags to determine cargo location in bay area

- Tracking cargo to final destination

- Suggesting bay area for cargo depending on other cargo in line

- Pricing based on weight/location and type

- Reporting capability and integration with procurement system

Finance
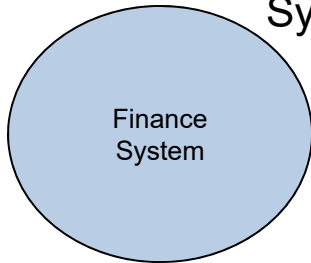
System to provide the easy/configurable view of how airline is performing.

The system should at the minimum provide for

- Automating extracting data from revenue accounting and other sources

- Allow upload of manual data such as budget and target

- Should integrate with Forecasting and Procurement system

- Provide KPI as

  - Load factor

  - By period , sector, route, origin and destination

  - By market-By point of sale/agent wise, product

- Allow user to create reports on demand

- Should integrate with DW, Audit controls

Finance System

Recall Airline performance data (Operations)

Business Processing
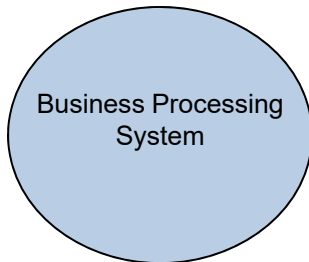
The use of system to define new business scenario and processes including

Business Processing System

- New fares in response to campaign .
- Security and baggage handling process
- Baggage tracking
- Procurement policy
  - IT
  - Material
- Easy to use reporting and data analysis
- Defining new distribution channels
- Check In process
- Catering and dining forecasting process
- The core is to use system to define process and track and improve the business process

Airport Management

Airport Management System

Compliance and integration with airport scheduling system, security measures, circulars, are taken care of.

- Integrate with airport scheduling system
- Integrate with airport security system, for checking passenger
- Departure control system integration

Crew Management

Crew Management System
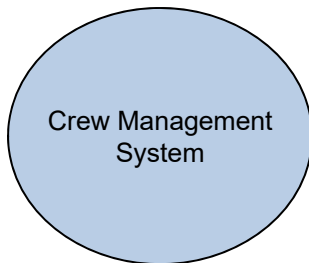
Scheduling of crew staff:

- Scheduling of cabin crew
- Compliance to labor laws
- Crew teaming alert (to alert if 2 people on same flight/team are in bad terms)
- Crew hour logging

Have a motivated and energized crew either on board/front desk or ground operations
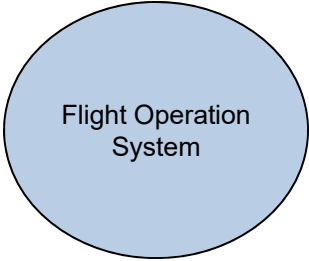
Maintenance and Engineering

Maintenance And Engineering System

Manage aircraft maintenance and engineering operations

Ensure real-time, total control of the maintenance environment

Optimize daily operations and complement managerial decisions,

Should integrate with flight operation systems and different finance and human resource management applications.

Flight Operations
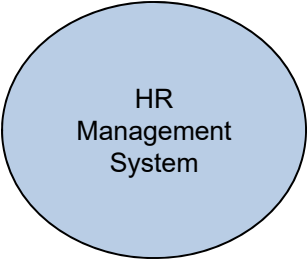
Flight Operation System

Manage flight daily operations:

- Movement management
- Graph/monitor schedules and their status
- Aircraft availability
- Delay reports
- Handle incoming SITA, GDS messages
- Update schedule

HR Management

HR Management System

Manage the most important resource: Employees

Managing employee lifecycle in organization includes

- Recruitment, interview and reference check
- Employee hiring and training
- Leave management
- Performance management
- Security checks
- Retention and motivation schemes
- Productivity improvement

