NETWORK

DESIGN & ANALYSIS

PTIIK - 2012

Networking … at a glance

Discrete Mathematics

Advance Networking

Operating Systems

Network Analysis

Computer Networks

Multimedia Networking

Network Security

Network Programming

Distributed Systems

Server and System Administrations

Course Design

- Classes
  - 2 Credits
- Exercises (assistant required)
  - 1 Credits
- Evaluation
  - 2 Structured Task (20 %)
  - 1 Midterm Test (40 %)
  - 1 Final Test (40 %)

Reference

- Mc. Cabe, D. James : “Network Analysis, Architecture and Design: Third Edition“ , Morgan Kaufmann, 2007
- Gebali, Fayez : “Analysis of Computer and Communication Networks“ , Springer, 2008

Course Content

01 Introduction

1.1 Overview

1.1.1 Process Components

1.1.2 Tactical and Strategic Significance

1.1.3 Importance of Network Analysis

1.1.4 Model for Networking Analysis, Architecture and Design

1.2 A Systems Methodology

1.3 System Description

1.4 Service Description

Course Content

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1.7

1.1 Overview

- ***Network analysis***, ***architecture***, *and* ***design*** *are* ***processes used to produce designs*** *that are logical, reproducible, and defensible.*
- **Network analysis** entails learning *what users, their applications, and devices need from the network*.

1.1 Overview

- **Network analysis** also *defines, determines, and describes relationships among users, applications, devices, and networks*.
- The ***purpose*** of **network analysis** is twofold:
  - first, to listen to users and understand their needs; and
  - second, to understand the system.

1.1 Overview

- **Network architecture** *uses the information from the analysis process to develop a conceptual, high-level, end-to-end structure for the network*.
- **Network architecture** process
  - determines sets of technology and topology choices;
  - the classes of equipment needed; and
  - the relationships among network

1.1 Overview

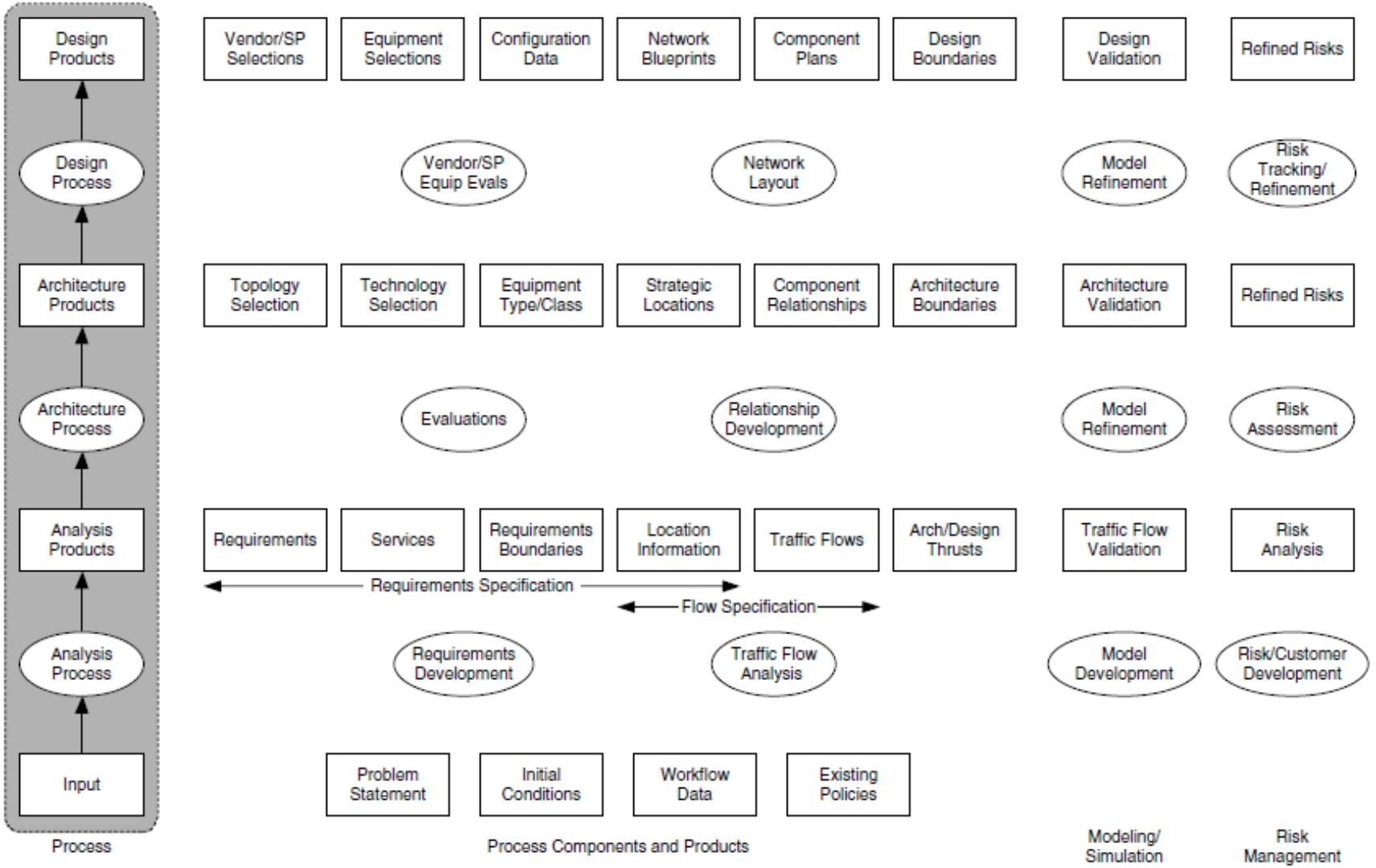
- **Network design** *provides physical detail to the architecture.*
- Physical detail includes:
  - blueprints and drawings of the network;
  - selections of vendors and service providers; and
  - selections of equipment
- Network design is also about applying the trade-offs, dependencies, and constraints developed as part of the network architecture.

1.1 Overview

1.1.1 Process Components

- Each of network design, architecture and analysis processes describe specific actions or results.
- Set of process components represents a complete implementation of network analysis, architecture, and design.

1.1 Overview

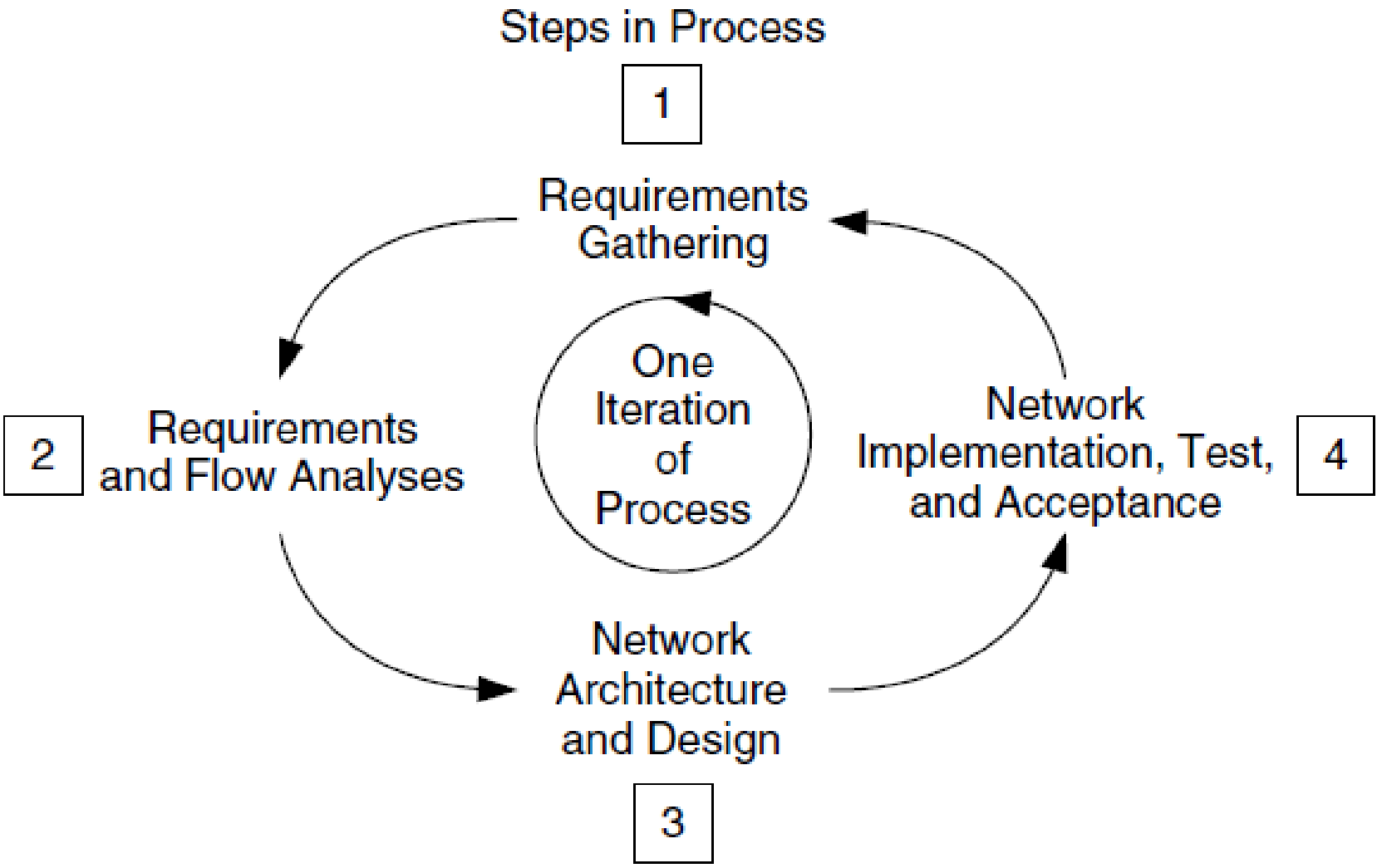

Design Products
Design Process
Architecture Products
Architecture Process
Analysis Products
Analysis Process
Input
Process
Vendor/SP Selections
Equipment Selections
Configuration Data
Network Blueprints
Component Plans
Design Boundaries
Design Validation
Refined Risks
Vendor/SP Equip Evals
Network Layout
Model Refinement
Risk Tracking/ Refinement
Topology Selection
Technology Selection
Equipment Type/Class
Strategic Locations
Component Relationships
Architecture Boundaries
Architecture Validation
Refined Risks
Evaluations
Relationship Development
Model Refinement
Risk Assessment
Requirements
Services
Requirements Boundaries
Location Information
Traffic Flows
Arch/Design Thrusts
Traffic Flow Validation
Risk Analysis
Requirements Specification
Flow Specification
Requirements Development
Traffic Flow Analysis
Model Development
Risk/Customer Development
Problem Statement
Initial Conditions
Workflow Data
Existing Policies
Process Components and Products
Modeling/ Simulation
Risk Management

1.1 Overview

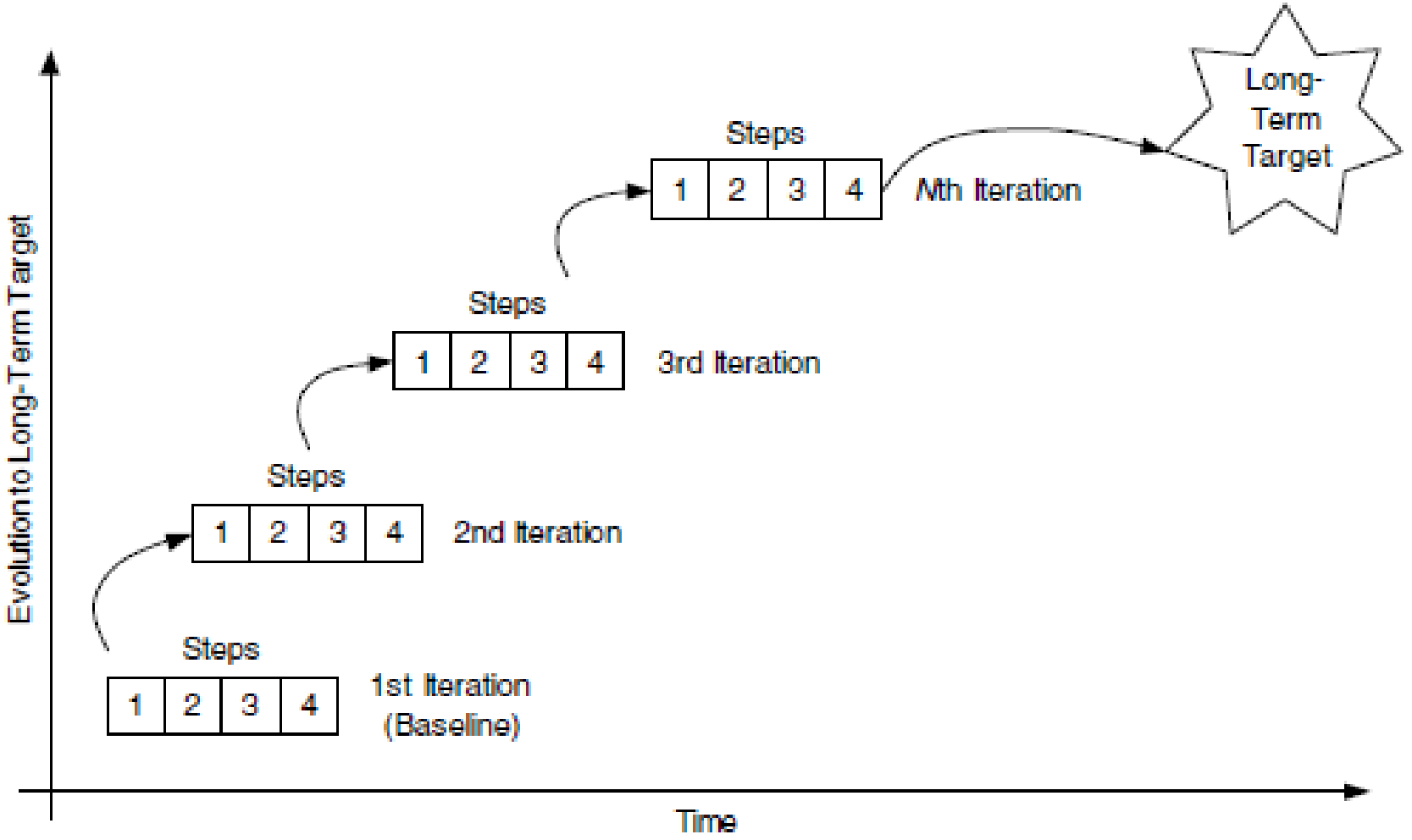
1.1.2 Tactical and Strategic Significance