ARMS® V2 - AVIATION RESOURCE MANAGEMENT SYSTEM
Scope of an Airline-wide Integrated InfoTech Solution
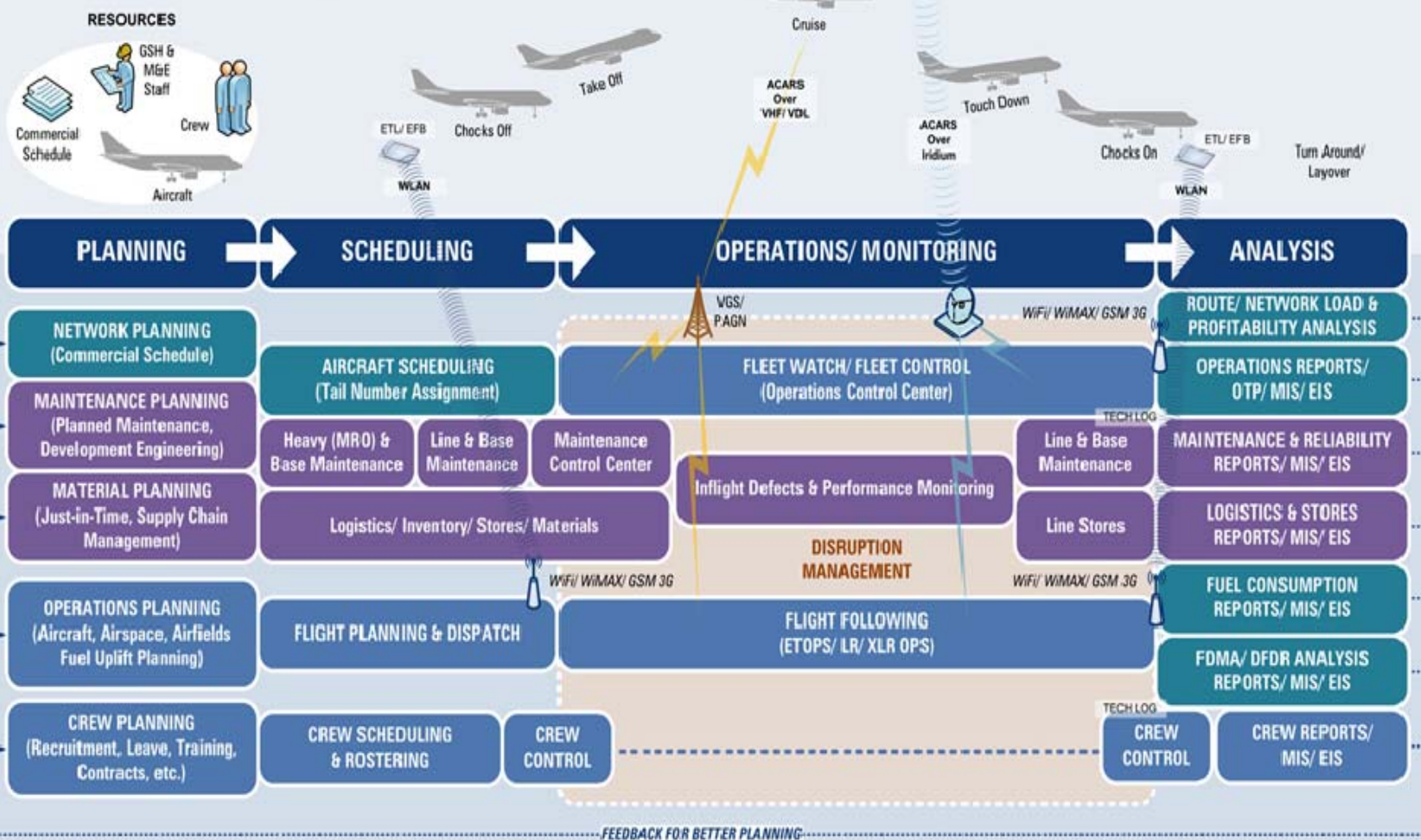
Airline Industry Value Chain

FIRM INFRASTRUCTURE	-Financial Policy - Accounting -Regulatory Compliance Legal - Community Affairs				
HUMAN RESOURCE MANAGEMENT	Flight, route and yield analyst training	Pilot Training Safety Training	Baggage Handling Training	Agent Training	In-flight Training
TECHNOLOGY DEVELOPMENT	Computer Reservation System, In-flight System Flight Scheduling System, Yield Management System			Product Development Market Research	Baggage Tracking System
PROCUREMENT	Information Technology Communications				
	•Route Selection •Passenger Service System •Yield Management System (Pricing) •Fuel •Flight Scheduling •Crew Scheduling •Facilities Planning •Aircraft Acquisition	•Ticket Counter Operations •Gate Operations •Aircraft Operations •On-board Service •Baggage Handling •Ticket Offices	•Baggage System •Flight Connections •Rental Car and Hotel Reservation System	•Promotion •Advertising •Advantage Program •Travel Agent Programs •Group Sales	•Lost Baggage Service •Complaint Follow-up
	INBOUND LOGISTICS	OPERATIONS	OUTBOUND LOGISTICS	MARKETING AND SALES	SERVICE