- Network analysis, architecture, and design are part of the engineering process that form the basis of networking projects.
- Such projects have immediate, tactical (near-term), and strategic (long-term) significance, and networking projects should consider all of these areas.
- These plans are intended to be iterative and should be regularly reviewed.

1.1 Overview


Steps in Process
1
Requirements Gathering
2
Requirements and Flow Analyses
3
Network Architecture and Design
4
Network Implementation, Test, and Acceptance
One Iteration of Process

1.1 Overview

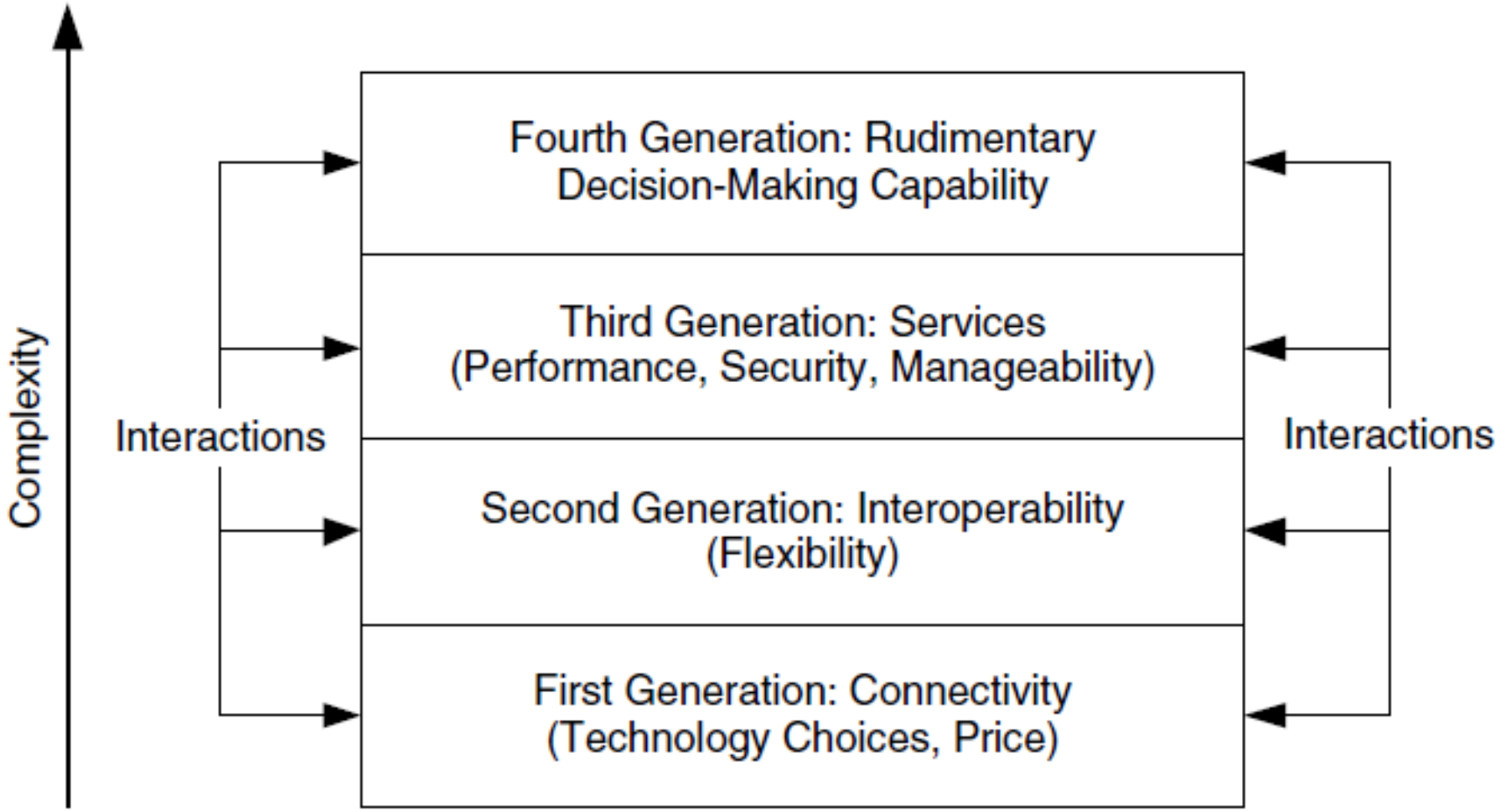

Evolution to Long-Term Target
Steps
1 2 3 4
1st Iteration
(Baseline)
Steps
1 2 3 4
2nd Iteration
Steps
1 2 3 4
3rd Iteration
Steps
1 2 3 4
Nth Iteration
Long-
Term
Target
Time

1.1 Overview

1.1.3 Importance of Network Analysis

- In general, networks and the systems they support are becoming increasingly complex.
- Network analysis is important in that it helps us understand the *complexity* and nuances of each network and the systems they support.
- Also, analysis helps us understand how technologies influence networks, users, applications, and devices (and vice versa).

1.1 Overview


Complexity
Interactions
Fourth Generation: Rudimentary Decision-Making Capability
Third Generation: Services (Performance, Security, Manageability)
Second Generation: Interoperability (Flexibility)
First Generation: Connectivity (Technology Choices, Price)
Interactions

1.1 Overview

1.1.4 Model for Network Analysis, Architecture and Design

- Network analysis, architecture, and design are similar to other engineering processes in that they address the following areas:
  - Defining the problems to be addressed
  - Establishing and managing customer expectations
  - Monitoring the existing network, system, and its environment
  - Analyzing data
  - Developing a set of options to solve problems

1.1 Overview

- Evaluating and optimizing options based on various trade-offs
- Selecting one or more options
- Planning the implementation

1.2 System Methodology

- **Systems methodology** means viewing the network that you are architecting and designing, along with a subset of its environment (everything that the network interacts with or impacts), as a system.
- The fundamental concepts of the systems methodology is that network architectures and designs take into account the services that each network will provide and support.

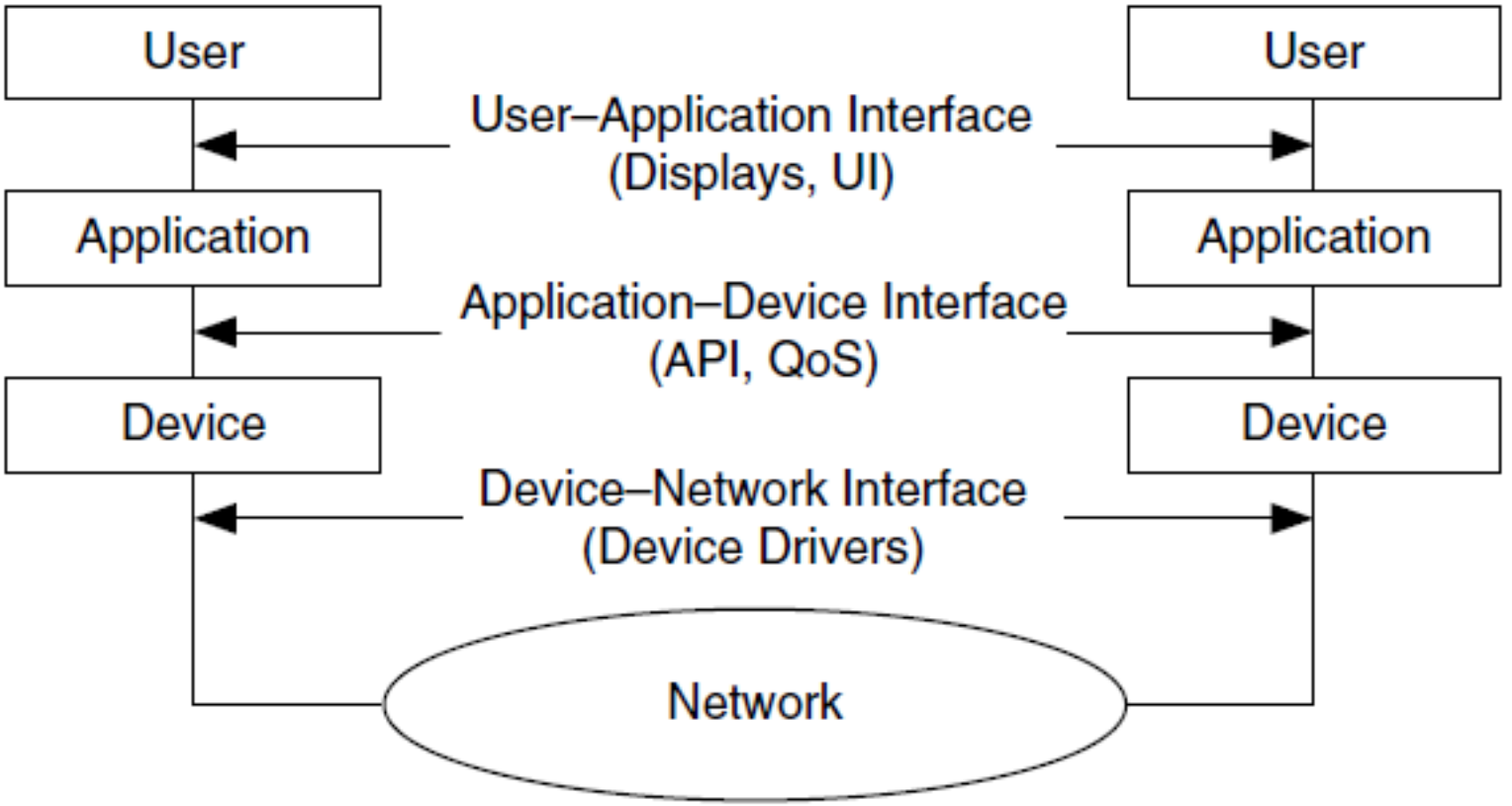
1.2 System Methodology

- This reflects the growing sophistication of networks, which have evolved from providing basic connectivity and packet-forwarding performance to being a platform for various services.
- System methodology helps in determining, defining, and describing the important characteristics and capabilities of your network.

1.3 System Description

- A *system* is a set of components that work together to support or provide connectivity, communications, and services to users of the system.
- Generically speaking, components of the system include users, applications, devices, and networks.