We need process and efficient system, to derive value from value chain

from *Competitive Advantage: Creating and Sustaining Superior Performance*, copyright 1985 by Michael E. Porter.

Challenges facing Airline Industry

1. Sustaining profitability
2. Managing customer demand of various touch point
3. Turning inflexible operative *chains* into responsive and adaptive service *networks*
4. Enabling new business models for long-term business transformation
5. Smooth real-time synchronization of information internally/externally:
    - Allow faster deployment of new strategic customer-oriented services,
    - Increase supply chain efficiency
6. Economic and competitive pressure
    - Falling yields/fares
    - Costs not falling proportionately (e.g., fuel)
    - Emergence of (ultra) low cost carrier and distribution models
    - Friction with GDS, increased GDS charges
7. Legacy IT systems:
    - Costs are high
    - Do not provide modern interfaces that customers demand and employees expect
        - Inflexible systems – hard to maintain / improve
        - Transaction oriented systems do not easily support product-based or customer-centric views
        - Systems were not built to meet current user demands – web sites, screen scrapers and more
    - Do not exploit low-cost, scalable technology or modern web-based economics
8. Need for Accurate real-time business performance management capabilities

Challenges facing Airline Industry

9.   Need for fully automated, paper-less, and process-oriented collaborative workflows that conform to the regulatory environment.

10. Empowering employees to be more productive

11. Demand for any time access to business application through secured layers

12. Maintaining/improving competitive advantage and differentiation

13. Compliance with (changing) industry standards

14. Automating customer touch points with transformational technologies, such as e-ticketing and self-service kiosks, remains the focal point for investment.

15. Decreased customer loyalty
     - Changing loyalty accrual (miles vs. $)

16. Tracking customer luggage/ cargo by use of RFID

17. Need for same day revenue reporting

18. New emerging payment modes; Changing security requirements (Internet fraudulent transaction)

19. Merger and acquisition

20. Entering the wireless/mobile arena

Using IT to Improve Operations
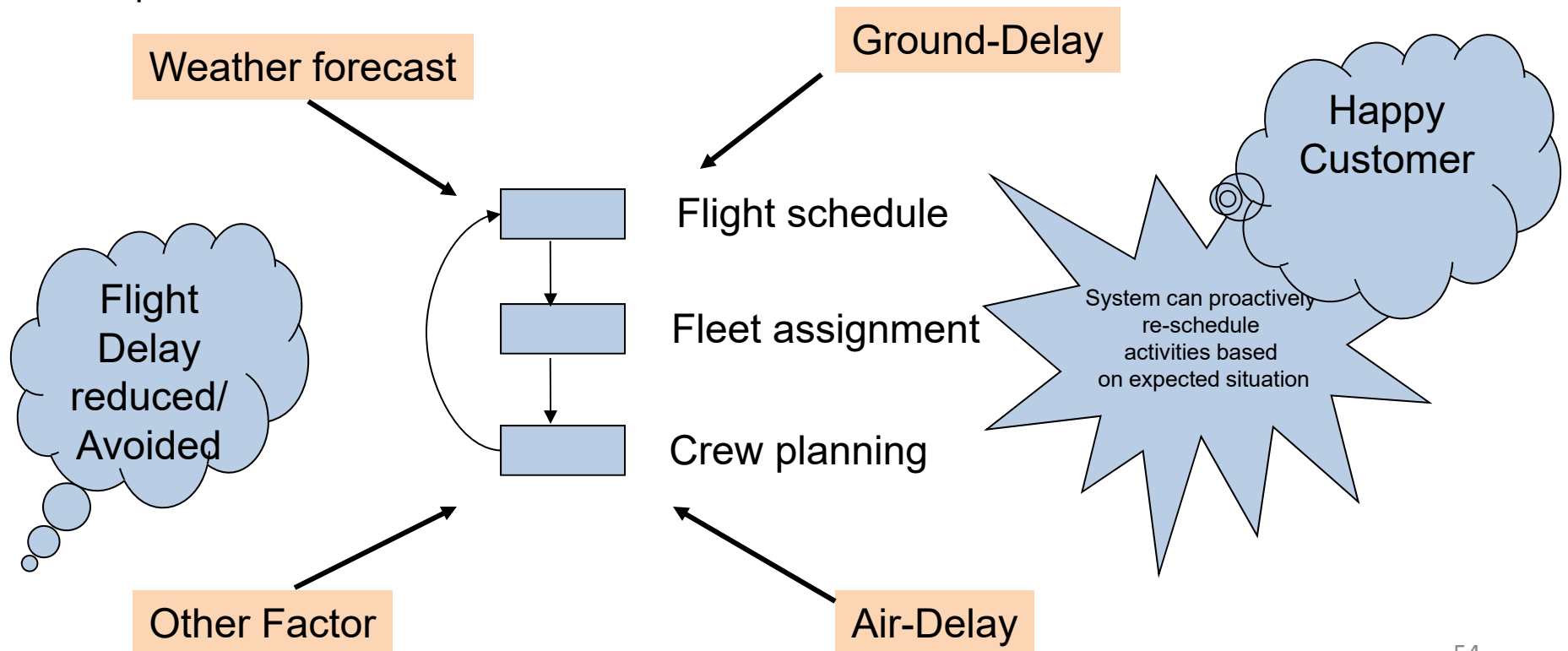
Dynamic management: Intelligent queuing