1.3 System Description



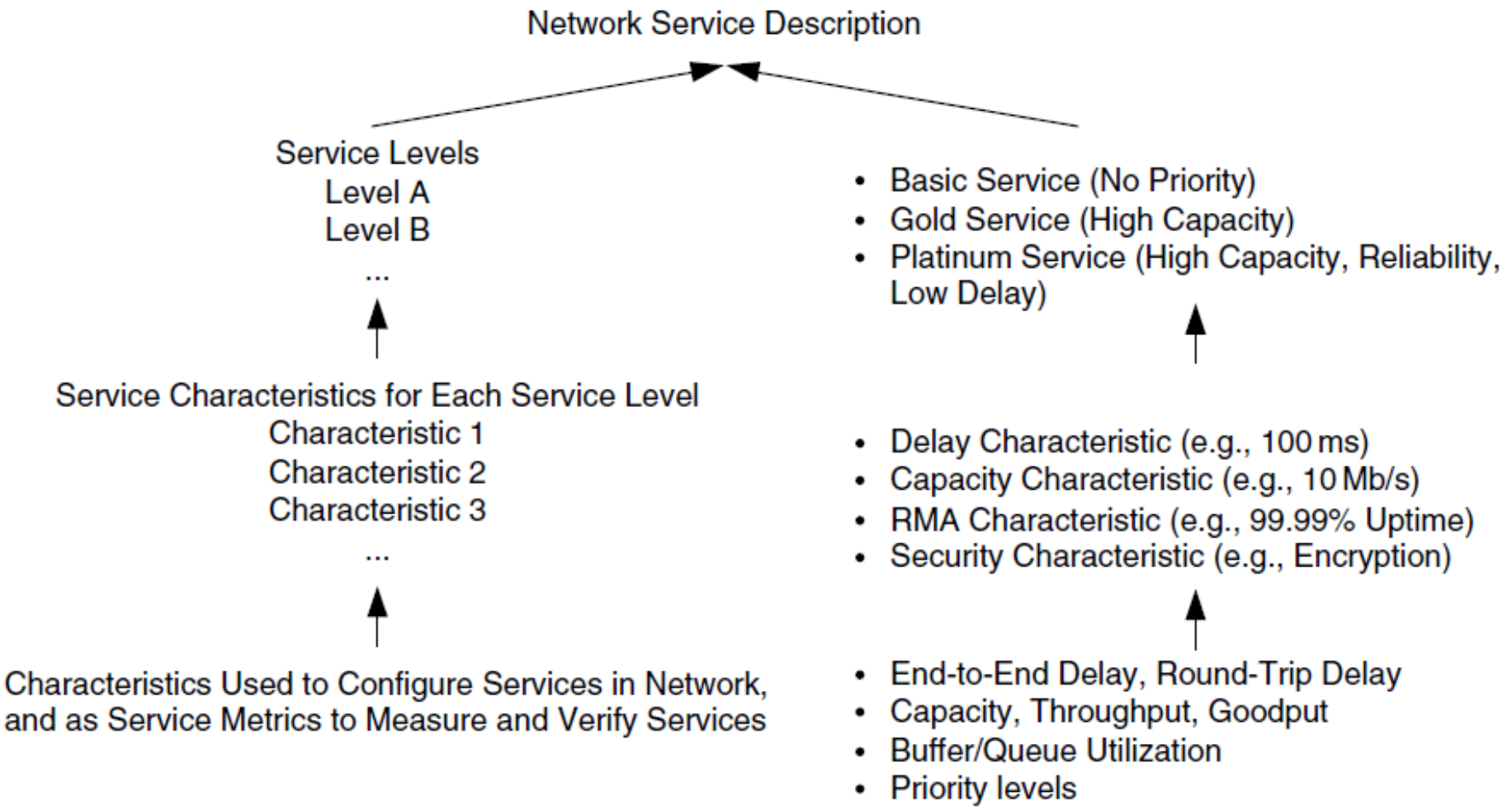
1.4 Service Description

- *Network services*, or services, are defined here as levels of performance and function in the network.
- Two perspectives of network services:
  - as services being offered by the network to the rest of the system, or
  - as sets of requirements from the network that are expected by the users, applications, or devices.

1.4 Service Description

- Network services in most of today's networks are based on best-effort (unpredictable and unreliable) delivery.

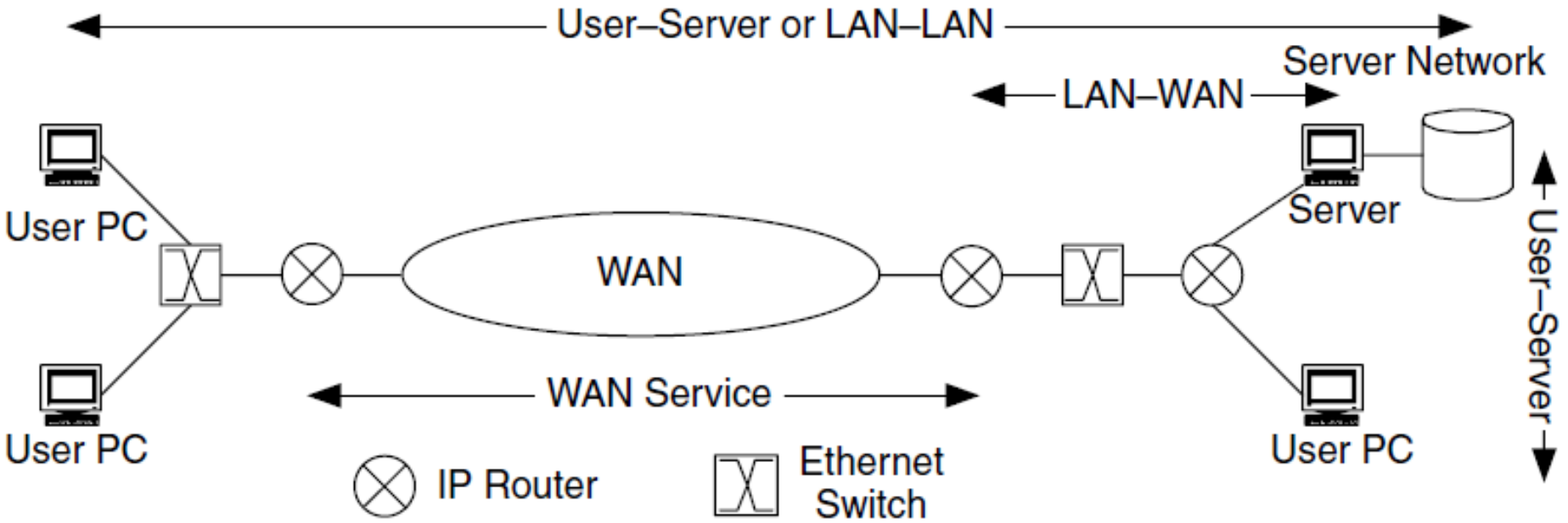
1.4 Service Description



1.5 Services Characteristics

- One of the goals of network analysis is to be able to characterize services.
- For services to be useful and effective, they must be described and provisioned end-to-end at all network components between well-defined demarcation points.
- The demarcation points determine where end-to-end is in the network. Determining these demarcation points is an important part of describing a service.