Passenger information is available to airline (amount of luggage, nationality, number of children, visa status etc.)
separate passenger into fast/medium/slow based on their demand service rate
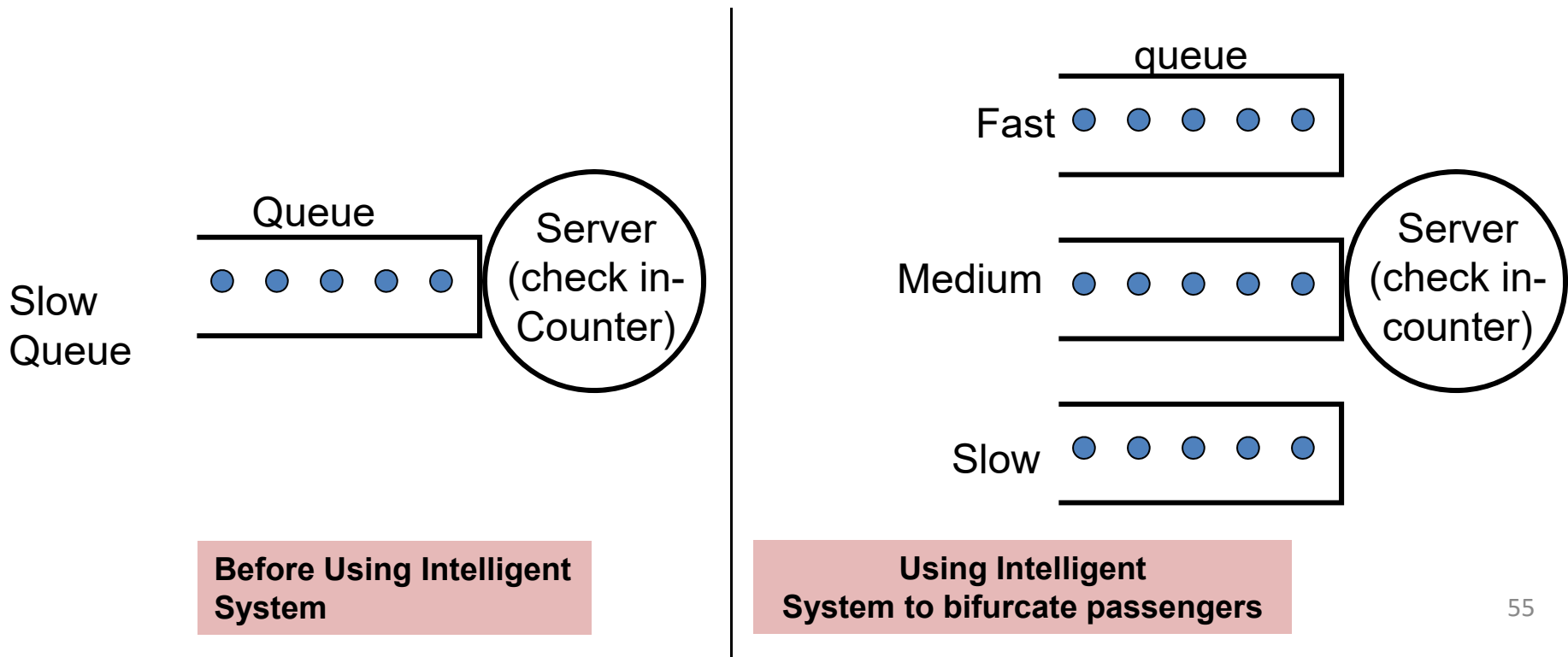
Before Using Intelligent System