1.5 Services Characteristics

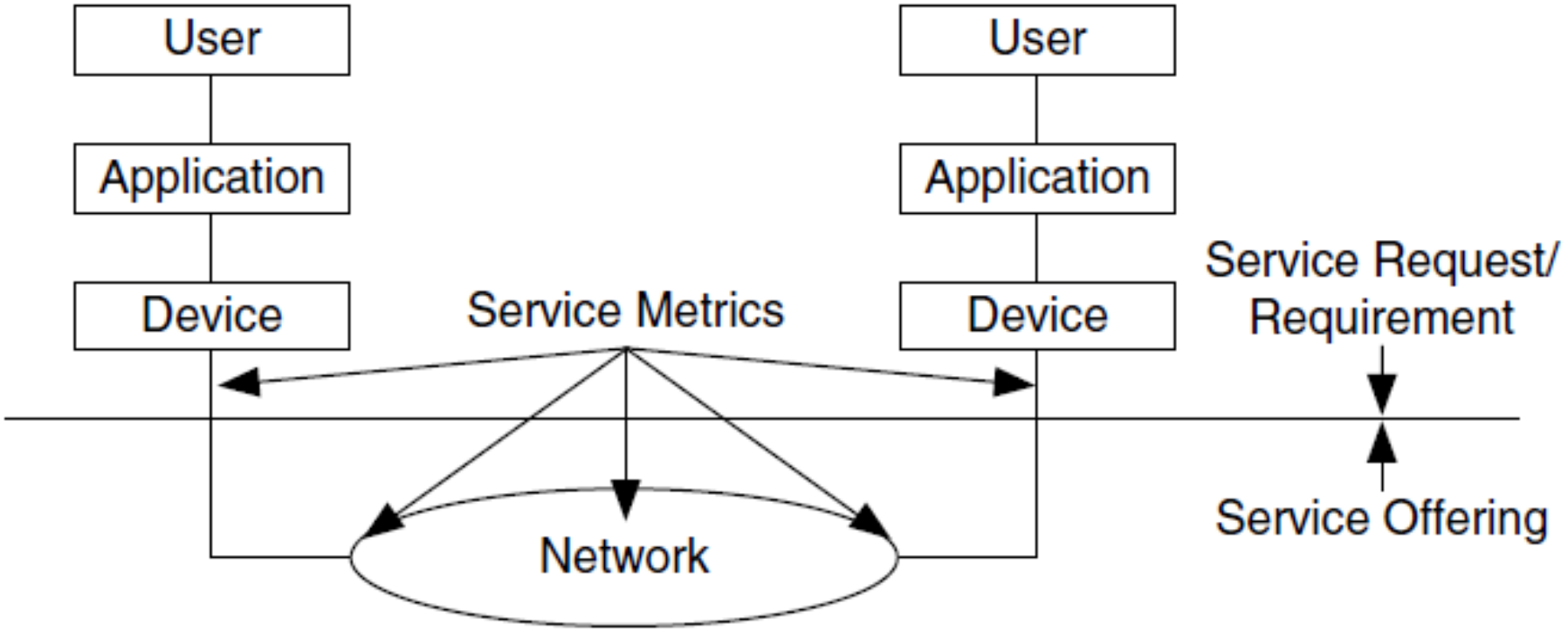


1.5 Services Characteristics

1.5.1 Service Levels

- Service characteristics can be grouped together to form one or more *service levels* for the network.
- There are many ways to describe service levels, including:
  - committed information rates (CIRs);
  - levels of capacity;
  - classes of service (CoSs);
  - delay and capacity characteristics;
  - types of service (ToSs);
  - qualities of service (QoSs);

1.5 Services Characteristics

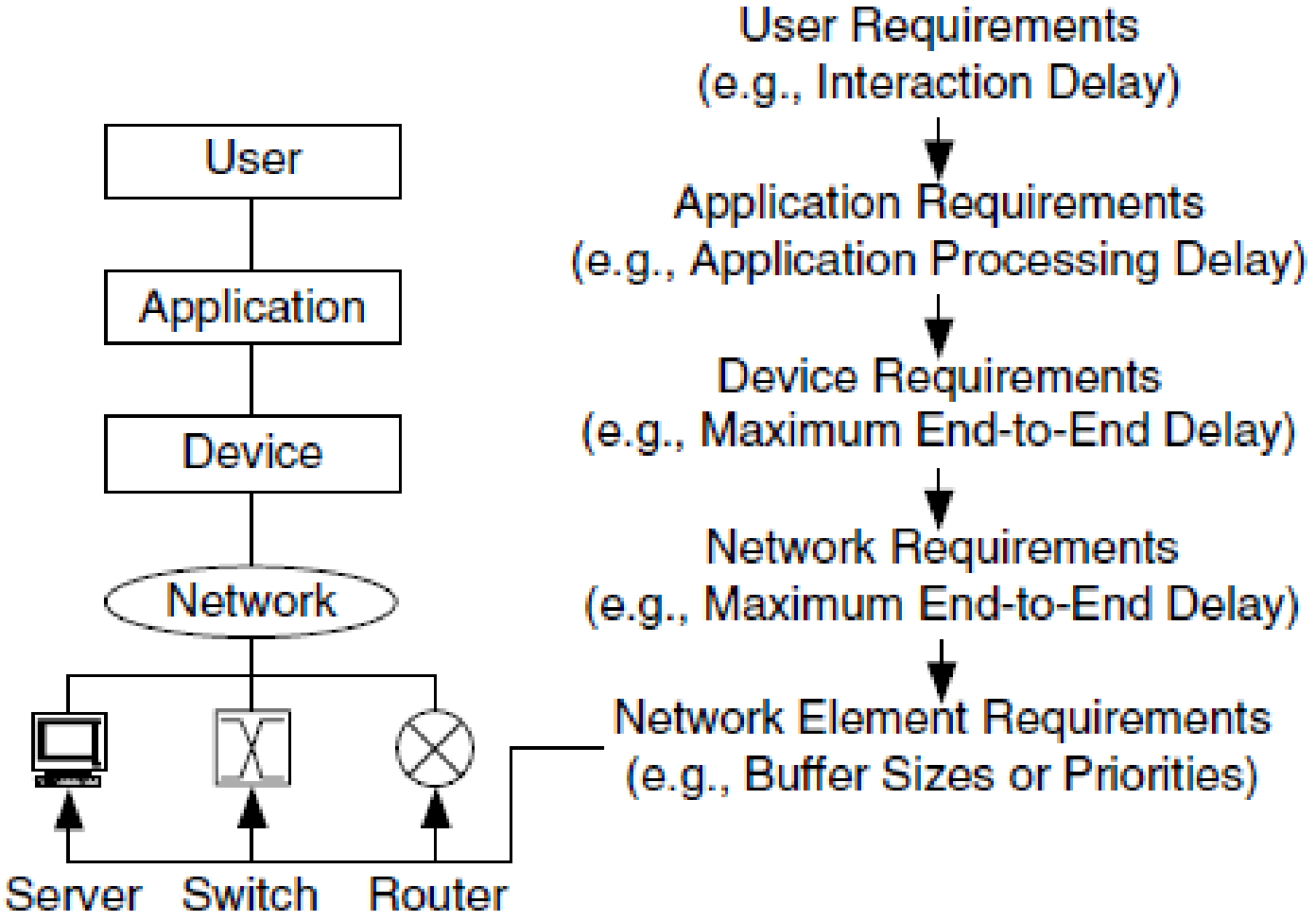


1.5 Services Characteristics

1.5.2 System Components and Network Services

- Network services are derived from requirements at each of the components in the system.
- Defining network services and service metrics helps keep the system functioning and can provide extra value or convenience to users and their applications.
- Recall that network services are sets of performance and function, so requirements may also include functions of one of the components.

1.5 Services Characteristics



1.5 Services Characteristics

1.5.3 Service Requests & Requirements

- Service requests and requirements are, in part, distinguished by the degree of predictability needed from the service by the user, application, or device making the request.
- Based on their predictability, service requests are categorized as best effort, predictable, or guaranteed.
  - *Best-effort service* means that there is no control over how the network will satisfy the service request—that there are no guarantees associated with this service.

1.5 Services Characteristics

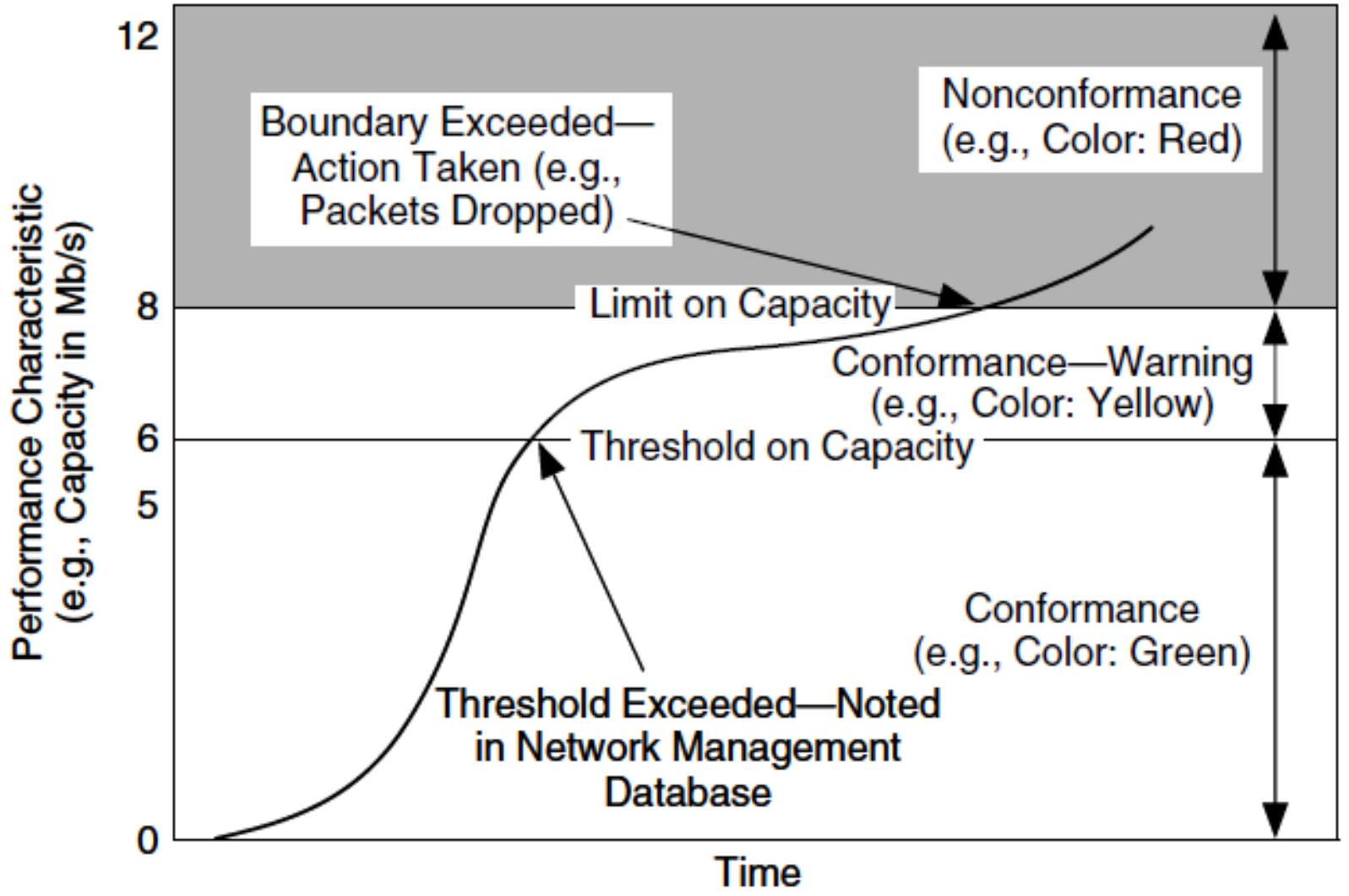
- *Guaranteed service* is the opposite of best-effort service. It must be predictable and reliable to such a degree that, when service is not available, the system is held accountable.
- *predictable services*, is placed in between best-effort and guaranteed. It requires some degree of predictability (more than best effort) yet do not require the accountability of a guaranteed service.

- Note that there are times when a service can be best effort, predictable, or guaranteed, depending on how it is interpreted.

1.5 Services Characteristics

- For service performance requirements and characteristics to be useful, they must be configurable, measurable, and verifiable within the system.
- Therefore, performance requirements and characteristics were described in terms of *service metrics*, which are intended to be:
  - ***configurable***, set a value for threshold and limit ; and,
  - ***measurable***, by monitoring current state value.