Using Intelligent System to bifurcate passengers

55

Using IT to Improve Operations

Dynamic management: Intelligent queuing

Adopting ideas from other industries:

- Kroger started rolling out its QueVision technology in 2010 and now nearly all of its 2,419 stores – 97 percent – have it.
- QueVision has monitors above Kroger entrances and cash registers counting customers entering, standing in checkout lines and leaving
- "**Using data collected in the most recent 10 weeks, it predicts how many checkout registers will need to be open**."
- the calculations keep a store 30 minutes ahead of checkout traffic, taking into account customer shopping patterns. (e.g., Sunday afternoon is longer)
- **Before the system, the average wait for Kroger was four minutes. Now the average is 26 seconds.** That's for all Kroger stores at all times of the day."
- This is critical: a study shows that more than 40 %of grocery shoppers who had to wait more than four minutes would consider changing stores.

Using IT to Improve Operations

Dynamic management: Intelligent queuing

Adopting ideas from other industries:

- MyMagic+
  - A $1b experiment in crowd control, data collection, and wearable technology
  - Bracelet called MagicBand
  - Allows for bookings months in advance
  - Link to a database, serve as admission tickets, hotel keys, credit card
  - RFID – critics: this is a spychip
  - Could change the way people play and spend
  - **Forecasting and planning: MyMagic+ helps Disney determine when to add more staff at rides, what restaurant should serve, which souvenirs should be stocked, how many employees in costumes should roam around at any given time…**
  - Not using may be a disadvantage: day-trippers and others who don't plan in advance will arrive to the park to find out all good rides are booked for the day…

JetBlue: Case Study

- Gained competitive advantage where others failed
- Proper technology and management methods
- Reducing costs resulting in reduced prices
- Improving service
- Massive Automation
  - Automation of services with software
    - Combining reservation system and accounting system
    - Supports customer services and sales tracking
  - Electronic tickets
    - No paper handling or expense
    - Encourages online ticket purchases
    - Avoids travel agents
    - Significant savings in cost
  - Maintenance information system
    - Logs all airplane parts and time cycles
    - Reduces manual tracking costs
  - Flight planning software
    - Maximize seats occupied on a flight
    - Reduced planning costs

JetBlue: Case Study

- Massive Automation
  - In-house software for tracking operational data
    - Updated on a flight by flight basis
    - Accessible by airline's 2,800 employees
    - Managers are able to respond immediately to problems
- Wireless devices for employees
  - Report and respond to irregular events
  - Quick response
  - Events recorded for future analysis
  - Training records stored electronically
    - Easy to update
    - Efficient retrieval

- Away from Tradition
  - Decision to not use the hub and spoke routing method
  - Paperless Cockpits
  - Laptops for Pilots
  - Harnessing IT to maintain a strategic advantage

TYPES OF IS
OPERATIONS, MANAGEMENT, OFFICE

Operation Support Systems (OSS)

- Objective: improving operational efficiency:
    - Processing business transactions, controlling industrial processes, supporting enterprise communications and collaborations, updating of corporate database
- OSS can be divided into three categories:
    - Transaction Processing Systems (TPS)
    - Process Control Systems (PCS)
    - Enterprise Collaboration Systems (ECS)