1.5 Services Characteristics



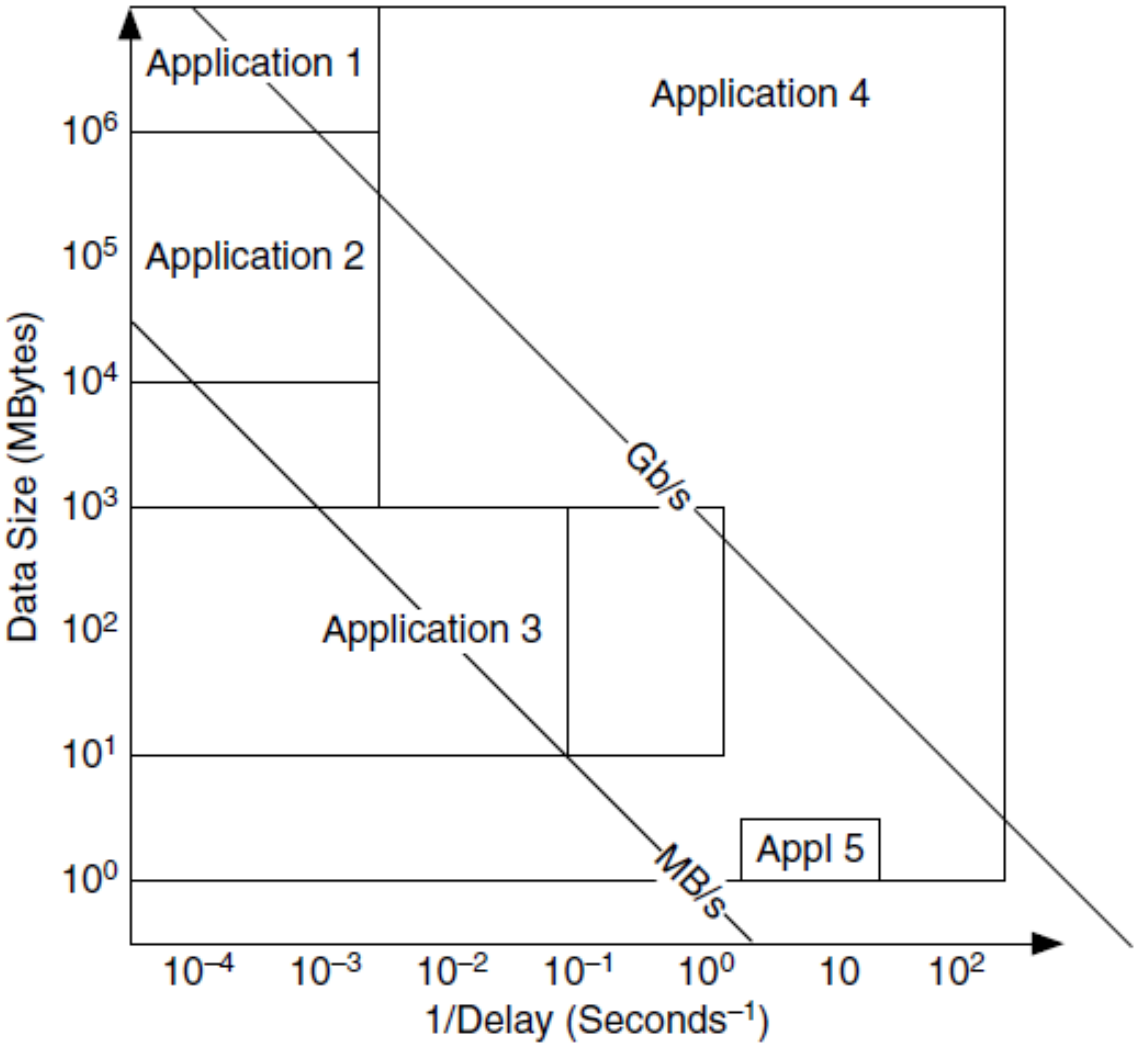
1.6 Performance Characteristics

- Services may include one or more of the performance characteristics:
  - capacity, is used as a label for the class of characteristics that involves moving information from place to place, including bandwidth, throughput, and so forth.
  - delay, is a label for the class of characteristics that includes end-to-end delay, round-trip delay, and delay variation.
  - RMA, is a label for the class of characteristics that includes reliability, maintainability, and availability.

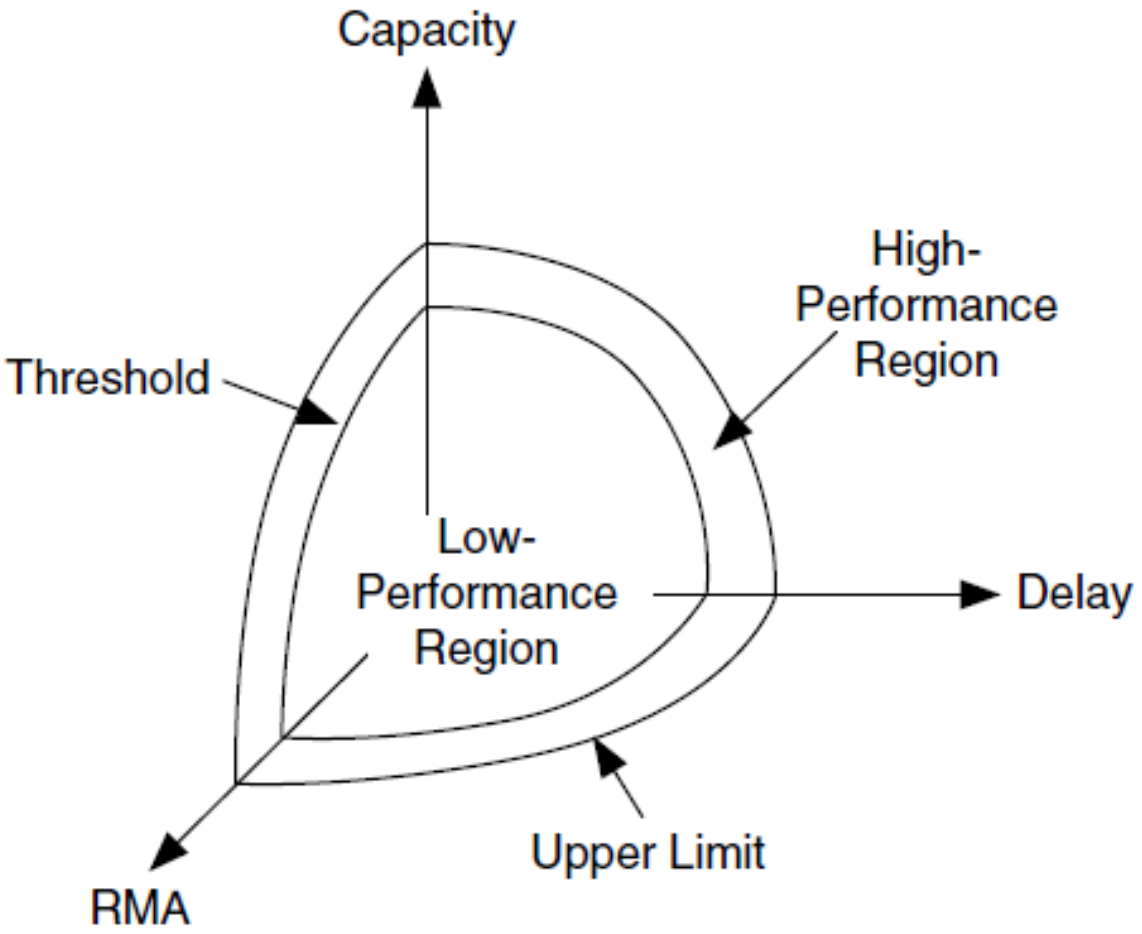
1.6 Performance Characteristics

- Performance requirements can be combined to describe a performance range for the system.
- A *performance envelope* is a combination of two or more performance requirements, with thresholds and upper and/or lower limits for each.

1.6 Performance Characteristics



1.6 Performance Characteristics



1.7 Network Supportability

- Good network architects/designers take into account the major factors that affect operability and supportability as they make their decisions.
- The post-implementation phases of a network's life cycle can be broken into three elements:
  - operations,
  - maintenance, and
  - human knowledge.

1.7 Network Supportability

- Failure to consider supportability in the analysis, architecture, and design processes has a number of serious consequences.
  - Customer will reject the network project or refuse to pay for it.
  - Customer will have inadequate resources, experience unacceptable performance.
  - Other customers will be highly dissatisfied with their network.

1.7 Network Supportability

- Key characteristics of a network architecture and design that affect the post-implementation costs include:
  - Network and system reliability
  - Network and system maintainability
  - Training of the operators to stay within operational constraints
  - Quality of the staff required to perform maintenance actions

1.7 Network Supportability

- Two major tasks must be accomplished to ensure supportability:
  - Conformance to the network architecture and design must be validated and nonconformance corrected or (at least) documented to ensure that performance is adequate and that maintenance can be performed.
  - Operations and maintenance personnel must understand and be trained in the technologies that are being deployed