Transaction Processing Systems (TPS)

- A system (collection of people, procedures, software, databases, and devices) used to record completed business transactions.
- Goals:
  - automation of basic business operations
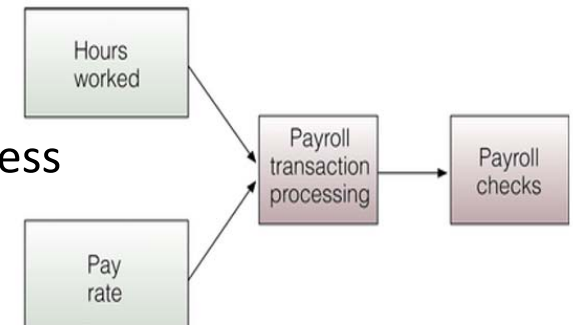 - Reduction of workload and increase of efficiency

- Lowest/operational level
- Manipulates data from business transactions
- Processes and stores large data amounts
- TPS processes:
  - Capturing data from business activity
  - Processing files using software
  - Generating information reports
 - Processing of queries from different parts of business

Process Control Systems (PCS)

- Computer-controlled ongoing processes
- Computer makes automatic decisions to adjust physical production/service process
  - Artificial Intelligence

Enterprise Collaboration Systems (ECS)

- Support of collaboration for communicating ideas, sharing resources, coordinating co-operative work efforts
- Goal: use of IT to improve productivity and creativity in enterprises
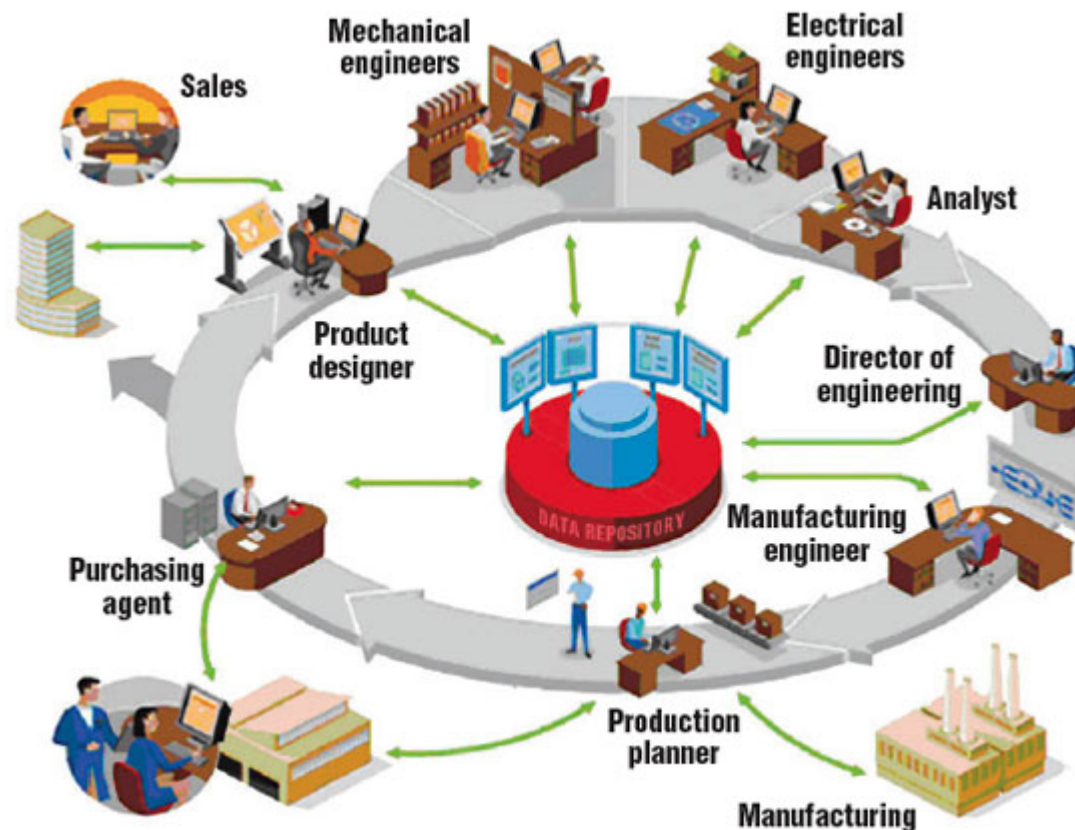
Management Support Systems (MSS)

Divided into three categories:

- Management Information Systems (MIS)
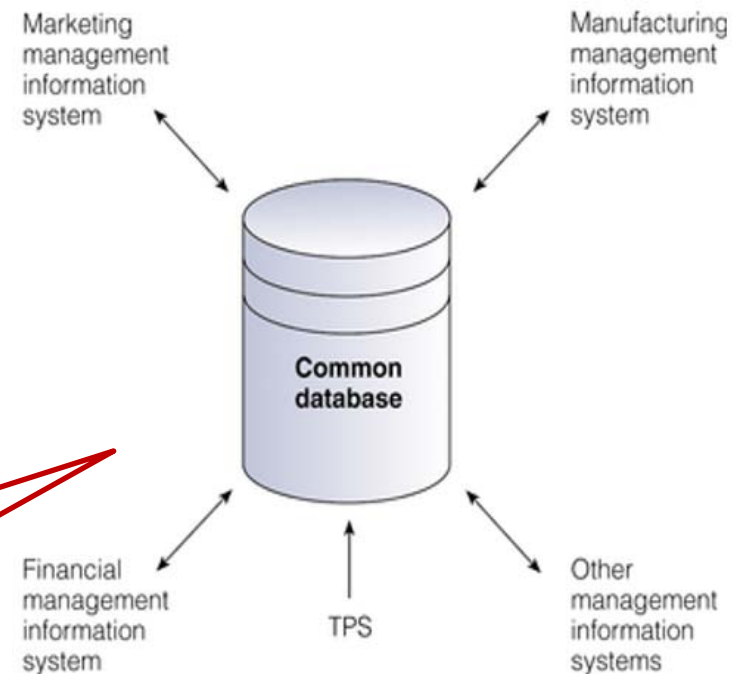- Decision Support Systems (DSS)
- Executive Information Systems (EIS)

Management Information Systems (MIS)

- Routine information for routine decisions
- Operational efficiency
- Use transaction data from TPS as main input
- Databases integrate MIS in different functional areas
- Mid-level: tactical decisions
- Top-level: strategic decisions

- MIS outputs:
  - Scheduled reports
  - Demand reports
  - Exception reports

Functional MIS draw data from organization's TPS

Marketing management information system

Manufacturing management information system

Common database

Financial management information system

TPS

Other management information systems

Limitations of MIS

Quality of output depends on quality of input

MIS takes into account mainly quantitative factors

MIS not substitute for effective management

Decision Support Systems (DSS)

A system used to support problem-specific decision making.

- Interactive support for non-routine decisions or problems
- End-users are more involved in creating a DSS than an MIS

DSS vs. traditional MIS

Dimensions	DSS	Traditional MIS
Philosophy	Providing integrated tools, data, models, and language to end users	Providing structured information to end users
Orientation	External orientation	Internal orientation
Flexibility	Highly flexible	Relatively flexible
Analytical capability	More analytical capacity	Little analytical flexibility
System analysis	Emphasis on tools to be used in decision process	Emphasis on information requirement analysis
System design	Interactive process	System development based on static information requirements

Executive Information System (EIS)

- Strategic/top level

- Generalized computing and communications environment

- Users can utilize EIS without knowing query languages, advanced statistics, computing skills

- Accesses internal and external data

EIS vs. traditional information systems

Dimensions of difference	EIS	Traditional information systems
Level of management	Top executives	Lower management levels
Nature of information process	Specific problems and aggregate reports	Status reporting
Nature of information provided	Online tools and analysis	Online status reporting
Information sources	More external, less internal	Internal
Drill down facility to go through details at successive levels	Available	Unavailable
Informational format	Text with graphics	Tabular
Nature of interface	User-friendly	Computer-operator generated

Office Automation Systems (OAS)

- Can be divided into:
  - Text Processing Systems (TPS)
    - Removes the need for paper
  - Electronic Document Management Systems (EDMS)
  - Electronic Message Communication Systems (EMCS)
    - Emails, etc.
  - Teleconferencing & Videoconferencing Systems (TVS)